



**EIILM UNIVERSITY**  
S I K K I M

## **HUMAN BIOLOGY AND MEDICAL TERMINOLOGY**

## **SYLLABUS**

### **Human anatomy and physiology**

Human body, Muscles in the Human Body, Importance of Human Body.

### **Digestive system**

Why Digestion? Study of the digestive system, How Does the Digestive System Work? Role of Absorption in the Digestive System, Functions of the Digestive System?

### **Respiratory system**

Respiratory system, Functions, Breathing and Lung Mechanics, The Pathway of Air, Inspiration, Expiration, Lung Compliance, Control of respiration, Respiratory System: Upper and Lower Respiratory Tracts, Homeostasis and Gas Exchange, External Respiration, The Passage Way From the Trachea to the Bronchioles, Cellular Respiration, Lung Capacity, Stimulation of Breathing, Regulation of Blood pH, Problems Associated With the Respiratory Tract and Breathing, Lower Respiratory Tract Disorders, Restrictive Pulmonary Disorders, Respiratory Distress Syndrome, Sleep Apnea, Nutrition for COPD (Chronic Obstructive Pulmonary Disease) Patients, Case Study.

### **Central nervous system**

The Human Nervous System, The Central Nervous System (CNS), Brain Divisions, Somatic Nervous System, The Autonomic Nervous System, Causes of Brain Damage, Evolution of Human Intelligence, Ability to Learn, Intelligence, Creativity, The Falling Asleep Process, Sleep Troubles, Human Perception – Neurology.

### **Musculoskeletal system**

Human musculoskeletal system, Subsystems.

### **Common roots**

Human anatomy, The Common Integument

### **General healthcare**

Healthcare, Health care delivery, Primary health care, Secondary Care, Health system, Health care industry, Health care research, Health care financing, Health care administration and regulation, Health information technology.

### **Routes of medication and laboratory**

Routes of Administration Requiring Sterile Formulations, Injection Dependent Routes, Injection Independent Routes, Ophthalmics, Guidelines, Equipment, and Supplies for Sterile Compounding.

**Illness Direct and indirect causes**

Illness, Root Causes of Illness, Terminal Illness? Catastrophic Illness? Acute Illness? Psychosomatic Illnesses?  
Different Types of Mental Illness?

**Classification and description of disease**

Disease, Terminology, Types, Stages, Scope, Causes and transmissibility, Burdens of disease, Prevention, Treatments, Epidemiology, Social and cultural responses, Language of disease, Classification of Disease.

**Infection control**

Infection control, Infection control in healthcare facilities, Vaccination of health care workers, Post exposure prophylaxis, Surveillance for emerging infections, Isolation, Outbreak investigation, Training in infection control and health care epidemiology.

**Carrier and mode of transmission of infection**

Transmission (medicine), Horizontal and vertical, Transmission, symptoms and survival, Routes of transmission.

**Hospital services intensive care unit**

Coronary care unit

**Paraplegic and malignant disease treatment**

Paraplegia, Malignant, Benign vs Malignant, Neuroleptic malignant syndrome

**Hospital welfare services**

Hospital, Types, Hospital welfare services

**Suggested Reading:**

1. Human Biology and Medical Terminology Applications by George A. Wistreich
2. Anatomy, Physiology, and Disease: An Interactive Journey for Health Professions by Bruce J. Colbert, Jeff J. Ankney and Karen Lee
3. Human Reproduction: Some Common Genetic Terms by Doreen King and Michael William King
4. B D Chaurasia's Human Anatomy : Regional and Applied Dissection and Clinical Head Neck and Brain (Volume - 3) 5 Edition
5. Hand book of Human anatomy and physiology by Henry Hartshorne
6. Digestive System (Quickstudy) by Inc. BarCharts

## Human anatomy and physiology

### Lesson 1 – 1 Basic functions and importance of Human body system

#### Learning Objectives

- To define the Human body.
- To explain the basic form and development.
- To explain the functions of Human Body Systems.
- To describe the importance of Human Body.

#### 1.1 Human body

**Human body**, the physical substance of the human organism, composed of living cells and extracellular materials and organized into tissues, organs, and systems.

Human beings are, of course, animals—more particularly, members of the order Mammalia in the subphylum Vertebrata of the phylum Chordata. Like all chordates, the human animal has a bilaterally symmetrical body that is characterized at some point during its development by a dorsal supporting rod (the notochord), gill slits in the region of the pharynx, and a hollow dorsal nerve cord. Of these features, the first two are present only during the embryonic stage in the human; the notochord is replaced by the vertebral column, and the pharyngeal gill slits are lost completely. The dorsal nerve cord is the spinal cord in human beings; it remains throughout life.

Characteristic of the vertebrate form, the human body has an internal skeleton that includes a backbone of vertebrae. Typical of mammalian structure, the human body shows such characteristics as hair, mammary glands, and highly developed sense organs.

Beyond these similarities, however, lie some profound differences. Among the mammals, only human beings have a predominantly two-legged (bipedal) posture, a fact that has greatly modified the general mammalian body plan. (Even the kangaroo, which hops on two legs when moving rapidly, walks on four legs and uses its tail as a “third leg” when standing.) Moreover, the human brain, particularly that part called the neocortex, is far and away the most highly developed in the animal kingdom. As intelligent as are many other mammals—such as chimpanzees and dolphins—none have achieved the intellectual status of the human species.

##### 1.1.1 Chemical composition of the body

Chemically, the human body consists mainly of water and of organic compounds—i.e., lipids, proteins, carbohydrates, and nucleic acids. Water is found in the extracellular fluids of the body (the blood plasma,

the lymph, and the interstitial fluid) and within the cells themselves. It serves as a solvent without which the chemistry of life could not take place. The human body is about 60 percent water by weight.

Lipids—chiefly fats, phospholipids, and steroids—are major structural components of the human body. Fats provide an energy reserve for the body, and fat pads also serve as insulation and shock absorbers. Phospholipids and the steroid compound cholesterol are major components of the membrane that surrounds each cell.

Proteins also serve as a major structural component of the body. Like lipids, proteins are an important constituent of the cell membrane. In addition, such extracellular materials as hair and nails are composed of protein. So also is collagen, the fibrous, elastic material that makes up much of the body's skin, bones, tendons, and ligaments. Proteins also perform numerous functional roles in the body. Particularly important are those cellular proteins called enzymes, which catalyze the chemical reactions necessary for life.

Carbohydrates are present in the human body largely as fuels, either as simple sugars circulating through the bloodstream or as glycogen, a storage compound found in the liver and the muscles. Small amounts of carbohydrates also occur in cell membranes, but, in contrast to plants and many invertebrate animals, humans have little structural carbohydrate in their bodies.

Nucleic acids make up the genetic materials of the body. Deoxyribonucleic acid (DNA) carries the body's hereditary master code, the instructions according to which each cell operates. It is DNA, passed from parents to offspring, that dictates the inherited characteristics of each human being. Ribonucleic acid (RNA), of which there are several types, helps carry out the instructions encoded in the DNA.

Along with water and organic compounds, the body's constituents include various inorganic minerals. Chief among these are calcium, phosphorus, sodium, magnesium, and iron. Calcium and phosphorus, combined as calcium-phosphate crystals, form a large part of the body's bones. Calcium is also present as ions in the blood and interstitial fluid, as is sodium. Ions of phosphorus, potassium, and magnesium, on the other hand, are abundant within the intercellular fluid. All of these ions play vital roles in the body's metabolic processes. Iron is present mainly as part of hemoglobin, the oxygen-carrying pigment of the red blood cells. Other mineral constituents of the body, found in minute but necessary concentrations, include cobalt, copper, iodine, manganese, and zinc.

### **1.1.2 Organization of the body**

The cell is the basic living unit of the human body—indeed, of all organisms. The human body consists of more than 75 trillion cells, each capable of growth, metabolism, response to stimuli, and, with some exceptions, reproduction. Although there are some 200 different types of cells in the body, these can be grouped into four basic classes. These four basic cell types, together with their extracellular materials, form the fundamental tissues of the human body: (1) epithelial tissues, which cover the body's surface and line the internal organs, body cavities, and passageways; (2) muscle tissues, which are capable of contraction and form the body's musculature; (3) nerve tissues, which conduct electrical impulses and make up the nervous system; and (4) connective tissues, which are composed of widely spaced cells and large amounts of intercellular matrix and which bind together various body structures. (Bone and blood are considered specialized connective tissues, in which the intercellular matrix is, respectively, hard and liquid.)

The next level of organization in the body is that of the organ. An organ is a group of tissues that constitutes a distinct structural and functional unit. Thus, the heart is an organ composed of all four tissues, whose function is to pump blood throughout the body. Of course, the heart does not function in isolation; it is part of a system composed of blood and blood vessels as well. The highest level of body organization, then, is that of the organ system.

The body includes nine major organ systems, each composed of various organs and tissues that work together as a functional unit. The chief constituents and prime functions of each system are summarized below. (1) The integumentary system, composed of the skin and associated structures, protects the body from invasion by harmful microorganisms and chemicals; it also prevents water loss from the body. (2) The musculoskeletal system (also referred to separately as the muscle system and the skeletal system), composed of the skeletal muscles and bones (with about 206 of the latter in adults), moves the body and protectively houses its internal organs. (3) The respiratory system, composed of the breathing passages, lungs, and muscles of respiration, obtains from the air the oxygen necessary for cellular metabolism; it also returns to the air the carbon dioxide that forms as a waste product of such metabolism. (4) The circulatory system, composed of the heart, blood, and blood vessels, circulates a transport fluid throughout the body, providing the cells with a steady supply of oxygen and nutrients and carrying away such waste products as carbon dioxide and toxic nitrogen compounds. (5) The digestive system, composed of the mouth, esophagus, stomach, and intestines, breaks down food into usable substances (nutrients), which are then absorbed from the blood or lymph; this system also eliminates the unusable or excess portion of the food as fecal matter. (6) The excretory system, composed of the kidneys, ureters, urinary bladder, and urethra, removes toxic nitrogen compounds and other wastes from the blood. (7) The nervous system, composed of the sensory organs, brain, spinal cord, and nerves, transmits, integrates, and analyzes sensory information and carries impulses to effect the appropriate muscular or glandular responses. (8) The endocrine system, composed of the hormone-secreting glands and tissues, provides a chemical communications network for coordinating various body processes. (9) The reproductive system, composed of the male or female sex organs, enables reproduction and thereby ensures the continuation of the species.

### **1.1.3 Basic form and development**

In general structure, the human body follows a plan that can be described as a cylinder enclosing two tubes and a rod. This body plan is most clearly evident in the embryo; by birth, the plan is apparent only in the trunk region—i.e., in the thorax and abdomen.

The body wall forms the cylinder. The two tubes are the ventrally located alimentary canal (i.e., the digestive tract) and the dorsally located neural tube (i.e., the spinal cord). Between the tubes lies the rod—the notochord in the embryo, which becomes the vertebral column prior to birth. (The terms dorsal and ventral refer respectively to the back and the front, or belly, of an animal.)

Within the embryo, the essential body parts are: (1) the outer enclosing epidermal membrane (in the embryo called ectoderm); (2) the dorsal neural tube; (3) the supporting notochord; (4) the ventral alimentary tube, which becomes the lining of the stomach and intestine (in the embryo called endoderm); (5) the intermediate mass (in the embryo called mesoderm); and (6) a rather fluid tissue that fills the interspaces, derived from the mesoderm and in the embryo called mesenchyme. Everything in the body derives from one of these six embryonic parts.

The mesoderm constitutes a considerable pad of tissue on each side of the embryo, extending all the way from the back to the front sides of the body wall. It is hollow, for a cleftlike space appears in it on each side. These are the right and left body cavities. In the dorsal part of the body they are temporary; in the ventral part they become permanent, forming the two pleural cavities, which house the lungs; the

peritoneal cavity, which contains the abdominal organs; and the pericardial cavity, which encloses the heart. The dorsal part of the mesoderm becomes separated from the ventral mesoderm and divides itself into serial parts like a row of blocks, 31 on each side. These mesodermal segments grow in all directions toward the epidermal membrane. They form bones, muscles, and the deeper, leathery part of the skin. Dorsally they form bony arches protecting the spinal cord, and ventrally the ribs protecting the alimentary canal and heart. Thus they form the body wall and the limbs—much the weightier part of the body. They give the segmental character to the body wall in neck and trunk, and, following their lead, the spinal cord becomes correspondingly segmented. The ventral mesoderm is not so extensive; it remains near the alimentary tube and becomes the continuous muscle layer of the stomach and intestine. It also forms the lining of the body cavities, the smooth, shining, slippery pleura and peritoneum. The mesenchyme forms blood and lymph vessels, the heart, and the loose cells of connective tissues.

The neural tube itself is formed from the ectoderm at a very early stage. Anteriorly (i.e., toward the head) it extends above the open end of the cylinder and is enlarged to form the brain. It is not in immediate contact with the epidermis, for the dorsal mesoderm grows up around it and around the roots of the cranial nerves as a covering, separating the brain from the epidermis. Posteriorly the neural tube terminates in the adult opposite the first lumbar vertebra.

If the cylindrical body wall is followed headward, it is found to terminate ventrally as the tongue, dorsally in the skull around the brain, ears, and eyes. There is a considerable interval between eyes and tongue. This is occupied partly by a deep depression of the epidermis between them, which dips in to join the alimentary tube (lining of the mouth). Posteriorly the ventral body wall joins the dorsal at the tailbone (coccyx), thus terminating the body cavities.

Headward, the alimentary tube extends up in front of the notochord and projects above the upper part of the body wall (tongue) and in front of and below the brain to join the epidermal depression. From the epidermal depression are formed the teeth and most of the mouth lining; from the upper end of the alimentary canal are formed the pharynx, larynx, trachea, and lungs. The alimentary canal at its tail end splits longitudinally into two tubes—an anterior and a posterior. The anterior tube becomes the bladder, urethra, and, in the female, the lining of the vagina, where it joins a depression of the ectoderm. The posterior (dorsal) tube becomes the rectum and ends just in front of the coccyx by joining another ectodermal depression (the anus).

#### **1.1.4 Effects of aging**

As the human body ages it undergoes various changes, which are experienced at different times and at varying rates among individuals.

The skin is one of the most accurate registers of aging. It becomes thin and dry and loses elasticity. Patches of darker pigmentation appear, commonly called liver spots, though they have no relation to that organ. Hair grays and thins. Wounds take longer to heal; some reparations take five times as long at 60 as at 10 years of age. Sensory fibres in spinal nerves become fewer; the ganglion cells become pigmented and some of them die. In the auditory apparatus some nerve cells and fibres are lost, and the ability to hear high notes diminishes. In the eye the lens loses its elasticity.

Organs such as the liver and kidneys lose mass with age and decline in efficiency. The brain is somewhat smaller after the age of 40 and shrinks markedly after age 75, especially in the frontal and occipital lobes. This shrinkage is not, however, correlated with declines in mental capacity. Intellectual declines in the elderly are the consequence of underlying disease conditions, such as Alzheimer's disease or cerebrovascular disease.

The bones become lighter and more brittle because of a loss of calcium. This loss in bone mass is greater in women than men after the fifth decade. In joints the cartilage covering the ends of bone becomes thinner and sometimes disappears in spots, so bone meets bone directly and the old joints creak. Compression of the spinal column can lead to a loss of height. Muscular strength decreases but with marked individual variability.

The arteries become fibrous and sclerosed. Because of decreasing elasticity, they tend to become rigid tubes. Fatty spots, which appear in their lining even in youth, are always present in old age.

In vitro experiments indicate that the body's cells are programmed to undergo a finite number of divisions, after which time they lose their reproductive capacity. Thus, the potential longevity of the human body—about 100 years—seems to be encoded within the very cells of the body.

### **1.1.5 Change incident to environmental factors**

Although the basic form of the human body was established in man's anthropoid ancestors, evolutionary adaptations to different environments are apparent among various human populations. For example, physical adaptations in human beings are seen in response to extreme cold, humid heat, and high altitudes.

Extreme cold favours short, round persons with short arms and legs, flat faces with fat pads over the sinuses, narrow noses, and a heavier than average layer of body fat. These adaptations provide minimum surface area in relation to body mass for minimum heat loss, minimum heat loss in the extremities (which allows manual dexterity during exposure to cold and guards against frostbite), and protection of the lungs and base of the brain against cold air in the nasal passages.

In hot climates the problem is not in maintaining body heat but in dissipating it. Ordinarily the body rids itself of excess heat by sweating. In conditions of humid heat, however, the humidity of the surrounding air prevents the evaporation of perspiration to some extent, and overheating may result. Hence, the heat-adapted person in humid climates is characteristically tall and thin, so that there is maximum surface area for heat radiation. The person living in hot climates has little body fat; often a wide nose, since warming of the air in the nasal passages is not desirable; and, usually, dark skin, which provides a shield from harmful solar radiation.

High altitudes demand a degree of cold adaptation, as well as adaptation for low air pressure and the consequent low oxygen. This adaptation is accomplished by an increase in lung tissue generally.

Despite the fact that the general shape and size of the body and its parts are determined by heredity, the body can undergo some modifications in response to present conditions. Thus, a person who moves from a home at sea level to one at mountain altitudes will experience an increase in the number of red blood cells; this increase helps compensate for the lower oxygen levels of his new environment. Similarly, a light-skinned individual who moves to a hot tropical region will develop increased pigmentation in his skin. In such situations, the resultant form is seldom perfect for the new conditions, but it is adapted to present needs well enough to maintain life with the least waste of energy.

## **1.2 Muscles in the Human Body**

The human body is comprised of hundreds of muscles, about 640 in total. There is no exact count largely because expert opinions are conflicted regarding what constitutes a distinct muscle. Therefore, some experts will suggest 639 total while others may suggest there are more. Muscles are found within the



muscular system, which is the body's own network of tissues and fibers responsible for both outward and inward movements of the body.

While the exact number in the human body may not be known, what is known is that muscles are categorized as one of three different types: striated, smooth, and cardiac.

Striated muscles, also called voluntary or skeletal muscles, are those the body has conscious control of. These include those in the face and those that move all the bones of the body. Striated muscles are made of light and dark bands called fibrils. They are the ones typically injured in sports or during physical activity.

Smooth muscles are known as involuntary or visceral muscles, and are controlled by the autonomic nervous system. They differ in appearance from striated and lack the bundles of fiber and patterned fibrils found in striated muscles. They move internal organs, including the digestive tract and secretory glands, and cannot be made to work by conscious effort.

Cardiac muscles are those that make up the heart. Though similar to striated in appearance, cardiac are also involuntary. They work together to pump blood to and from the heart and throughout the body.

Muscles are able to contract, or pull, and are typically paired together in sets that work in conjunction with one another. They come in various sizes and perform many different functions. The busiest are found in the eye and are responsible for blinking, which occurs involuntarily, though can be a voluntary action, approximately 100,000 times each day. The smallest in the human body is located deep inside the ear and called the stapedius. The largest in the human body is the gluteus maximus, or buttock.

### **1.3 Functions of Human Body Systems**

The human body is a complex organism made up of several individual systems working together to create a balance known as "homeostasis." This balance is required to enable full function and survival. Without these systems, we would not be able to move, eat, defend against disease, eliminate waste from the body, create offspring, circulate blood or breathe.

#### **1.3.1 Circulation and Oxygenation**

The cardiovascular and respiratory system work together to provide oxygen and vital nutrients to the body. The respiratory system consists of the nose, throat, trachea, larynx and lungs. Outside air is brought in through the nose or mouth, where it is cleaned of impurities such as mold spores and dust before it is sent down the throat into the lungs. Oxygen is exchanged with carbon dioxide and exhaled back out. Blood from the heart is sent into the lungs to be oxygenated before it is dispersed to the rest of the body through the cardiovascular system, which is made up of the heart and circulatory system. The continuous loop carries fresh, oxygenated blood through the body via the arteries. From there, it is sent to the capillaries, which nourish the cells, then sent back to the heart through veins to be oxygenated again.

#### **1.3.2 Control Centers**

The brain, spinal cord and a vast network of nerves make up the nervous system. Without this system, we couldn't think, feel, move or express emotion. It sends signals to every other system in the body and controls the fast processes. Neurons move back and forth along the system, carrying external information to the brain and relaying commands from the brain. The endocrine system releases hormones that control

or influence just about every type of cell in the body. The glands that make up the system include the hypothalamus, pituitary, thyroid, parathyroids, adrenal, pineal, ovaries and testes. Hormones are sent through the blood stream to different cells and the slow processes in the body such as growth, reproduction and metabolism.

### **1.3.3 Digestion and Elimination**

The digestive system consists of all the organs required to process food, including the mouth, esophagus, stomach, small intestines, large intestines, liver, pancreas and gallbladder. Food is broken down in the mouth, sent through the esophagus and pushed into the stomach. Acids and enzymes break it down further and push it through the intestines where nutrients are removed. Solid waste is expelled from the colon. The liver, pancreas and gallbladder add digestive juices to help the process. The urinary system removes liquid waste, toxins and excess salt. It includes the kidneys, bladder, ureters and urethra. The kidneys also ensure that the body has a healthy level of fluids to circulate through the systems and to keep the tissues alive and filter the blood of impurities.

### **1.3.4 Defense**

The lymphatic system is a defense system made up of lymph nodes, bone marrow, the spleen and the thymus. This system is responsible for distributing lymph fluids throughout the body, making lymphocytes to protect against disease and absorbing fats from the intestines. The lymphatic system also removes impurities from the blood, including dead blood cells.

### **1.3.5 Reproduction**

The male and female reproductive systems are different from each other in structure, but together, they are responsible for creating offspring. The female reproductive system is made up of the vagina, uterus, ovaries and fallopian tubes. Testicles, the penis, the duct system and accessory glands make up the male system. This is the only system in the body we do not need for survival.

## **1.4 Importance of Human Body**

Human Body is considered so loving that God even wants to have it. Spiritual Yogis have found that after going through the 84 millions species this souls get the most dignified human body. So it is the last step to explore the God or to get the view of almighty father god. We know that the soul never dies it takes birth again and again just like as we take new clothes to wear the soul as it takes new body and it is an infinite process. But the body what we get in next birth depend on our karma that has been cited in Gita by Lord Krishna to Arjuna. We all here to perform our duties. Our action makes our destiny and nothing else. The result is in the hand of supreme power. Karma is the seed of plant and if the seed is genuine it must be fruitful.

For a good plant only genuine seed is not important it also require the protection, irrigation and the fertile land with fresh air and proper sunlight. This has been facilitated through our accumulated good Deeds (Karma) which is judged by the supreme power which dwells always in our heart and it never sleeps and keeps record of our every deeds always.

Success is the sign of consistent labour with effective desire. Every person wants success in their life but their ways are different. Every day we have some goal to perform but some of us are without any purpose or motive just we live as we are alive. We always forget that time and tides wait for none. The person

who knows and gave importance to the time is a winner in life. The importance of time means utility of time according to circumstances or opportunity in good sense. To avail opportunity in bad sense is nonsense step made a person selfish and monster. The curtailment of the bad desire makes a person wise, calm, and cool.

#### *Review Questions*

1. Define the Human body?
2. Explain the basic form and development?
3. Explain the functions of Human Body Systems?
4. Explain the importance of Human Body?

#### Learning Objectives

- To define the Human body.
- To explain the Basic form and development.
- To explain the Functions of Human Body Systems.
- To describe the Importance of Human Body.

#### Discussion Questions

Discuss in detail the functions of Human body?

## Lesson 2 – Digestive system

### Learning Objectives

- To define the Digestive system.
- To explain the Early Digestion.
- To explain the Absorption in Digestive System.
- To describe the Functions of Digestive System.

### 2.1 Why Digestion?

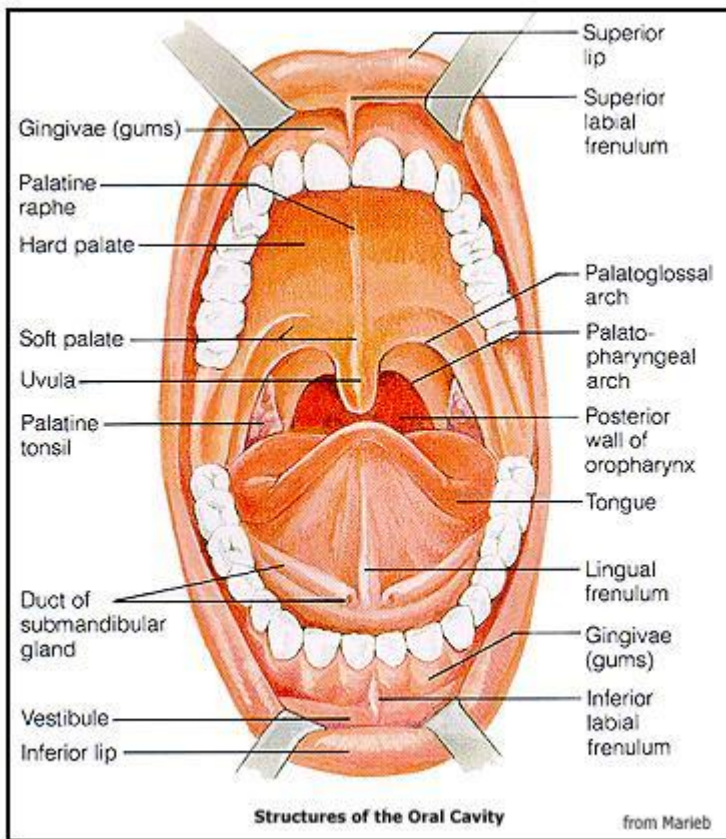
The human digestive system is one of the largest and most evolved systems in the human body; however, its complexity also opens us up to many disorders and diseases. How does it work and why does it fail so often?

The basic function of the digestive system is to convert food materials into usable energy and to provide our bodies with material its needs to grow and maintain itself. This long process has evolved to be very efficient- grabbing as many nutrients out of food as possible and leaving all unusable material to be excreted.

The organs of the digestive system on this site have been divided into early, middle, and late for simplicity sake. In the human body, the digestive system is really made up of a long, what can be thought as, tube called the **Alimentary Canal** or **GI Tract**. The GI tract begin in the mouth and ends in the Anus. To aid the process of digestion, several accessory organs line the GI tract. These organs include the **Salivary Glands, Teeth and Tongue, Liver, Gallbladder,** and **Pancreas**. These organs produce saliva, bile, and several other important catabolic (breakdown) enzymes. These molecules are added the the orderly flow of food in the GI Tract via several ducts.

The basic strategy of digestion is to break down all food into basic molecules and then absorb the useful ones. The specific roles of each section and organ is covered at the left: early, middle, and late digestion.

### 2.1.1 Early Digestion: Mouth



The human mouth has many functions, including the formation of speech and aiding in breathing, but the three main digestive purposes the mouth has are:

- the intake of food
- the beginning of mechanical digestion
- swallowing

Although the existence of the mouth may seem elementary to life as an animal, it's interesting to note that our two separate openings for food and waste are found only in the larger, more differentiated animals. Many species of animal possess only one opening for both functions and no canal through the body. Since humans evolved from these lower animals, human embryos similarly form a one-way body cavity and anus first during development and differentiate the mouth structure only later (this is a principle of developmental biology.)

### Coelenterates

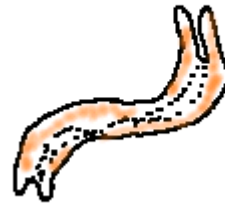
One body cavity opening



Hydras, anemones

### Eucoelomates

Two body cavity openings

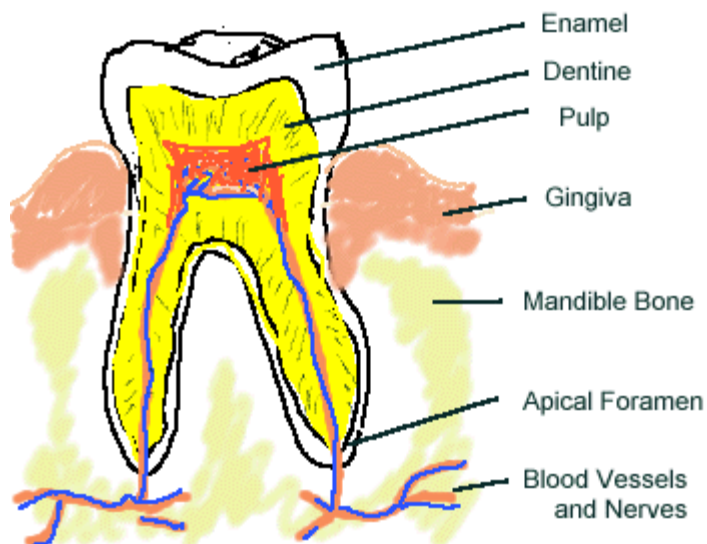


Earthworms, humans

The human mouth is lined with mucous membranes that protect the outer cell layer of the body cavity (the epithelium) from abrasive food and harmful digestive juices while the food passes through the upper alimentary canal. The mucous membrane, along with the submucosa and the serosa, is actually present throughout the entire alimentary tract. However, the mouth and esophageal mucous membranes are not involved in adsorption as their intestinal counterparts are, and subsequently these have a different morphology (stratified, squamous cells.)

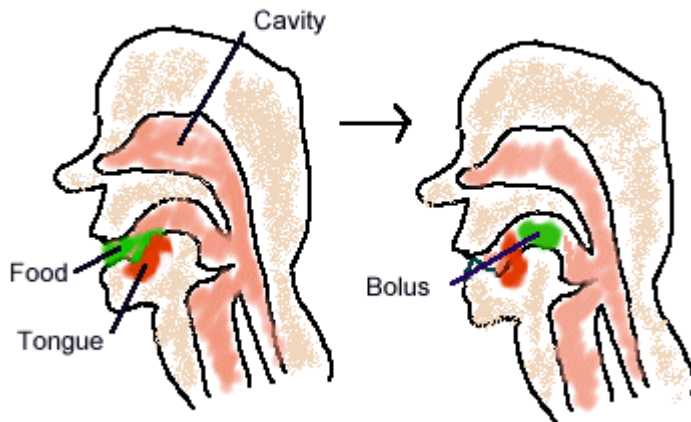
The mouth also bears teeth which aid in the mechanical digestion according to their shape and position. The crown (covered in a shiny layer of enamel) sticks out of the gum, while the root is implanted in the alveolar bone (and is encased in cementum.)

### The Tooth



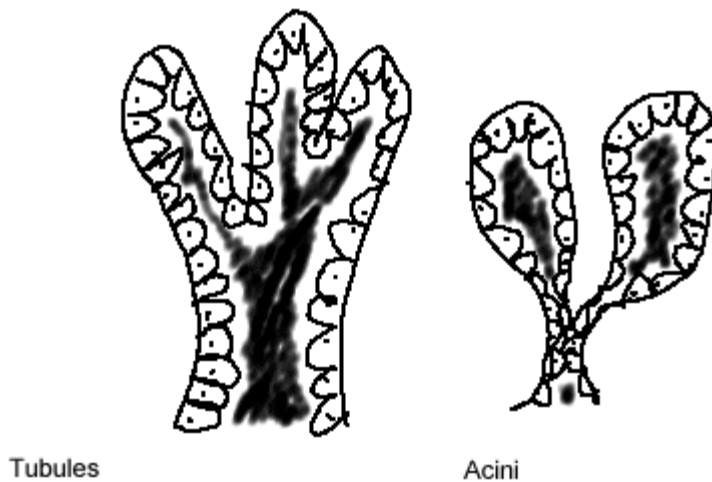
Children have 20 deciduous teeth and adults have 32 permanent teeth. They are only truly specialized in adults, but in general, they are the incisors, canines, premolars, and molars. Incisors have the cutting function of mastication or chewing of food. Canines are sometimes called cuspids and pierce and tear food that is being eaten. Premolars/bicusps and molars/tricusps have large, flat surfaces with two or three grinding cusps on their surface. Then a small rounded mass of food called a bolus is formed so that it can be swallowed easily.

## Swallowing - Bolus Formation



The bolus is a mixture of the solid food particles reduced in size and saliva. The action of swallowing begins with the elevation of the tongue against the top of the palate to separate a bolus of food. The tongue then propels the separated food into the oropharynx, the upper pharynx, where the process continues.

## Salivary Secretory (Mesenchymal) Cells



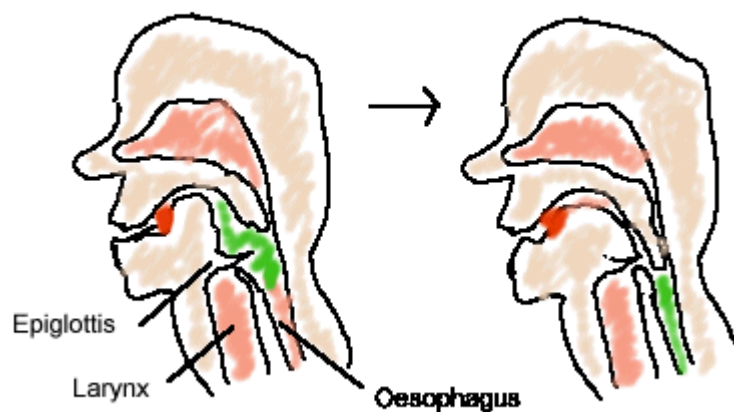
Three pairs of salivary glands secrete up to one liter of saliva a day. The **parotids** lie just below and in front of ear near the jaw and secrete through the parotid duct. Ducts for the **submandibular** and the **sublingual** glands lie on the floor of the mouth and either side of the **frenulum** which attaches the tongue to the mouth. It is when food enters the mouth that the extrinsic glands are activated and saliva starts to be secreted.

The substance secreted contains mucous and **salivary amylase** which begins the chemical digestion of carbohydrates. The mucus helps in reducing friction between the food and the esophagus. Saliva is roughly 98% water and therefore hypoosmotic. Solutes also include **electrolytes** (sodium, potassium, chloride, phosphate, and bicarbonate ions); the proteins mucin, lysozyme, and IgA; and metabolic wastes.

The proteins provide protection against microorganisms with antibodies and a bacteriostatic enzyme that may help stop bacterial growth. There is also some growth factor found in saliva that heal licked wounds of animals and humans as well.

#### 2.1.1.1 Early Digestion: Pharynx

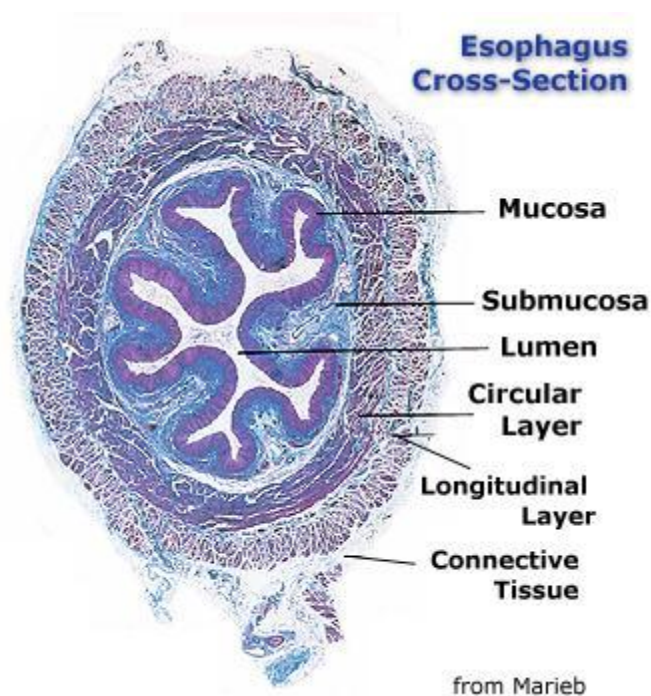
##### Swallowing - Pharynx



After food leaves the mouth, it passes posteriorly into the **pharynx** and then by the **epiglottis**. Histologically there are three types of pharynx tissues, but for the purposes of the digestive system only the **oropharynx** and the **laryngopharynx** are of concern. Initially food starts out in the oropharynx (located behind the tonsils and the palatopharyngeal arch), and via peristalsis moves through the laryngopharynx (located at the base of the neck) and eventually empties into the **esophagus**. These muscular tracks are lined with a mucosal membrane that is similar in histology as the rest of the oral cavity.

#### 2.1.2.2 Early Digestion: Esophagus

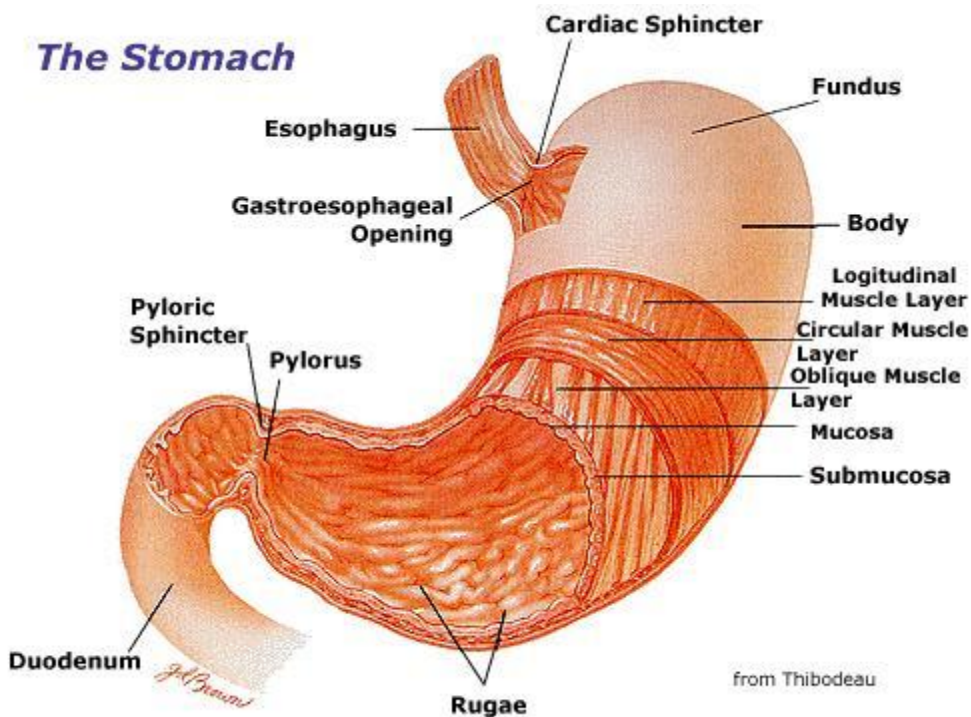




The esophagus is a long muscle lined tube that connects the mouth to the stomach. Its role is simple: move liquid and solid food to the stomach for further digestion. The esophagus accomplishes this using gravity and an intricate muscular motion called **peristalsis**. Peristalsis involves contraction of alternating muscular segments in the esophagus which results in movement of food down to the stomach.

To ensure that food does not come back into the mouth, the esophagus has a "pinch-cock" mechanism at its upper end. To protect the esophagus from food travel, a layer of squamous epithelial cells (similar to skin cells) lines the lumen - making up the **Mucosa**. When not in use, the esophagus is collapsed.

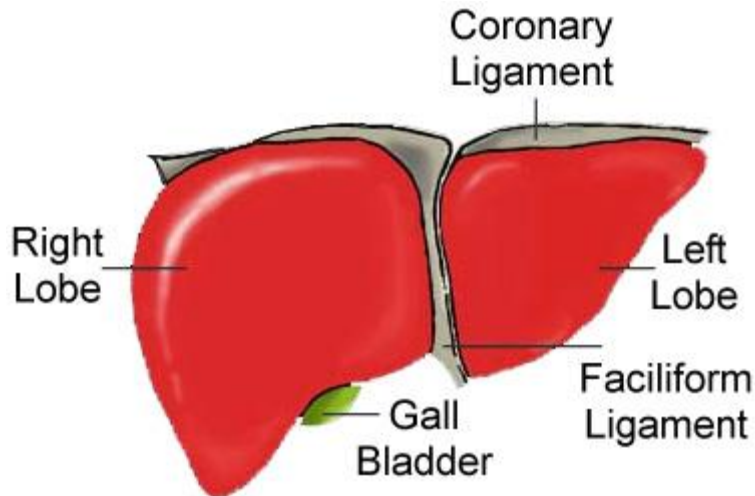
The connection between the stomach and the esophagus is called the **cardia orifice** and is surrounded by the important **gastroesophageal sphincter**. This sphincter acts as a true valve and is present to prevent stomach contents from leaking back into the esophagus. If stomach acid were to reach the esophagus, intense pain would result due to the relatively sensitive nature of the esophageal mucosa compared to the stomach mucosa.



The stomach lies in the upper part of the abdominal cavity under the **diaphragm**. Food enters here after having been chewed, swallowed, and passed through the esophagus. Size can change dramatically with the amount of food in the stomach. The **cardiac sphincter** is a ring of muscle that prevents food from reentering the esophagus while the stomach is contracting to form a semisolid mixture known as **chyme**. Hydrochloric acid and enzymes mix with the food to aid in the mechanical digestive process.

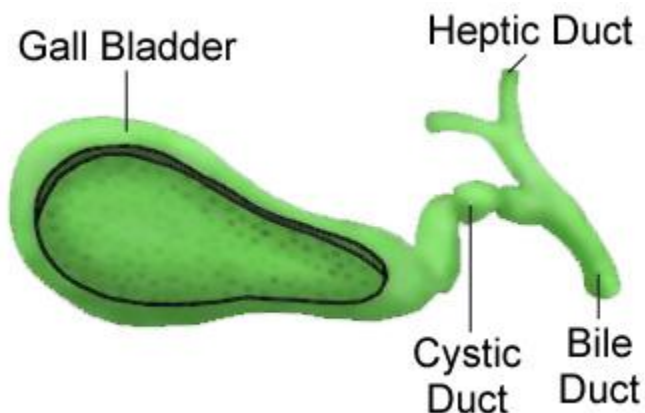
There are three layers of smooth muscle that run lengthwise, around, and obliquely make the stomach one of the strongest internal organs. The folds in the lining of the stomach are known as **rugae** secrete gastric juice and hydrochloric acid. Muscles contracting result in **peristalsis** which forces food down the esophagus.

The stomach can be divided into three parts. The **fundus** is the enlarged part that extends upwards past the opening of the **esophagus** into the stomach. The **body**, or the middle part, and the last third known as the **pylorus**, both function in partial digestion aided by the **pyloric sphincter** muscle which closes off the stomach from the small intestine.



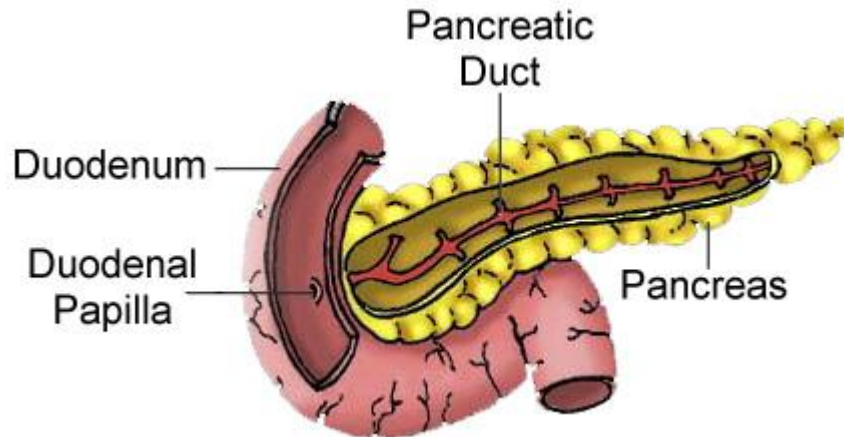
The liver is classified as the largest gland in body. It fills most of the abdominal cavity on the right side and most of the left. The secretion of bile is regulated through this organ which emulsifies fats. Fats in chyme stimulate the secretion of the hormone cholecystokinin or CCK from the intestinal lining cause contraction of the gallbladder which forces bile to enter into the duodenum.

#### Middle Digestion: Gallbladder



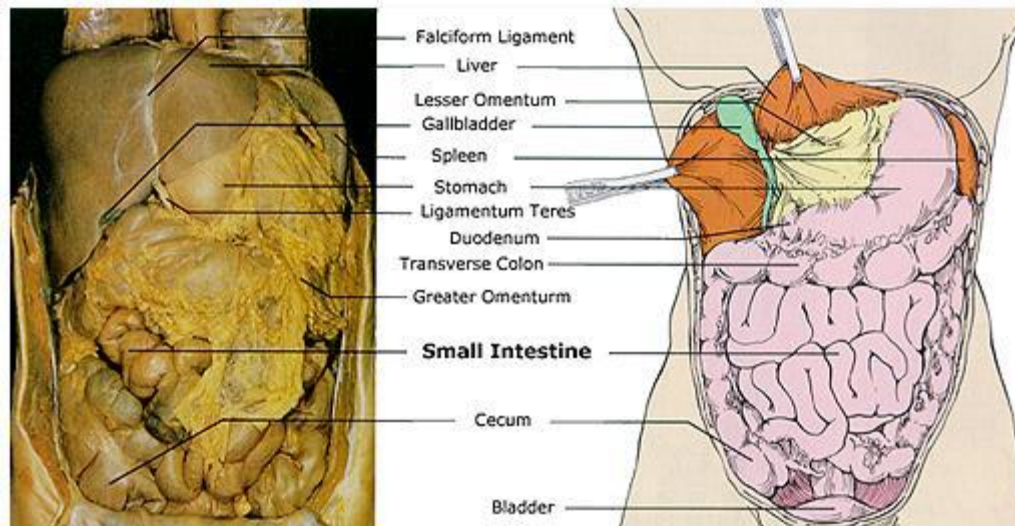
The **gallbladder** is a storage area for bile which is produced by the liver. It is when **chyme** containing fats or lipids that a mechanism to squeeze the gallbladder and push some of the bile into the **duodenum** and small intestine. The gallbladder also concentrates the liquid for storage purposes.

However this causes the production of gallstones to block the **common bile duct** which could then causes lack of drainage of the gallbladder. Feces change to a gray-white color and excessive amounts of bile is absorbed into the bloodstream changing to a yellowish tint and condition known as jaundice. Blockage of the **hepatic duct** can also cause this condition.



This C-shaped organ secretes **pancreatic juice** into ducts and hormones into the bloodstream. This digestive enzyme is the most important since it can break down all three major kinds of food. It contains **sodium bicarbonate** which is an alkaline substance that neutralizes the **hydrochloric acid** that enters the intestine.

There are clusters of cells in the center that have no contact with any other ducts which are called **pancreatic islets** which secrete the hormones into the bloodstream thus making this gland part of the both **endocrine and exocrine systems**.



The small intestine is slightly misnamed since it is over twenty feet long. With respect to diameter however, it is significantly smaller than the large intestine. Food passes through the **duodenum**, **jejunum**, and the **ileum**. There are thousands of microscopic intestinal glands in the mucous lining that secrete intestinal digestive juice. These in turn are organized into multiple circular folds known as **plicae** which in turn are covered with millions of tiny folds called **villi**.

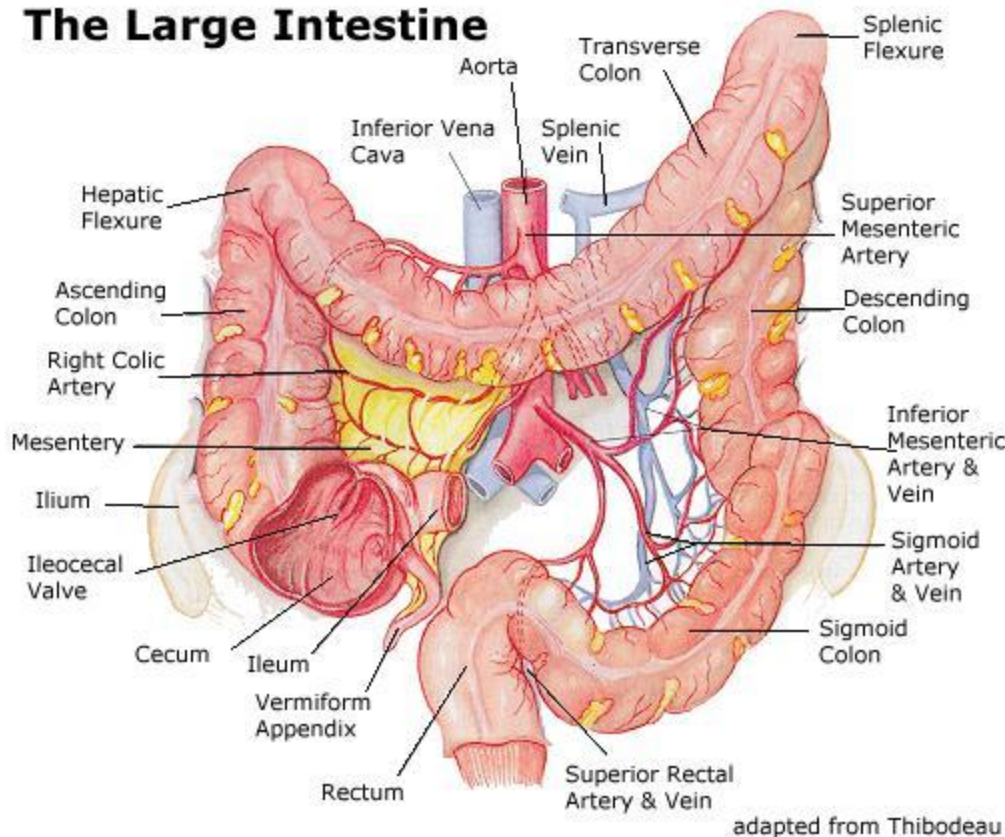
Villi project into the hollow interior of the intestine where a network of capillaries absorb the products of carbohydrate and protein digestion. This is highly advantageous for absorption of food into the blood and lymph. The lymphatic vessel of **lacteal** sucks in the lipid or fat materials from the chyme that passes



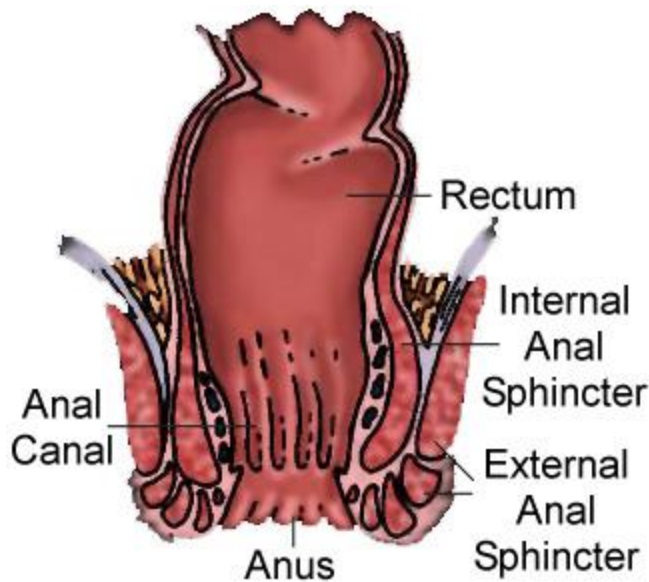
through the small intestine. In addition the brushlike border is composed of **microvilli** that increase the surface area significantly.

The majority of the chemical digestion is done in the duodenum or the first subdivision of small intestine. Because of this, most of the ulcers that form also appear here. The middle third has ducts that empty the pancreatic digestive juices as well as bile from the liver.

## The Large Intestine



The **large intestine** represents the terminal phase in digestion. Here, large amounts of water and salts are reabsorbed back into the blood, leaving only the familiar **fecal matter**. Unlike the fast-moving **Chyme** in the **small intestine**, this fecal matter moves slowly and contains much less nutrients and water. Chyme enter the large intestine via the sphincter, **ileocecal valve**, and continues into the **cecum**. From the cecum, fecal matter travels upward into the **ascending colon**, across the **transverse colon**, and down into the **descending colon**. The **sigmoid colon** (having a 'S' shape) is the last major portion of the large intestine. Here, this usually dry fecal matter terminates in the **rectum** to **anal canal** to **anus** pathway and then exits the body.



Also known as **retroperitoneal**, the rectum and the associated anal canal is the most caudal organ in the digestive system. While its name might mislead one into believing it is straight (from the Latin, *rectus*), it actually consists of three lateral curves or bends. These are represented internally as three transverse folds called the **rectal valves**, which are located at the top of above picture. These valves are extremely important as they are used to separate the feces (stool) from flatus (gas). Moving downwards, one encounters the **anal canal**. It is controlled by two sphincters, the **internal anal sphincter** and the **external anal sphincter**. The former set of muscles is primarily involuntary while the latter is voluntarily controlled. Essentially these sphincters keep the **anus**, the opening at the end of the digestive system, from staying open.

## 2.2 Study of the digestive system

Gastroenterology is the branch of medicine focused on studying and treating the digestive system disorders. Physicians practicing this specialty are called gastroenterologists. The name is a combination of three ancient Greek words: *gaster* (gastros) (stomach), *enteron* (intestine) and *logos* (reason). It is an internal medicine subspecialty certified by the American Board of Internal Medicine.

References to the digestive system can be traced back to the ancient Egyptians. Some milestones in the study of the gastrointestinal system include:

- Claudius Galen (circa 130-200) lived at the end of the ancient Greek period and reviewed the teachings of Hippocrates and other Greek doctors. He theorized that the stomach acted independently from other systems in the body, almost with a separate brain. This was widely accepted until the 17th century.
- In 1780, Italian physician Lazzaro Spallanzani conducted experiments to prove the impact of gastric juice on the digestion process.
- Philipp Bozzini developed the *Lichtleiter* in 1805. This instrument, which was used to examine the urinary tract, rectum and pharynx, was the earliest endoscopy.
- Adolf Kussmaul, a German physician, developed the gastroscope in 1868, using a sword swallower to help develop the diagnostic process.

- Rudolph Schindler, known to some as the “father of gastroscopy,” described many of the diseases involving the human digestive system in his illustrated textbook issued during World War I. He and Georg Wolf developed a semi-flexible gastroscope in 1932.
- In 1970, Hiromi Shinya, a Japanese-born general surgeon, delivered the first report of a colonoscopy to the New York Surgical Society and in May 1971 presented his experiences to the American Society for Gastrointestinal Endoscopy.
- In 2005, Australians Barry Marshall and Robin Warren were awarded the Nobel Prize in Physiology or Medicine for their discovery of *Helicobacter pylori* and its role in peptic ulcer disease.

### 2.3 How Does the Digestive System Work?

The human digestive system is a sequence of organs that use mechanical and chemical means to take in food, break it down, extract nutrients and energy, and eject waste products in the form of urine and feces. The digestive system evolved incrementally over the course of hundreds of millions of years and is the only natural way for humans to obtain energy for movement and thinking. It is capable of handling a variety of food sources, both animal and vegetable, but tends to handle food best when it is cooked. Because cooked food has been around for so long, humanity as a species is slightly “spoiled” in its favor, and many people get sick if they consume food that has not received adequate cooking.

The mouth is the entrance to the human digestive system. Teeth gnash the food, breaking it down mechanically, while the three salivary glands release saliva containing the enzyme amylase, which breaks down starch and fat chemically. Saliva makes food easier to swallow by moistening it, as well as preventing the erosion of tooth enamel by modulating pH.

After entering the body at the back of the throat, food travels down the esophagus, being transported not by gravity but by muscular contractions. This is why it is possible to eat while hanging upside down. The interior of the esophagus is very moist, which helps to further break down food and prevent damage to the rest of the digestive system.

After moving through the esophagus portion of the digestive system, food and drink reaches the stomach, where it is further broken down into manageable pieces. Because the nutrients in food are ultimately meant to be consumed by cells, they must be broken into very small parcels for delivery. The primary agent of digestion in the stomach is gastric juices, which are produced in large amounts and can be very acidic. A secondary agent is muscular contractions within the stomach.

After the stomach, the broken down food moves into the small intestine, the portion of the digestive system where most of the nutrient extraction takes place. As the food moves through the small intestine, it is mixed with bile, which is produced by the liver, as well as pancreatic juices, which perhaps unsurprisingly come from the pancreas. These two liquids help further the digestive process, breaking down the nutrients in food to the point where it can be absorbed by the blood. The inner intestine is home to the famous villi, tiny living extrusions which gather nutrients on a fine scale.

The final components of the digestive system are the large intestine or colon, the anus, and the urinary tract, which separate the liquid matter from the solid matter and send them to their respective exit ports. Of course, the human digestive system is not 100% efficient, and there are many nutrients left over in this “waste”, which will be consumed happily by bacteria or sent through a waste processing plant.

### 2.4 Role of Absorption in the Digestive System

The two primary roles of the digestive process are absorption and secretion. The role of absorption in the digestive system is vital to the body because without it, the vitamins, minerals, carbohydrates and other nutrients we consume could not be used. Absorption is the process by which the nutrients in food are passed on to the blood. The majority of absorption occurs in the small intestine, the digestive tract's primary organ.

After food passes through the stomach to the small intestines, it is turned into energy for the body to use. Absorption is made possible by the villi, small bristle-like protrusions in the mucosa. The mucosa is the moist tissue lining certain parts of the body's passages and organs. The villi act as channels through which the nutrients derived from digested foods can pass into the bloodstream and be carried to the rest of the body. The actual absorption process is slightly different for each type of nutrient.

The vast majority of absorption in the digestive system occurs in the duodenum and jejunum, specific sections of the small intestines located about two-thirds of the way down from the entrance. Carbohydrates, fats, and proteins are digested and absorbed, and the body sees that it gets the most use out of each. Digestive enzymes found in the small intestine are responsible for breaking down and converting certain foods into useable energy. Some individuals lack specific enzymes, which results in the inability to digest certain nutrients. The inability to digest or change certain foods into useable energy means that those nutrients are not absorbed, but stay in the digestive system.

While the majority of absorption occurs in the small intestines, absorption is also important to the large intestine. The undigested and non-useful nutrients from foods that are not absorbed in the small intestine pass through to the large intestine. The organ absorbs water and sodium, and through a process of exchanges, turns undigested and unneeded nutrients into waste, which is secreted as fecal matter.

Feces are mostly water, with the bulk comprised of bacteria and undigested matter. Mucus is what acts as a bile binder, giving "normal" feces a solid composition. Interference with excess mucus, bacteria, undigested and unabsorbed foods is what changes the composition of bowel movements from normal to abnormal, serving as an indicator that a virus, food-borne bacteria, or digestive problems are present. If the body somehow interferes with absorption in the digestive system, other symptoms may occur, including stomach cramping, nausea, indigestion, and vitamin deficiency.

## **2.5 Functions of the Digestive System?**

The functions of the digestive system are varied, but they mostly involve the breaking down and absorption of food and nutrients. The stomach, small intestine, and large intestine, combined with organs like the liver and pancreas, work together to break down food materials and absorb the nutrients they contain so that they can be used by the body. Many areas of digestion also affect the body's immune system and detoxification system.

Breaking down food so that it can be used is the first of many functions of the digestive system. This begins in the mouth where saliva helps dissolve and liquefy food and continues in the stomach where digestive enzymes break foods down further. Once it leaves the stomach, food goes into the small intestine, which is a long tubular organ that absorbs the bulk of food's nutrients.

Food is broken down even more in the small intestine by using bile from the pancreas and enzymes produced by the liver, as well as digestive mucus. Nutrients are absorbed into the tissues of the intestines and the remaining waste materials move downward into the large intestine, or colon. It is generally in liquid form by this time, but the colon reabsorbs moisture from the waste to prevent dehydration. Occasionally, the water is not absorbed, and this is what causes diarrhea.



There are other functions of the digestive system aside from providing nutrients for the rest of the body. The liver, which secretes important enzymes and bile for breaking down food, also works to detoxify the body by filtering toxins from food, drink, and other consumed substances. Both the kidneys and gallbladder help with this process, but the liver does the bulk of the work.

The pancreas also performs various important functions of the digestive system, including secreting insulin into the bloodstream to metabolize glucose so that it can be used as fuel by cells. If this isn't done properly, serious health complications can result. An improper production or implementation of insulin is what causes diabetes.

Additionally, good bacteria which live in the large intestine help to thwart pathogens or harmful bacteria. This helps the immune system to keep the body free of disease by reducing the numbers of harmful bacteria that white blood cells have to fight off. Imbalanced dangerous bacteria is one of the main causes of digestive upset. Taking a daily probiotic supplement may help to maintain balance.

### *Review Questions*

1. What is Digestive system?
2. Explain the Early Digestion?
3. Explain the Absorption in Digestive System?
4. Explain the Functions of Digestive System?

### *Discussion Questions*

Discuss the Digestive System in details?

## Lesson 3 – Respiratory system

### Learning Objectives

- To define the Respiratory system.
- To explain the Upper and the Lower Respiratory Tract.
- To explain the Breathing and Lung Mechanics.
- To describe the Control of respiration.

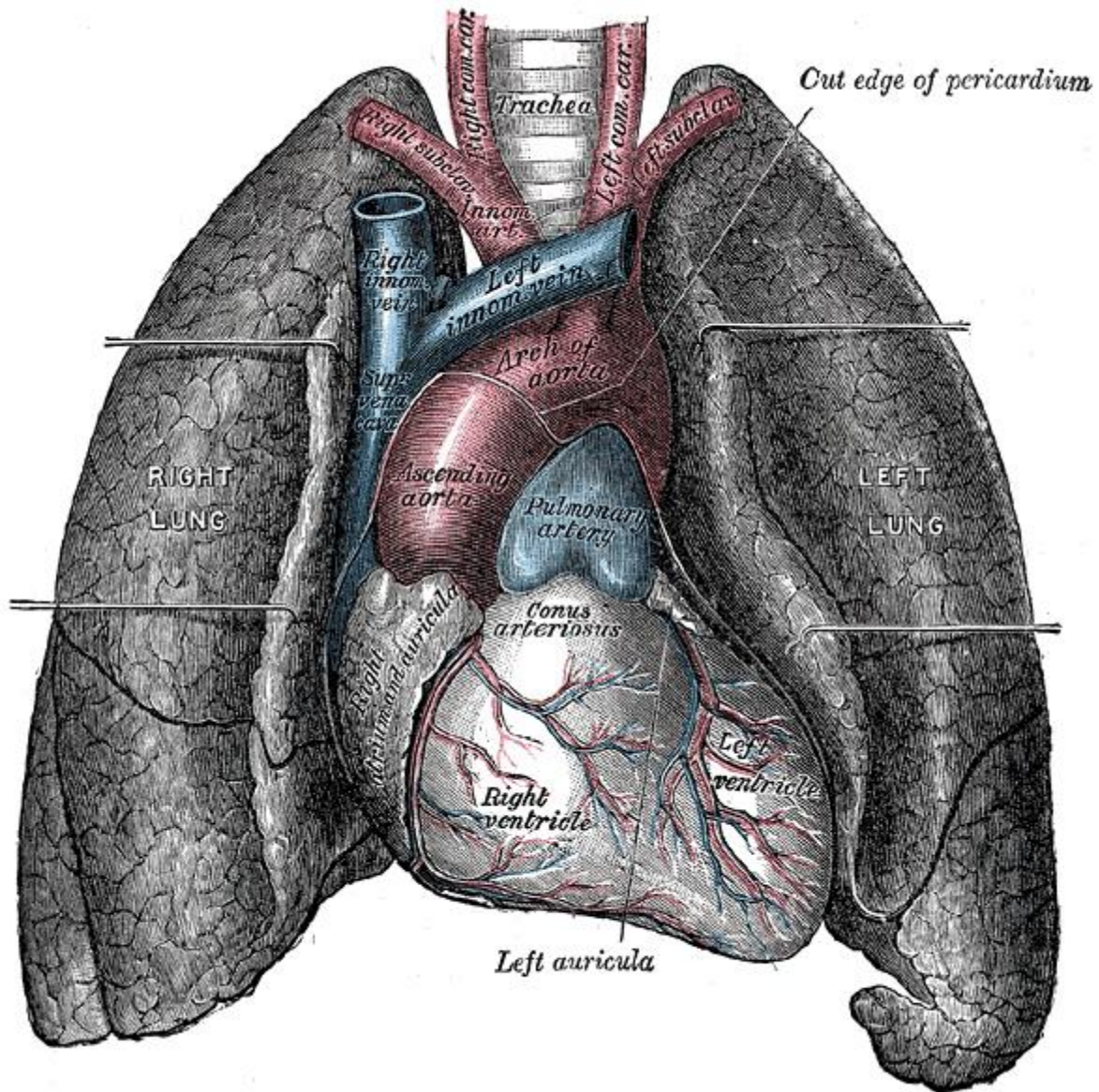
### 3.1 Respiratory system

The **Respiratory System** is crucial to every human being. Without it, we would cease to live outside of the womb. Let us begin by taking a look at the structure of the respiratory system and how vital it is to life. During inhalation or exhalation air is pulled towards or away from the lungs, by several cavities, tubes, and openings.

The organs of the respiratory system make sure that oxygen enters our bodies and carbon dioxide leaves our bodies.

The respiratory tract is the path of air from the nose to the lungs. It is divided into two sections: Upper Respiratory Tract and the Lower Respiratory Tract. Included in the upper respiratory tract are the **Nostrils, Nasal Cavities, Pharynx, Epiglottis**, and the **Larynx**. The lower respiratory tract consists of the **Trachea, Bronchi, Bronchioles**, and the **Lungs**.

As air moves along the respiratory tract it is warmed, moistened and filtered.



The **lungs** flank the heart and great vessels in the chest cavity. (Source: *Gray's Anatomy of the Human Body*, 20th ed. 1918.)

### 3.2 Functions

Four processes of respiration They are:

1. **BREATHING** or ventilation
2. **EXTERNAL RESPIRATION**, which is the exchange of gases (oxygen and carbon dioxide) between inhaled air and the blood.
3. **INTERNAL RESPIRATION**, which is the exchange of gases between the blood and tissue fluids.

## 4. CELLULAR RESPIRATION

### 3.2.1 In addition to these main processes, the respiratory system serves for:

- **REGULATION OF BLOOD pH**, which occurs in coordination with the kidneys, and as a
- *'DEFENSE AGAINST MICROBES*
- **Control of body temperature** due to loss of evaporate during expiration

### 3.3 Breathing and Lung Mechanics

**Ventilation** is the exchange of air between the external environment and the alveoli. Air moves by bulk flow from an area of high pressure to low pressure. All pressures in the respiratory system are relative to atmospheric pressure (760mmHg at sea level). Air will move in or out of the lungs depending on the pressure in the alveoli. The body changes the pressure in the alveoli by changing the volume of the lungs. As volume increases pressure decreases and as volume decreases pressure increases. There are two phases of ventilation; inspiration and expiration. During each phase the body changes the lung dimensions to produce a flow of air either in or out of the lungs.

The body is able to stay at the dimensions of the lungs because of the relationship of the lungs to the thoracic wall. Each lung is completely enclosed in a sac called the pleural sac. Two structures contribute to the formation of this sac. The parietal pleura is attached to the thoracic wall where as the visceral pleura is attached to the lung itself. In-between these two membranes is a thin layer of intrapleural fluid. The intrapleural fluid completely surrounds the lungs and lubricates the two surfaces so that they can slide across each other. Changing the pressure of this fluid also allows the lungs and the thoracic wall to move together during normal breathing. Much the way two glass slides with water in-between them are difficult to pull apart, such is the relationship of the lungs to the thoracic wall.

The rhythm of ventilation is also controlled by the "Respiratory Center" which is located largely in the medulla oblongata of the brain stem. This is part of the autonomic system and as such is not controlled voluntarily (one can increase or decrease breathing rate voluntarily, but that involves a different part of the brain). While resting, the respiratory center sends out action potentials that travel along the phrenic nerves into the diaphragm and the external intercostal muscles of the rib cage, causing inhalation. Relaxed exhalation occurs between impulses when the muscles relax. Normal adults have a breathing rate of 12-20 respirations per minute.

### 3.4 The Pathway of Air

When one breathes air in at sea level, the inhalation is composed of different gases. These gases and their quantities are Oxygen which makes up 21%, Nitrogen which is 78%, Carbon Dioxide with 0.04% and others with significantly smaller portions.

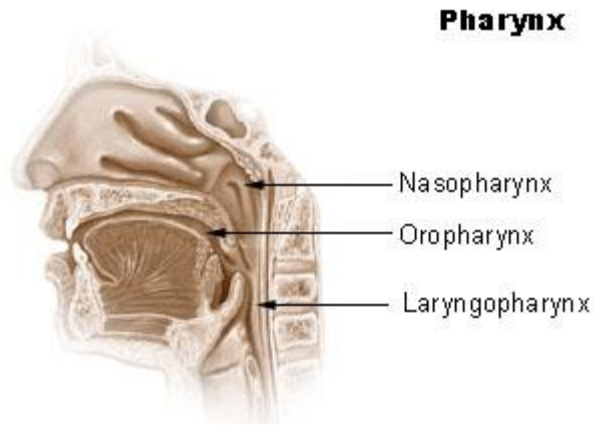


Diagram of the **Pharynx**.

In the process of breathing, air enters into the nasal cavity through the nostrils and is filtered by coarse hairs (*vibrissae*) and mucous that are found there. The vibrissae filter macroparticles, which are particles of large size. Dust, pollen, smoke, and fine particles are trapped in the mucous that lines the **nasal cavities** (hollow spaces within the bones of the skull that warm, moisten, and filter the air). There are three bony projections inside the nasal cavity. The **superior, middle, and inferior nasal conchae**. Air passes between these conchae via the nasal meatuses.

Air then travels past the nasopharynx, oropharynx, and laryngopharynx, which are the three portions that make up the pharynx. The **pharynx** is a funnel-shaped tube that connects our nasal and oral cavities to the larynx. The **tonsils** which are part of the lymphatic system, form a ring at the connection of the oral cavity and the pharynx. Here, they protect against foreign invasion of antigens. Therefore the respiratory tract aids the immune system through this protection. Then the air travels through the **larynx**. The larynx closes at the epiglottis to prevent the passage of food or drink as a protection to our trachea and lungs. The larynx is also our voicebox; it contains vocal cords, in which it produces sound. Sound is produced from the vibration of the vocal cords when air passes through them.

The **trachea**, which is also known as our windpipe, has ciliated cells and mucous secreting cells lining it, and is held open by C-shaped cartilage rings. One of its functions is similar to the larynx and nasal cavity, by way of protection from dust and other particles. The dust will adhere to the sticky mucous and the cilia helps propel it back up the trachea, to where it is either swallowed or coughed up. The **mucociliary escalator** extends from the top of the trachea all the way down to the **bronchioles**, which we will discuss later. Through the trachea, the air is now able to pass into the bronchi.

### 3.5 Inspiration

**Inspiration is initiated by contraction of the diaphragm** and in some cases the intercostals muscles when they receive nervous impulses. During normal quiet breathing, **the phrenic nerves stimulate the diaphragm to contract and move downward into the abdomen**. This downward movement of the diaphragm enlarges the thorax. When necessary, the intercostal muscles also increase the thorax by contacting and drawing the ribs upward and outward.

As the diaphragm contracts inferiorly and thoracic muscles pull the chest wall outwardly, the volume of the thoracic cavity increases. The lungs are held to the thoracic wall by negative pressure in the pleural cavity, a very thin space filled with a few milliliters of lubricating pleural fluid. The negative pressure in

the pleural cavity is enough to hold the lungs open in spite of the inherent elasticity of the tissue. Hence, as the thoracic cavity increases in volume the lungs are pulled from all sides to expand, causing a drop in the pressure (a partial vacuum) within the lung itself (but note that this negative pressure is still not as great as the negative pressure within the pleural cavity--otherwise the lungs would pull away from the chest wall). Assuming the airway is open, air from the external environment then follows its pressure gradient down and expands the alveoli of the lungs, where gas exchange with the blood takes place. As long as pressure within the alveoli is lower than atmospheric pressure air will continue to move inwardly, but as soon as the pressure is stabilized air movement stops.

### 3.6 Expiration

During quiet breathing, expiration is normally a passive process and does not require muscles to work (rather it is the result of the muscles relaxing). When the lungs are stretched and expanded, stretch receptors within the alveoli send inhibitory nerve impulses to the medulla oblongata, causing it to stop sending signals to the rib cage and diaphragm to contract. The muscles of respiration and the lungs themselves are elastic, so when the diaphragm and intercostal muscles relax there is an elastic recoil, which creates a positive pressure (pressure in the lungs becomes greater than atmospheric pressure), and air moves out of the lungs by flowing down its pressure gradient.

Although the respiratory system is primarily under involuntary control, and regulated by the medulla oblongata, we have some voluntary control over it also. This is due to the higher brain function of the cerebral cortex.

When under physical or emotional stress, more frequent and deep breathing is needed, and both inspiration and expiration will work as active processes. Additional muscles in the rib cage forcefully contract and push air quickly out of the lungs. In addition to deeper breathing, when coughing or sneezing we exhale forcibly. Our abdominal muscles will contract suddenly (when there is an urge to cough or sneeze), raising the abdominal pressure. The rapid increase in pressure pushes the relaxed diaphragm up against the pleural cavity. This causes air to be forced out of the lungs.

Another function of the respiratory system is to sing and to speak. By exerting conscious control over our breathing and regulating flow of air across the vocal cords we are able to create and modify sounds.

### 3.7 Lung Compliance

**Lung Compliance** is the magnitude of the change in lung volume produced by a change in pulmonary pressure. Compliance can be considered the opposite of stiffness. A low lung compliance would mean that the lungs would need a greater than average change in intrapleural pressure to change the volume of the lungs. A high lung compliance would indicate that little pressure difference in intrapleural pressure is needed to change the volume of the lungs. More energy is required to breathe normally in a person with low lung compliance. Persons with low lung compliance due to disease therefore tend to take shallow breaths and breathe more frequently.

**Determination of Lung Compliance** Two major things determine lung compliance. The first is the elasticity of the lung tissue. Any thickening of lung tissues due to disease will decrease lung compliance. The second is surface tensions at air water interfaces in the alveoli. The surface of the alveoli cells is moist. The attractive force, between the water cells on the alveoli, is called surface tension. Thus, energy is required not only to expand the tissues of the lung but also to overcome the surface tension of the water that lines the alveoli.

To overcome the forces of surface tension, certain alveoli cells (Type II pneumocytes) secrete a protein and lipid complex called "Surfactant", which acts like a detergent by disrupting the hydrogen bonding of water that lines the alveoli, hence decreasing surface tension.

### **3.8 Control of respiration**

#### **3.8.1 central control**

#### **3.8.2 Peripheral control**

CO<sub>2</sub> is converted to HCO<sub>3</sub><sup>-</sup>; most CO<sub>2</sub> produced at the tissue cells is carried to lungs in the form of HCO<sub>3</sub><sup>-</sup>

- CO<sub>2</sub> & H<sub>2</sub>O form carbonic acid (H<sub>2</sub>CO<sub>3</sub>)
- changes to H<sup>+</sup> CO<sub>3</sub><sup>-</sup> & H<sup>+</sup> ions
- result is H<sup>+</sup> ions are buffered by plasma proteins

### **3.9 Respiratory System: Upper and Lower Respiratory Tracts**

For the sake of convenience, we will divide the respiratory system into the upper and lower respiratory tracts:

#### **3.9.1 Upper Respiratory Tract**

The upper respiratory tract consists of the nose and the pharynx. Its primary function is to receive the air from the external environment and filter, warm, and humidify it before it reaches the delicate lungs where gas exchange will occur.

Air enters through the nostrils of the nose and is partially filtered by the nose hairs, then flows into the nasal cavity. The nasal cavity is lined with epithelial tissue, containing blood vessels, which help warm the air; and secrete mucous, which further filters the air. The endothelial lining of the nasal cavity also contains tiny hairlike projections, called cilia. The *cilia* serve to transport dust and other foreign particles, trapped in mucous, to the back of the nasal cavity and to the pharynx. There the mucus is either coughed out, or swallowed and digested by powerful stomach acids. After passing through the nasal cavity, the air flows down the pharynx to the larynx.

#### **3.9.2 Lower Respiratory Tract**

The lower respiratory tract starts with the larynx, and includes the trachea, the two bronchi that branch from the trachea, and the lungs themselves. This is where gas exchange actually takes place.

##### **1. Larynx**

The larynx (plural larynges), colloquially known as the voice box, is an organ in our neck involved in protection of the trachea and sound production. The larynx houses the vocal cords, and is situated just below where the tract of the pharynx splits into the trachea and the esophagus. The larynx contains two important structures: the epiglottis and the vocal cords.

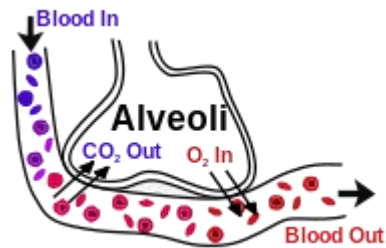
The epiglottis is a flap of cartilage located at the opening to the larynx. During swallowing, the larynx (at the epiglottis and at the glottis) closes to prevent swallowed material from entering the lungs; the larynx is

also pulled upwards to assist this process. Stimulation of the larynx by ingested matter produces a strong cough reflex to protect the lungs. Note: choking occurs when the epiglottis fails to cover the trachea, and food becomes lodged in our windpipe.

The vocal cords consist of two folds of connective tissue that stretch and vibrate when air passes through them, causing vocalization. The length the vocal cords are stretched determines what pitch the sound will have. The strength of expiration from the lungs also contributes to the loudness of the sound. Our ability to have some voluntary control over the respiratory system enables us to sing and to speak. In order for the larynx to function and produce sound, we need air. That is why we can't talk when we're swallowing.

1. Trachea
2. Bronchi
3. Lungs

### 3.10 Homeostasis and Gas Exchange



#### Gas exchange

Homeostasis is maintained by the respiratory system in two ways: gas exchange and regulation of blood pH. Gas exchange is performed by the lungs by eliminating carbon dioxide, a waste product given off by cellular respiration. As carbon dioxide exits the body, oxygen needed for cellular respiration enters the body through the lungs. ATP, produced by cellular respiration, provides the energy for the body to perform many functions, including nerve conduction and muscle contraction. Lack of oxygen affects brain function, sense of judgment, and a host of other problems.

#### 3.10.1 Gas Exchange

Gas exchange in the lungs and in the alveoli is between the alveolar air and the blood in the pulmonary capillaries. This exchange is a result of increased concentration of oxygen, and a decrease of CO<sub>2</sub>. This process of exchange is done through diffusion.

### 3.11 External Respiration

External respiration is the exchange of gas between the air in the alveoli and the blood within the pulmonary capillaries. A normal rate of respiration is 12-25 breaths per minute. In external respiration, gases diffuse in either direction across the walls of the alveoli. Oxygen diffuses from the air into the blood and carbon dioxide diffuses out of the blood into the air. Most of the carbon dioxide is carried to the lungs **in plasma** as bicarbonate ions (HCO<sub>3</sub><sup>-</sup>). When blood enters the pulmonary capillaries, the bicarbonate ions and hydrogen ions are converted to carbonic acid (H<sub>2</sub>CO<sub>3</sub>) and then back into carbon dioxide (CO<sub>2</sub>) and water. This chemical reaction also uses up hydrogen ions. The removal of these ions gives the blood a



more neutral pH, allowing hemoglobin to bind up more oxygen. De-oxygenated blood "blue blood" coming from the pulmonary arteries, generally has an oxygen partial pressure (pp) of 40 mmHg and CO<sub>2</sub> pp of 45 mmHg. Oxygenated blood leaving the lungs via the pulmonary veins has a O<sub>2</sub> pp of 100 mmHg and CO<sub>2</sub> pp of 40 mmHg. It should be noted that alveolar O<sub>2</sub> pp is 105 mmHg, and not 100 mmHg. The reason why pulmonary venous return blood has a lower than expected O<sub>2</sub> pp can be explained by "Ventilation Perfusion Mismatch".

## Internal Respiration

Internal respiration is the exchanging of gases at the cellular level.

### 3.12 The Passage Way From the Trachea to the Bronchioles

There is a point at the inferior portion of the trachea where it branches into two directions that form the right and left primary bronchus. This point is called the **Carina** which is the keel-like cartilage plate at the division point. We are now at the **Bronchial Tree**. It is named so because it has a series of respiratory tubes that branch off into smaller and smaller tubes as they run throughout the lungs.

#### 3.12.1 Right and Left Lungs

##### Bronchi, Bronchial Tree, and Lungs

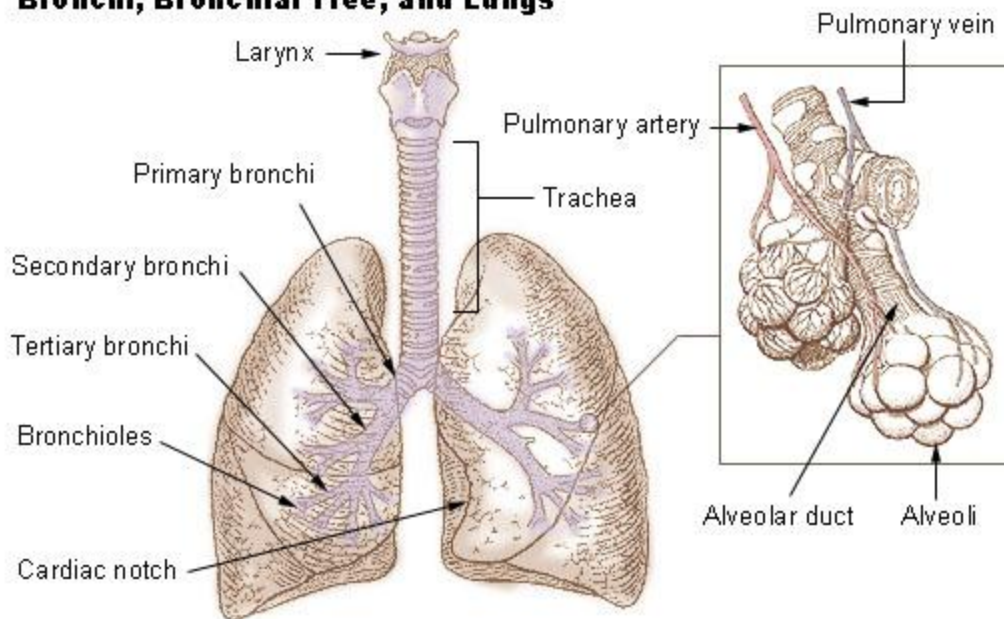


Diagram of the **lungs**

The **Right Primary Bronchus** is the first portion we come to, it then branches off into the **Lobar (secondary) Bronchi, Segmental (tertiary) Bronchi**, then to the **Bronchioles** which have little cartilage and are lined by simple cuboidal epithelium. The bronchi are lined by pseudostratified columnar epithelium. Objects will likely lodge here at the junction of the Carina and the Right Primary Bronchus because of the vertical structure. Items have a tendency to fall in it, where as the Left Primary Bronchus has more of a curve to it which would make it hard to have things lodge there.

The **Left Primary Bronchus** has the same setup as the right with the lobar, segmental bronchi and the bronchioles.

The lungs are attached to the heart and trachea through structures that are called the **roots of the lungs**. The roots of the lungs are the bronchi, pulmonary vessels, bronchial vessels, lymphatic vessels, and nerves. These structures enter and leave at the **hilus** of the lung which is "the depression in the medial surface of a lung that forms the opening through which the bronchus, blood vessels, and nerves pass" (medlineplus.gov).

There are a number of **terminal bronchioles** connected to **respiratory bronchioles** which then advance into the **alveolar ducts** that then become **alveolar sacs**. Each bronchiole terminates in an elongated space enclosed by many air sacs called **alveoli** which are surrounded by blood capillaries. Present there as well, are **Alveolar Macrophages**, they ingest any microbes that reach the alveoli. The **Pulmonary Alveoli** are **microscopic**, which means they can only be seen through a microscope, membranous air sacs within the lungs. They are units of respiration and the site of gas exchange between the respiratory and circulatory systems.

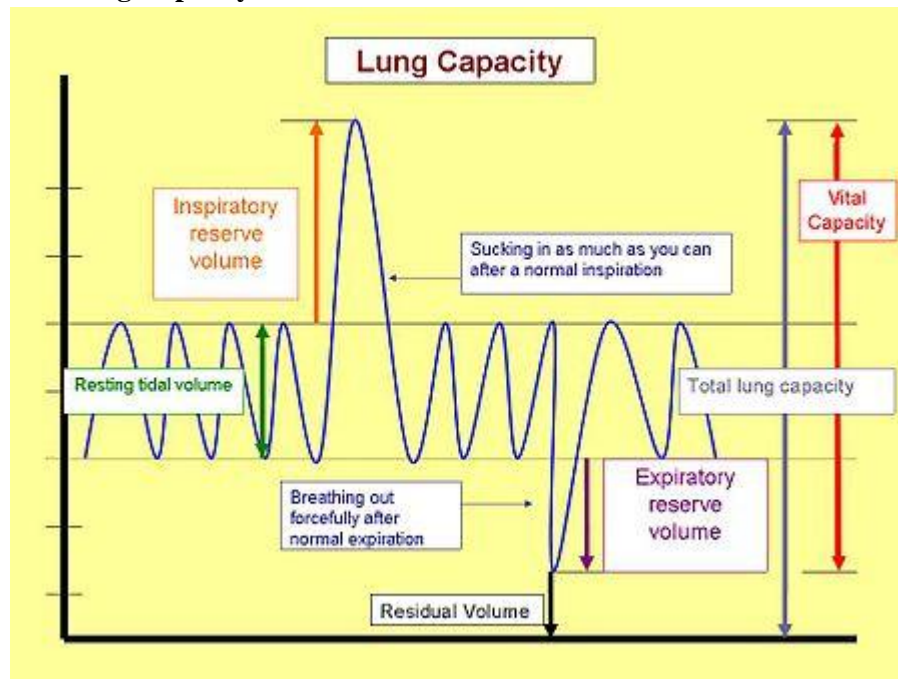
### 3.13 Cellular Respiration

First the oxygen must diffuse from the alveolus into the capillaries. It is able to do this because the capillaries are permeable to oxygen. After it is in the capillary, about 5% will be dissolved in the blood plasma. The other oxygen will bind to red blood cells. The red blood cells contain hemoglobin that carries oxygen. Blood with hemoglobin is able to transport 26 times more oxygen than plasma without hemoglobin. Our bodies would have to work much harder pumping more blood to supply our cells with oxygen without the help of hemoglobin. Once it diffuses by osmosis it combines with the hemoglobin to form oxyhemoglobin.

Now the blood carrying oxygen is pumped through the heart to the rest of the body. Oxygen will travel in the blood into arteries, arterioles, and eventually capillaries where it will be very close to body cells. Now with different conditions in temperature and pH (warmer and more acidic than in the lungs), and with pressure being exerted on the cells, the hemoglobin will give up the oxygen where it will diffuse to the cells to be used for cellular respiration, also called aerobic respiration. Cellular respiration is the process of moving energy from one chemical form (glucose) into another (ATP), since all cells use ATP for all metabolic reactions.

It is in the mitochondria of the cells where oxygen is actually consumed and carbon dioxide produced. Oxygen is produced as it combines with hydrogen ions to form water at the end of the electron transport chain. As cells take apart the carbon molecules from glucose, these get released as carbon dioxide. Each body cell releases carbon dioxide into nearby capillaries by diffusion, because the level of carbon dioxide is higher in the body cells than in the blood. In the capillaries, some of the carbon dioxide is dissolved in plasma and some is taken by the hemoglobin, but most enters the red blood cells where it binds with water to form carbonic acid. It travels to the capillaries surrounding the lung where a water molecule leaves, causing it to turn back into carbon dioxide. It then enters the lungs where it is exhaled into the atmosphere.

### 3.14 Lung Capacity



The normal volume moved in or out of the lungs during quiet breathing is called **tidal volume**. When we are in a relaxed state, only a small amount of air is brought in and out, about 500 mL. You can increase both the amount you inhale, and the amount you exhale, by breathing deeply. Breathing in very deeply is **Inspiratory Reserve Volume** and can increase lung volume by 2900 mL, which is quite a bit more than the tidal volume of 500 mL. We can also increase expiration by contracting our thoracic and abdominal muscles. This is called **expiratory reserve volume** and is about 1400 ml of air. **Vital capacity** is the total of tidal, inspiratory reserve and expiratory reserve volumes; it is called vital capacity because it is vital for life, and the more air you can move, the better off you are. There are a number of illnesses that we will discuss later in the chapter that decrease vital capacity. Vital Capacity can vary a little depending on how much we can increase inspiration by expanding our chest and lungs. Some air that we breathe never even reaches the lungs! Instead it fills our nasal cavities, trachea, bronchi, and bronchioles. These passages aren't used in gas exchange so they are considered to be **dead air space**. To make sure that the inhaled air gets to the lungs, we need to breathe slowly and deeply. Even when we exhale deeply some air is still in the lungs,(about 1000 ml) and is called **residual volume**. This air isn't useful for gas exchange. There are certain types of diseases of the lung where residual volume builds up because the person cannot fully empty the lungs. This means that the vital capacity is also reduced because their lungs are filled with useless air.

### 3.15 Stimulation of Breathing

There are two pathways of motor neuron stimulation of the respiratory muscles. The first is the control of voluntary breathing by the cerebral cortex. The second is involuntary breathing controlled by the medulla oblongata.

There are chemoreceptors in the aorta, the carotid body of carotid arteries, and in the medulla oblongata of the brainstem that are sensitive to pH. As carbon dioxide levels increase there is a buildup of carbonic acid, which releases hydrogen ions and lowers pH. Thus, the chemoreceptors do not respond to changes in oxygen levels (which actually change much more slowly), but to pH, which is dependent upon plasma

carbon dioxide levels. **In other words, CO<sub>2</sub> is the driving force for breathing.** The receptors in the aorta and the carotid sinus initiate a reflex that immediately stimulates breathing rate and the receptors in the medulla stimulate a sustained increase in breathing until blood pH returns to normal.

This response can be experienced by running a 100 meter dash. During this exertion (or any other sustained exercise) your muscle cells must metabolize ATP at a much faster rate than usual, and thus will produce much higher quantities of CO<sub>2</sub>. The blood pH drops as CO<sub>2</sub> levels increase, and you will involuntarily increase breathing rate very soon after beginning the sprint. You will continue to breathe heavily after the race, thus expelling more carbon dioxide, until pH has returned to normal. Metabolic acidosis therefore is acutely corrected by respiratory compensation (hyperventilation).

### 3.16 Regulation of Blood pH

Many of us are not aware of the importance of maintaining the acid/base balance of our blood. It is vital to our survival. Normal blood pH is set at 7.4, which is slightly alkaline or "basic". If the pH of our blood drops below 7.2 or rises above 7.6 then very soon our brains would cease functioning normally and we would be in big trouble. Blood pH levels below 6.9 or above 7.9 are usually fatal if they last for more than a short time. Another wonder of our amazing bodies is the ability to cope with every pH change – large or small. There are three factors in this process: the lungs, the kidneys and buffers.

So what exactly is pH? pH is the concentration of hydrogen ions (H<sup>+</sup>). Buffers are molecules which take in or release ions in order to maintain the H<sup>+</sup> ion concentration at a certain level. When blood pH is too low and the blood becomes too acidic (acidosis), the presence of too many H<sup>+</sup> ions is to blame. Buffers help to soak up those extra H<sup>+</sup> ions. On the other hand, the lack of H<sup>+</sup> ions causes the blood to be too basic (alkalosis). In this situation, buffers release H<sup>+</sup> ions. Buffers function to maintain the pH of our blood by either donating or grabbing H<sup>+</sup> ions as necessary to keep the number of H<sup>+</sup> ions floating around the blood at just the right amount.

The most important buffer we have in our bodies is a mixture of carbon dioxide (CO<sub>2</sub>) and bicarbonate ion (HCO<sub>3</sub><sup>-</sup>). CO<sub>2</sub> forms carbonic acid (H<sub>2</sub>CO<sub>3</sub>) when it dissolves in water and acts as an acid giving up hydrogen ions (H<sup>+</sup>) when needed. HCO<sub>3</sub><sup>-</sup> is a base and soaks up hydrogen ions (H<sup>+</sup>) when there are too many of them. In a nutshell, blood pH is determined by a balance between bicarbonate and carbon dioxide.

**Bicarbonate Buffer System.** With this important system our bodies maintain homeostasis. (Note that H<sub>2</sub>CO<sub>3</sub> is Carbonic Acid and HCO<sub>3</sub><sup>-</sup> is Bicarbonate)



- If pH is too high, carbonic acid will donate hydrogen ions (H<sup>+</sup>) and pH will drop.
- If pH is too low, bicarbonate will bond with hydrogen ions (H<sup>+</sup>) and pH will rise.

Too much CO<sub>2</sub> or too little HCO<sub>3</sub><sup>-</sup> in the blood will cause acidosis. The CO<sub>2</sub> level is increased when hypoventilation or slow breathing occurs, such as if you have emphysema or pneumonia. Bicarbonate will be lowered by ketoacidosis, a condition caused by excess fat metabolism (diabetes mellitus).

Too much HCO<sub>3</sub><sup>-</sup> or too little CO<sub>2</sub> in the blood will cause alkalosis. This condition is less common than acidosis. CO<sub>2</sub> can be lowered by hyperventilation.

So, in summary, if you are going into respiratory acidosis the above equation will move to the right. The body's  $H^+$  and  $CO_2$  levels will rise and the pH will drop. To counteract this the body will breathe more and release  $H^+$ . In contrast, if you are going into respiratory alkalosis the equation will move to the left. The body's  $H^+$  and  $CO_2$  levels will fall and the pH will rise. So the body will try to breathe less to release  $HCO_3^-$ . You can think of it like a leak in a pipe: where ever there is a leak, the body will "fill the hole".

### 3.17 Problems Associated With the Respiratory Tract and Breathing

The environment of the lung is very moist, which makes it a hospitable environment for bacteria. Many respiratory illnesses are the result of bacterial or viral infection of the lungs. Because we are constantly being exposed to harmful bacteria and viruses in our environment, our respiratory health can be adversely affected. There are a number of illnesses and diseases that can cause problems with breathing. Some are simple infections, and others are disorders that can be quite serious.

**Carbon Monoxide Poisoning:** caused when carbon monoxide binds to hemoglobin in place of oxygen. Carbon monoxide binds much tighter, without releasing, causing the hemoglobin to become unavailable to oxygen. The result can be fatal in a very short amount of time.

Mild Symptoms: flu like symptoms, dizziness, fatigue, headaches, nausea, and irregular breathing

Moderate Symptoms: chest pain, rapid heart beat, difficulty thinking, blurred vision, shortness of breath and unsteadiness

Severe Symptoms: seizures, palpitations, disorientation, irregular heart beat, low blood pressure, coma and death.

**Pulmonary Embolism:** blockage of the pulmonary artery (or one of its branches) by a blood clot, fat, air or clumped tumor cells. By far the most common form of pulmonary embolism is a thromboembolism, which occurs when a blood clot, generally a venous thrombus, becomes dislodged from its site of formation and embolizes to the arterial blood supply of one of the lungs.

Symptoms may include difficulty breathing, pain during breathing, and more rarely circulatory instability and death. Treatment, usually, is with anticoagulant medication.

#### 3.17.1 Upper Respiratory Tract Infections

The upper respiratory tract consists of our nasal cavities, pharynx, and larynx. Upper respiratory infections (URI) can spread from our nasal cavities to our sinuses, ears, and larynx. Sometimes a viral infection can lead to what is called a secondary bacterial infection. "**Strep throat**" is a primary bacterial infection and can lead to an upper respiratory infection that can be generalized or even systemic (affects the body as a whole). Antibiotics aren't used to treat viral infections, but are successful in treating most bacterial infections, including strep throat. The symptoms of strep throat can be a high fever, severe sore throat, white patches on a dark red throat, and stomach ache.

##### 3.17.1.1 Sinusitis

An infection of the cranial sinuses is called **sinusitis**. Only about 1-3% of URI's are accompanied by sinusitis. This "sinus infection" develops when nasal congestion blocks off the tiny openings that lead to the sinuses. Some symptoms include: post nasal discharge, facial pain that worsens

when bending forward, and sometimes even tooth pain can be a symptom. Successful treatment depends on restoring the proper drainage of the sinuses. Taking a hot shower or sleeping upright can be very helpful. Otherwise, using a spray decongestant or sometimes a prescribed antibiotic will be necessary.

### **3.17.1.2 Otitis Media**

Otitis media is an infection of the middle ear. Even though the middle ear is not part of the respiratory tract, it is discussed here because it is often a complication seen in children who have a nasal infection. The infection can be spread by way of the '*auditory (Eustachian) tube*' that leads from the nasopharynx to the middle ear. The main symptom is usually pain. Sometimes though, vertigo, hearing loss, and dizziness may be present. Antibiotics can be prescribed and tubes are placed in the eardrum to prevent the buildup of pressure in the middle ear and the possibility of hearing loss.



### **3.18.1 Photo of Tonsillitis.**

#### **3.18.1.1 Tonsillitis**

Tonsillitis occurs when the tonsils become swollen and inflamed. The tonsils located in the posterior wall of the nasopharynx are often referred to as adenoids. If you suffer from tonsillitis frequently and breathing becomes difficult, they can be removed surgically in a procedure called a tonsillectomy.

#### **3.18.1.2 Laryngitis**

An infection of the larynx is called laryngitis. It is accompanied by hoarseness and being unable to speak in an audible voice. Usually, laryngitis disappears with treatment of the URI. Persistent hoarseness without a URI is a warning sign of cancer, and should be checked into by your physician.

### 3.19 Lower Respiratory Tract Disorders

Lower respiratory tract disorders include infections, restrictive pulmonary disorders, obstructive pulmonary disorders, and lung cancer.

#### 3.19.1 Lower Respiratory Infections

##### 3.19.1 .1 Acute bronchitis

An infection that is located in the primary and secondary bronchi is called bronchitis. Most of the time, it is preceded by a viral URI that led to a secondary bacterial infection. Usually, a nonproductive cough turns into a deep cough that will expectorate mucus and sometimes pus.

##### 3.19.1 .2 Pneumonia

A bacterial or viral infection in the lungs where the bronchi and the alveoli fill with a thick fluid. Usually it is preceded by influenza. Symptoms of pneumonia include high fever & chills, with headache and chest pain. Pneumonia can be located in several lobules of the lung and obviously, the more lobules involved, the more serious the infection. It can be caused by a bacteria that is usually held in check, but due to stress or reduced immunity has gained the upper hand.

### 3.20 Restrictive Pulmonary Disorders

#### 3.20.1 Pulmonary Fibrosis

Vital capacity is reduced in these types of disorders because the lungs have lost their elasticity. Inhaling particles such as sand, asbestos, coal dust, or fiberglass can lead to **pulmonary fibrosis**, a condition where fibrous tissue builds up in the lungs. This makes it so our lungs cannot inflate properly and are always tending toward deflation.

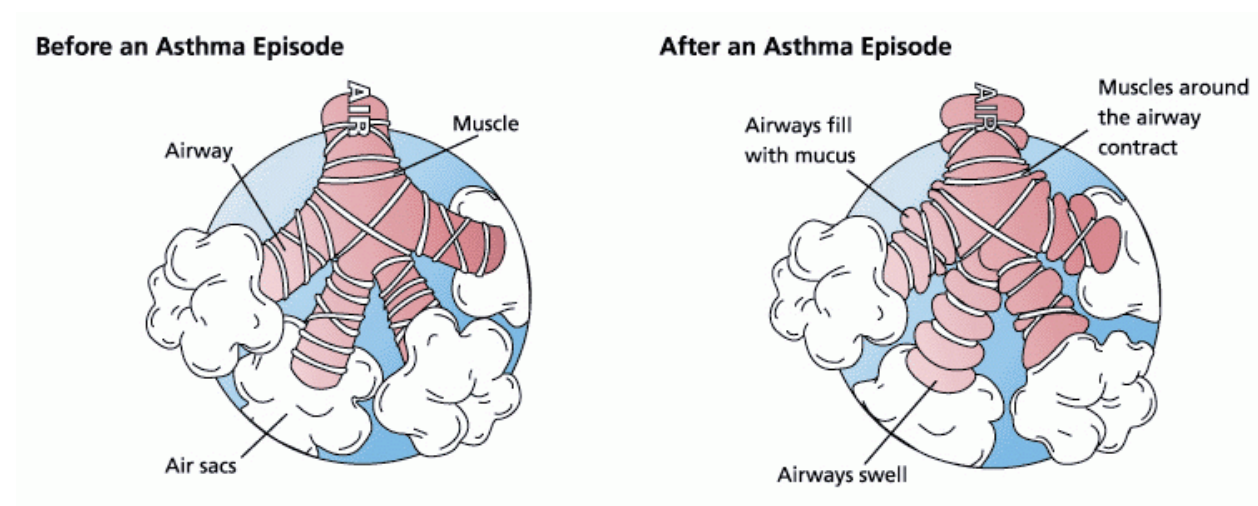


Diagram of the lungs during an **asthma attack**.

### 3.20.2 Asthma

Asthma is a respiratory disease of the bronchi and bronchioles. The symptoms include wheezing, shortness of breath, and sometimes a cough that will expel mucus. The airways are very sensitive to irritants which can include pollen, dust, animal dander, and tobacco. Even being out in cold air can be an irritant. When exposed to an irritant, the smooth muscle in the bronchioles undergoes spasms. Most asthma patients have at least some degree of bronchial inflammation that reduces the diameter of the airways and contributes to the seriousness of the attack.

## 3.21 Respiratory Distress Syndrome

### 3.21.1 Pathophysiology

At birth the pressure needed to expand the lungs requires high inspiratory pressure. In the presence of normal surfactant levels the lungs retain as much as 40% of the residual volume after the first breath and thereafter will only require far lower inspiratory pressures. In the case of deficiency of surfactant the lungs will collapse between breaths, this makes the infant work hard and each breath is as hard as the first breath. If this goes on further the pulmonary capillary membranes become more permeable, letting in fibrin rich fluids between the alveolar spaces and in turn forms a hyaline membrane. The hyaline membrane is a barrier to gas exchange, this hyaline membrane then causes hypoxemia and carbon dioxide retention that in turn will further impair surfactant production.

### 3.21.2 Etiology

Type two alveolar cells produce surfactant and do not develop until the 25th to the 28th week of gestation, in this, respiratory distress syndrome is one of the most common respiratory disease in premature infants. Furthermore, surfactant deficiency and pulmonary immaturity together leads to alveolar collapse. Predisposing factors that contribute to poorly functioning type II alveolar cells in a premature baby are if the child is a preterm male, white infants, infants of mothers with diabetes, precipitous deliveries, cesarean section performed before the 38th week of gestation. Surfactant synthesis is influenced by hormones, this ranges from insulin and cortisol. Insulin inhibits surfactant production, explaining why infants of mothers with diabetes type 1 are at risk of development of respiratory distress syndrome. Cortisol can speed up maturation of type II cells and therefore production of surfactant. Finally, in the baby delivered by cesarean section are at greater risk of developing respiratory distress syndrome because the reduction of cortisol produced because the lack of stress that happens during vaginal delivery, hence cortisol increases in high stress and helps in the maturation of type II cells of the alveoli that cause surfactant.

### 3.21.3 Treatment

Today to prevent respiratory distress syndrome are animal sources and synthetic surfactants, and administrated through the airways by an endotracheal tube and the surfactant is suspended in a saline solution. Treatment is initiated post birth and in infants who are at high risk for respiratory distress syndrome.



### 3.22 Sleep Apnea



CPAP is the most common treatment for obstructive sleep apnea.

Sleep apnea or sleep apnoea is a sleep disorder characterized by pauses in breathing during sleep. These episodes, called apneas (literally, "without breath"), each last long enough so one or more breaths are missed, and occur repeatedly throughout sleep. The standard definition of any apneic event includes a minimum 10 second interval between breaths, with either a neurological arousal (3-second or greater shift in EEG frequency, measured at C3, C4, O1, or O2), or a blood oxygen desaturation of 3-4 percent or greater, or both arousal and desaturation. Sleep apnea is diagnosed with an overnight sleep test called polysomnogram. One method of treating central sleep apnea is with a special kind of CPAP, APAP, or VPAP machine with a Spontaneous Time (ST) feature. This machine forces the wearer to breathe a constant number of breaths per minute.

(CPAP), or continuous positive airway pressure, in which a controlled air compressor generates an airstream at a constant pressure. This pressure is prescribed by the patient's physician, based on an overnight test or titration.

### 3.23 Nutrition for COPD (Chronic Obstructive Pulmonary Disease) Patients

Nutrition is particularly important for ventilator-dependent patient. When metabolizing macronutrients carbon dioxide and water are produced. The respiratory quotient (RQ) is a ratio of produced carbon dioxide to amount consumed. Carbohydrates metabolism produces the most amount of carbon dioxide so they have the highest (RQ). Fats produce the least amount of carbon dioxide along with proteins. Protein has a slightly higher RQ ratio. It is recommended that this kind of patient not exceed a 1.0 respiratory quotient (RQ). Lowering carbohydrates and supplementing fat or protein in the diet might not result in maintaining the desired outcome because, excess amounts fat or protein may also result in a respiratory quotient (RQ) higher than 1.0.

- Please reference source and fact accuracy. It seems like by definition, it is impossible to exceed a respiratory quotient (RQ) of 1.0. \*

### 3.24 Case Study

#### 3.24.1 Cystic Fibrosis

This disease is most common in Caucasians and will happen to 1 in every 2500 people. It is most known for its effects on the respiratory tract although it does effect other systems as well. The respiratory

passages become clogged with a thick mucus that is difficult to expel even with vigorous coughing. Breathing becomes difficult and affected individuals run the risk of choking to death on their own secretions unless strenuous effort is made to clear the lungs multiple times every day. Victims frequently will die in the 20's of pneumonia. All of us secrete mucus by certain cells in the epithelium that line the respiratory passage ways. In normal cases the cells also secrete a watery fluid that will dilute the mucus making it easier to pass through the airways. In cystic fibrosis that secretion of watery fluid is impaired. This makes the mucus thicker and difficult to clear from the passageways. A recent discovery found that in cystic fibrosis is caused by a defect in a type of chloride protein found in apical membranes of epithelial cells in the respiratory system and elsewhere. This defect directly impedes the chloride ions transport, which will then indirectly effect the transport of potassium ions. This causes the epithelium, to not create its osmotic gradient necessary for water secretion. It has been known for a long time that cystic fibrosis is caused by a recessive gene inheritance. This gene codes for a portion of the chloride channel protein, which can malfunction in a variety of ways, each with specific treatment required.

### *Review Questions*

1. Define the Respiratory system?
2. Explain the Upper and the Lower Respiratory Tract?
3. Explain the Breathing and Lung Mechanics?
4. Explain the Breathing disorders?

### *Discussion Questions*

Discuss the Respiratory system in details?

## Lesson 4 – Central nervous system

### Learning Objectives

- To define the Central nervous system.
- To explain the Classification of Neurones.
- To explain the Brain Divisions.
- To describe the Causes of Brain Damage.

### 4.1 The Human Nervous System

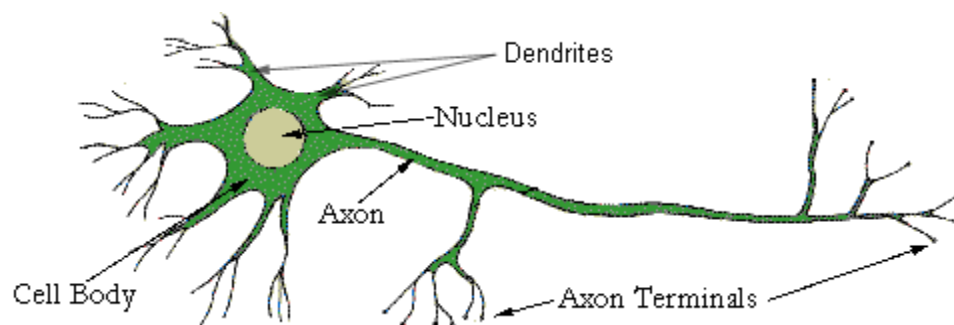
The nervous system is essentially a biological information highway, and is responsible for controlling all the biological processes and movement in the body, and can also receive information and interpret it via electrical signals which are used in this nervous system

It consists of the Central Nervous System (CNS), essentially the processing area and the Peripheral Nervous System which detects and sends electrical impulses that are used in the nervous system

### 4.2 The Central Nervous System (CNS)

The Central Nervous System is effectively the centre of the nervous system, the part of it that processes the information received from the peripheral nervous system. The CNS consists of the brain and spinal cord. It is responsible for receiving and interpreting signals from the peripheral nervous system and also sends out signals to it, either consciously or unconsciously. This information highway called the nervous system consists of many nerve cells, also known as neurones, as seen below.

#### 4.2.1 The Nerve Cell



Each neurone consists of a nucleus situated in the cell body, where outgrowths called processes originate from. The main one of these processes is the axon, which is responsible for carrying outgoing messages from the cell. This axon can originate from the CNS and extend all the way to the body's extremities, effectively providing a highway for messages to go to and from the CNS to these body extremities.

Dendrites are smaller secondary processes that grow from the cell body and axon. On the end of these dendrites lie the axon terminals, which 'plug' into a cell where the electrical signal from a nerve cell to the target cell can be made. This 'plug' (the axon terminal) connects into a receptor on the target cell and can transmit information between cells

#### **4.2.2 The Way Nerve Cells Communicate**

The "All-Or-None-Law" applies to nerve cell communication as they use an on / off signal (like a digital signal) so that the message can remain clear and effective from its travel from the CNS to the target cell or vice versa. This is a factor because just like electricity signals, the signal fades out and must be boosted along its journey. But if the message is either 1 or 0 (i.e.) on or off the messages are absolute.

#### **4.2.3 Classification of Neurones**

**Interneurones** - Neurones lying entirely within the CNS

**Afferent Neurones** - Also known as sensory neurones, these are specialised to send impulses towards the CNS away from the peripheral system

**Efferent Neurones** - These nerve cells carry signals from the CNS to the cells in the peripheral system

#### **4.2.4 The Conscious & Unconscious Nervous System**

The Central Nervous System is arguably the most important part of the body because of the way it controls the biological processes of our body and all conscious thought. Due to their importance, they are safely encased within bones, namely the cranium protecting the brain and the spine protecting the spinal cord

### **4.3 Brain Divisions**

There are three main components of the brain, namely the brainstem, cerebellum and the forebrain. These are elaborated upon below

- **The Brainstem** - The brainstem is the connection between the rest of the brain and the rest of the central nervous system. This part of the brain was the first to be found in the evolutionary chain, though has developed over time and via evolution to develop into the two other components. It is primarily concerned with life support and basic functions such as movement, thus meaning that more advanced processes are left to the more evolved areas of the brain, as explained below.
- **The Cerebellum** - Consisting of two hemispheres, the cerebellum is primarily concerned with movement and works in partnership with the brainstem area of the brain and focuses on the well being and functionality of muscles. The structure can be found below the occipital lobe and adjacent to the brainstem
- **The Forebrain** - The forebrain lies above the brainstem and cerebellum and is the most advanced in evolutionary terms. Due to its complexity, more info is divulged about this part of the brain below

### **4.3.1The Forebrain**

The forebrain has many activities that it is responsible for and is divided into many component parts. The below list elaborates on the localised areas of the forebrain and their functions.

- The Hypothalamus - A section of the brain found next to the thalamus that is involved in many regulatory functions such as osmoregulation and thermoregulation. The hypothalamus has a degree of control over the pituitary gland, another part of the brain situated next to it, and also controls sleeping patterns, eating and drinking and speech. The hypothalamus is also responsible for the secretion of ADH (Anti-Diuretic Hormone) via its neurosecretory cells
  - The Cerebrum - The cerebrum is the largest part of the human brain, and the part responsible for intelligence and creativity, and also involved in memory. The 'grey matter' of the cerebrum is the cerebral cortex, the centre that receives information from the thalamus and all the other lower centres in the brain.
  - The Cerebral Cortex - Part of the cerebrum, this part of the brain deals with almost all of the higher functions of an intelligent being. It is this part of brain that deals with the masses of information incoming from the periphery nervous system, furiously instructing the brain of what is going on inside its body and the external environment. It is this part that translates our nervous impulses into understandable quantifiable feelings and thoughts. So important is the cerebral cortex that it is sub-divided into 4 parts, explained below
1. Frontal Lobe - Found at the front of the head, near the temples and forehead, the frontal lobe is essential to many of the advanced functions of an evolved brain. It deals with voluntary muscle movements and deals with more intricate matters such as thought and speech
  2. Parietal Lobe - Situated behind the frontal lobe, this section deals with spatial awareness in the external environment and acts as a receptor area to deal with signals associated with touch.
  3. Temporal Lobe - The temporal lobes are situated in parallel with the ears, they serve the ears by interpreting audio signals received from the auditory canal
  4. Occipital Lobe - This is the smallest of the four lobe components of the cerebrum, and is responsible in interpreting nerve signals from the eye at the back of the brain

The above components of the brain work in tandem in a healthy brain. However, in some cases the brain can be injured in some way, causing brain damage.

### **4.3.2Myelin Sheath**

Myelin is a substance that forms the myelin sheath associated with nerve cells. This sheath is a layer of phospholipids that increases the conductivity of the electrical messages that are sent through the cell. Diseases such as multiple sclerosis are a result in a lack of this myelin sheath, with the resultant effect being that the conductivity of signals is much slower severely decreasing the effectiveness of the nervous system in sufferers.

In total, there are 43 main nerves that branch of the CNS to the peripheral nervous system (the peripheral system is the nervous system outside the CNS. These are the efferent neurones that carry signals away from the CNS to the peripheral system.

#### **4.4 Somatic Nervous System**

These efferent fibres are divided into the somatic nervous system and the autonomic nervous system. The somatic fibres are responsible for the voluntary movement of our body, i.e. movement that you consciously thought about doing.

#### **4.5 The Autonomic Nervous System**

The autonomic nervous system incorporates all the impulses that are done involuntarily, and are usually associated with essential functions such as breathing, heartbeat etc. However this type of system can further be broken down into the sympathetic and parasympathetic systems which keep one another in check in a form of negative feedback such as the release of insulin and glucagon in sugar control of the blood.

All of the actions executed by the autonomic nervous system are unconsciously done.

These informational pulses executed in our nervous system allow us to do our daily functions. The processing of this information is done in the CNS, the brain, a highly developed mass of nerve cells.

#### **4.6 Causes of Brain Damage**

The brain is a highly specialised tissue, far more complex than today's 21st century supercomputers. Due to this magnificent complexity, even the slightest damage can have extreme consequences

The brain can be damaged in a variety of ways, and depending on the areas damaged and the severity of the damage, it can prove relatively harmless to fatal. Some causes of brain damage are below

- Genetics - A dysfunctional hereditary gene could have been passed on to the offspring which prevented the full development of a healthy brain
- Blow - A sufficient blow to the head can supercede the skulls defences (particularly at the temple) and can therefore allow structural damage to occur.
- Lack of Blood - Lack of blood to the brain can cause severe problems for the cells associated with the brain. A human can survive for four minutes without oxygen before the brain damage becomes so severe there is no realistic chance of survival. A stroke is an event where there is a blood shortage to the brain, which is caused by a blood clot
- Tumours - Cancer has been a major non-infectious disease more recognised over the last decade, and more cases of brain tumours are detected nowadays due to more sophisticated techniques. The continued growth of these cancerous cells puts pressure on the brain, which can cause a blood clot or directly cause brain damage due to the pressure of the tumour pressing against it.

##### **4.6.1 Types of Brain Damage**

- Aphasia - A type of brain damage affecting communication capabilities in the organism. This can range from the inability to construct a sentence either in voice or on paper, to the inability to recognise speech itself. This sort of damage focuses on the frontal lobe area of the brain
- Visual Neglect - This is where the information collated on one half of the brain is rejected and therefore the sufferer can only operate with one eye, because the part of the brain receiving visual information from the other eye is not functioning properly. In some cases, sufferers may only be

able to paint half a painting or eat one half of a plate of food as they are unaware of the information about the other half of the environment.

- Amnesia - Or retrograde amnesia, this sort of damage affects the memory, caused by degeneration / damage in the frontal lobe. Sufferers have memory blanks when relating to past experiences in their life
- Agnosia - This unusual sort of brain damage is where sufferers still have the complete ability to see around them (unlike visual neglect), though cannot relate their surroundings in a quantifiable way, i.e. they fail to recognise a familiar surrounding, person or object, due to a malfunction in recalling past events involving the surrounding, person or object

#### **4.7 Evolution of Human Intelligence**

Human's, as evolved as we are, are the species most capable of exhibiting intelligence and creativity due to our capacity to learn. It is nothing short of remarkable how we, intelligent beings, came to exist.

- Humans evolved from similar primates millions of years ago, who were better equipped to survive in their environment (more info in the Evolution of Species tutorial)
- This knowledge gained has been passed on (greatly accelerated by advances in the way we communicate)
- As a consequence, offspring of our species have harnessed previously accumulated (and written) knowledge to our advantage.
- Our technological and intellectual powers has allowed us to exist in huge numbers, and take advantage of our environment in remarkable ways - *continuing to attempt to make best use of what we know or could possibly know.*

In light of this snowball effect, and as a continuation of the last bulleted point; we have been able to sustain a rising human population over time. In turn, in accordance with natural selection, more intelligent people may be favoured by our gene pool over the long term, thus making the species as a whole more intelligent as a collective.

#### **4.8 Ability to Learn**

Humans continually learn from one another and share their information over generations. This is what makes our species a cut above the rest. Our ability to understand the value of learning and to do so gives us the tool to understand more and more about ourselves and our environment.

#### **4.9 Intelligence**

Intelligence offers us the means to utilise abstract ideas and implement reasoning in our arguments to justify the things we do. The degree of intelligence in people is variable to a number of factors, like genetics, the local environment and even diet.

It is important to note the following

- Knowledge is the accumulation and retention of information
- Intelligence is the ability to analyse this information to the persons advantages, i.e. answering correctly in the exam by making best use of the information you know.

## 4.10 Creativity

It does not take an intelligent person to be creative. It is a popular belief that technically minded people tend to be less creative as others, who, in turn, are not very technically minded.

It is believed that creativity is made possible in the right brain hemisphere while the technical information is processed in the left hemisphere. It is worth noting that many of the famous creative individuals, all the famous writers, artists etc were generally intelligent.

Creativity can rely on a number of factors, some of which are named below

- **Motivation** - If the person has no desire to utilise their creativeness, they will not be creative.
- **Personality** - Peoples' unique inclinations and differences in decision making makes our choice of creativity unique and thus the decisions made in creating something will be different with each person.
- **Parental Guidance** - Parents provide the crucial link for learning between birth and maturity, therefore their learning, and partly their creativity and intelligence will rub off on those they learn, as will the people that you communicate with.

Moreover to the last factor, it is worth considering that any factor in the external environment will be a factor in your creativity. If someone offered you a million euros to write a good poem, you may instantaneously feel more creative!

## 4.11 The Falling Asleep Process

During the day when we are awake, our body and brain are working tirelessly to operate our body, and as they do so they slowly degrade at a cellular level. A person will get progressively tired from this bodily breakdown, because sleep gives us a chance to build and replace the cells and resolve our end of day homeostatic imbalances.

If you have not slept for a while, the decrease in the efficiency and effectiveness of the body begins to tell, and you will begin to feel sleepy as less energy is available to you. The longer we stay up the more likely we will fall asleep.

If certain conditions prevail, like a state of inactivity or relaxing in a warm dry place, there is a higher chance of us falling asleep due to the preferable conditions for us to do so.

### 4.11.1 Sleeping

When we fall asleep, our metabolic rate slows down, as does almost every other function across the board, we effectively go into hibernation mode. The amount of adrenaline in our body promoting awareness decreases and somatotrophin, controlling the repair of tissue is more abundant. This is effectively the healing process of sleep that revitalises us.

The synaptic nerve connections containing recollections about the last day are also strengthened, hence when you wake up the more you realised you did yesterday. This localised area of memory is what many of our dreams consist of, our past recollections of the day. You may have dreamt something twice, and on the second time it was only because you thought of that first dream the day before you dreamt the second.



When looking at it like this, it confirms the reason why you have the same dream, your conscious thought about it accesses that part of the brain thus 'remembers' it at night.

#### **4.11.2 Dreams Telling the Future?**

Some people believe that dreams tell the future. But, when 6 billion people dream every night, there is bound to be a coincidence when there are trillions of dreams every year. Those people who have dreamed of winning the lottery are one of many.

I, personally don't believe they tell the future, though could be a sign of intelligence, the brain interpreting possibilities in the future from the knowledge of past events. This would be perfectly viable, as it would be a case of the brain 'adapting' to its future environment, and preparing you for the possible future.

#### **4.11.3 REM**

REM stands for rapid eye movement and is the points in time during sleep where dreams occur. They occur after periods of deep sleep.

As suggested, rapid eye movement occurs in REM, while the body is under a state of paralysis.

In effect, our brain takes us on a virtual reality of our thoughts while it steadily repairs itself for the next day. The most vivid and deepest dreams will occur in the periods between REM while drowsy, almost conscious dreams occur in the REM stages.

#### **4.11.4 Our Environment Outside Sleep**

Have you ever had a dream where someone next door is playing music, and the music is conveniently woven into your dream? This is your body trying to lessen the chances of you awakening while it is repairing itself.

However, sleep deprived people go into much deeper sleep, and may not detect such noises. The overriding point here is, that sleep is essential to the body, and that there are compensations made to our usual behaviour (like paralysis) that enables our body to do what is required for itself.

#### **4.12 Sleep Troubles**

The older we get, the less sleep we require. Teenagers buck the trends in needing the most sleep of us all, due to the growth spurt occurring at puberty that involves a larger turnover of materials and energy.

- Newborn babies can sleep up to 60% of the day
- Adults require around 7 hours minimum
- With aging, the amount required is less due to the gradual degeneration of parts of the body that are not getting repaired.

Certain drugs are available to induce sleeping, but most are addictive and require controlled and responsible use.

#### 4.12.1 Sigmund Freud

Sigmund Freud was a famous Austrian neurologist (1856 - 1939), who stated that dreams were the manifestation of the unconscious. Himself and another neurologist, Carl Gustav Jung (1875 - 1961), believed that conscious behaviour derived from unconscious instinct which exists in all of us.

These unconscious thoughts were linked to suppressed sexual desires. Freud identified three key stages in the life cycle where the child's tendency to focus on sexual areas of the body changes over time.

- The first year of a babies life they focus on the mothers mammarian gland for feeding (the breast).
- This state is succeeded from age 1 to 3 where the toddler is learning how to control their bowel and concentrates on their anal region.
- This is in turn succeeded by attention towards the reproductive organs at age 3 to 4.

Freud argued that in these stages of unconscious repression, male children are attracted to their mother and become instinctively aggressive towards the father. The father reciprocally injects fear into the child by his male superiority, thus insinuating an essence of *competition* and *games theory*. Either way, the prime fact is that the child must grow to become sexually active and mature.

#### 4.12.2 Differences Between Jung and Freud

Jung believed that a persons' brain consisted of the forgotten conscious and a cluster of memories of past experiences. He came to this hypothesis by studying humans suffering a mental disorder, who had hallucinations that were not a past recollection, thus Jung deduced there was another component of the brain adding to this illusion, i.e. the unconscious.

Freud on the other hand believed that the brain was divided into three parts

- The ID - Inherited natural instincts
- The Ego - The sense of self and attitude towards the external environment
- The Superego - Superimposed values deriving from society and parental guidance

Essentially, this method of thinking, and approaching the brain from a self-realizing approach, neurology has been able to develop since these initial theories by Jung and Freud.

It also paved advance in psychiatry, and methods of psycho therapy to combat mental disorders, which are investigated upon in the next page.

#### 4.12.3 The Definition of Mad

When someone says 'mental disorder' many people associate it with madness. This is truly not the case. There are many states of mental disorder where the sufferer is not clinically insane.

Madness essentially means psychosis, being out of touch of reality and not being capable of rational and controlled thought. A person in psychosis may have irrational delusions and hallucinations that illustrate this imbalance in conscious and unconscious mind.

#### **4.12.4 Schizophrenia**

Schizophrenia can effect mind and personality. In severe cases, the sufferer believes that 'something' is in control of them, and that they have lost control of themselves.

#### **4.12.5 Affective Mood Disorder**

- Mania - The sufferer is overly cheerful and can possibly appear as if they are under the influence of alcohol
- Depression - Where beliefs and perceptions are unclear & unproductive

#### **4.12.6 Obsessive & Compulsive Disorder**

A mental disorder where the sufferer must undergo meticulous rituals to live their normal lives, such as excessive washing of their skin and hair. If the sufferer cannot do this, anxiety kicks in as a "withdrawal symptom" until they allow themselves to repeat the ritual once again.

#### **4.12.7 Phobias**

A preconception about a given situation or object, such as a fear of snakes or being in high places. A huge diversity of phobias have been discovered by psychologists.

#### **4.12.8 Depressive Neurosis**

The classic case of depression where depression is the primary emotion in the sufferer, resulting in a lack of motivation and self-esteem to be functional in society and to themselves.

#### **4.12.9 Physical Disease**

Not only can the way the brain works be affected by disorders, the physical components of the brain can also be infected by pathogens. Dementia is such a physical disease, where the long term memory of the sufferer is broken down due to the physical components of the brain and nervous synapses degrading over time.

#### **4.12.10 Drugs for Mental Disorders**

A wide range of drugs are now available for those suffering mental disorders, though many people face a psychological barrier when it comes to taking medication to cure their 'soul'. Many of the drugs used prove addictive which in turn can also lead to further psychiatric problems.

However, psychotherapy is an alternative communicative treatment designed to get the patient to understand themselves better. This can be combined with drugtherapy, and eventually develop the patients' self realisation into a moreproductive and positive state. Medicinal neurology is a fairly new area of medicine.

#### **4.13 Human Perception - Neurology**

A better understanding of human perception unlocks the key to how the mind works, an advantage when working with people with mental disorders.

#### **4.13.1 Visual Perception**

The below diagram is an illustration as to how we all perceive things in our own way, as suggested by the theories of Jung and Freud.



**What do you see?** Some of you may see 2 green faces, other may see a white chalice. This all depends on your initial perception of the diagram. You may find that when you look again, you may see the alternate picture within the diagram.

The retina is responsible for interpreting visual stimuli such as this, where it picks up photons of light via the 130 000 000 rods and cones situated on it. In pre-modern times it was considered that visual perception simply encompassed what was seen by the eye on the outside. This external stimuli would in turn produce a perception in the brain caused by the stimulus.

However this is not the case. Modern medicine now knows that information from the eye is simply a physiological process that does not actually process the signals it receives. This job is left to the brain.

The senses simply act as a messenger to a particular stimulus that is seen, the brain is the place where external stimuli is actually perceived.

#### **4.13.2 Spatial Awareness**

The environment we live in is 3 dimensional, thus needs a 3 dimensional approach to understand it. Therefore height, width and depth must be measured by the eyes

This is possible by the way the eyes are situated on the head. Positioned either side of the nose, the right eye picks up vision on the left hemisphere and the left eye picks up vision in the right hemisphere.

The images picked up by the eyes are projected upside down on each of the eyes retina. This in turn will be perceived the right way up by the brain, which will interpret the three dimensional values of the external environment at a very fast and effective rate

#### **4.13.3 Illusions**

It is possible for the physiological state of the brain to deviate from the norm and trigger of a mental disorder. Illusions are a symptom of such mental disorders.

However it is also possible to trick the senses of a perfectly functional healthy brain. Illusions, such as the mirages that appear in the desert are caused by trickery of the sense, leading us to believe there is something out there when this is not the case.

### *Review Questions*

1. Define the Central nervous system?
2. Explain the Brain Divisions?
3. Explain the Evolution of Human Intelligence?
4. Explain the Human Perception?

### Discussion Questions

Discuss the Central nervous system in details?

## Lesson 5 – Musculoskeletal system

### Learning Objectives

- To define the Musculoskeletal system.
- To explain the Muscular.
- To explain the Joints, ligaments, and bursae.
- To describe the Diseases and disorders related to Musculoskeletal system.

### 5.1 Human musculoskeletal system

A **musculoskeletal system** (also known as the **locomotor system**) is an organ system that gives animals (and humans) the ability to move using the muscular and skeletal systems. The musculoskeletal system provides form, support, stability, and movement to the body.

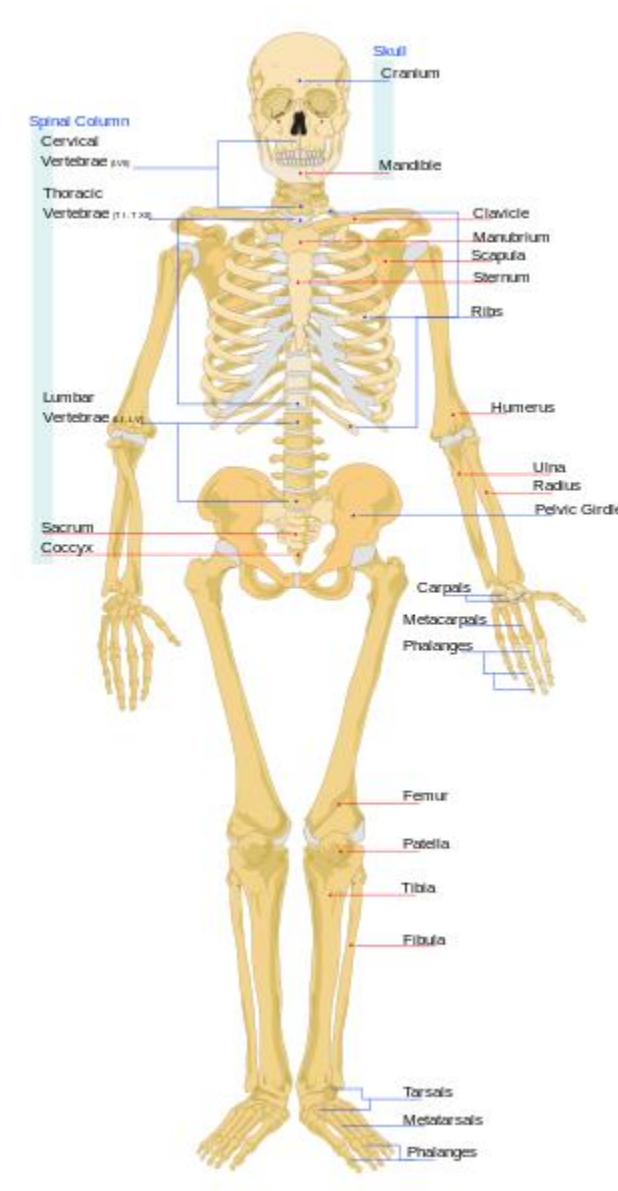
It is made up of the body's bones (the skeleton), muscles, cartilage, tendons, ligaments, joints, and other connective tissue that supports and binds tissues and organs together. The musculoskeletal system's primary functions include supporting the body, allowing motion, and protecting vital organs. The skeletal portion of the system serves as the main storage system for calcium and phosphorus and contains critical components of the hematopoietic system.

This system describes how bones are connected to other bones and muscle fibers via connective tissue such as tendons and ligaments. The bones provide the stability to a body in analogy to iron rods in concrete construction. Muscles keep bones in place and also play a role in movement of the bones. To allow motion, different bones are connected by joints. Cartilage prevents the bone ends from rubbing directly on to each other. Muscles contract (bunch up) to move the bone attached at the joint.

There are, however, diseases and disorders that may adversely affect the function and overall effectiveness of the system. These diseases can be difficult to diagnose due to the close relation of the musculoskeletal system to other internal systems. The musculoskeletal system refers to the system having its muscles attached to an internal skeletal system and is necessary for humans to move to a more favorable position. Complex issues and injuries involving the musculoskeletal system are usually handled by a physiatrist (specialist in Physical Medicine and Rehabilitation) or an orthopaedic surgeon.

## 5.2 Subsystems

### 5.2.1 Skeletal



Front view of a skeleton of an adult human

The Skeletal System serves many important functions; it provides the shape and form for our bodies in addition to supporting, protecting, allowing bodily movement, producing blood for the body, and storing minerals. The number of bones in the human skeletal system is a controversial topic. Humans are born with over 300 bones; however, many bones fuse together between birth and maturity. As a result an average adult skeleton consists of 206 bones. The number of bones varies according to the method used to derive the count. While some consider certain structures to be a single bone with multiple parts, others may see it as a single part with multiple bones. There are five general classifications of bones. These are

Long bones, Short bones, Flat bones, Irregular bones, and Sesamoid bones. The human skeleton is composed of both fused and individual bones supported by ligaments, tendons, muscles and cartilage. It is a complex structure with two distinct divisions. These are the axial skeleton and the appendicular skeleton.

### **5.2.2Function**

The Skeletal System serves as a framework for tissues and organs to attach themselves to. This system acts as a protective structure for vital organs. Major examples of this are the brain being protected by the skull and the lungs being protected by the rib cage.

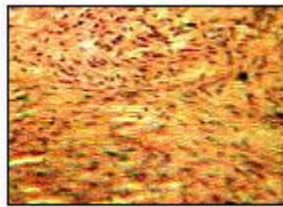
Located in long bones are two distinctions of bone marrow (yellow and red). The yellow marrow has fatty connective tissue and is found in the marrow cavity. During starvation, the body uses the fat in yellow marrow for energy. The red marrow of some bones is an important site for blood cell production, approximately 2.6 million red blood cells per second in order to replace existing cells that have been destroyed by the liver. Here all erythrocytes, platelets, and most leukocytes form in adults. From the red marrow, erythrocytes, platelets, and leukocytes migrate to the blood to do their special tasks.

Another function of bones is the storage of certain minerals. Calcium and phosphorus are among the main minerals being stored. The importance of this storage "device" helps to regulate mineral balance in the bloodstream. When the fluctuation of minerals is high, these minerals are stored in bone; when it is low it will be withdrawn from the bone.

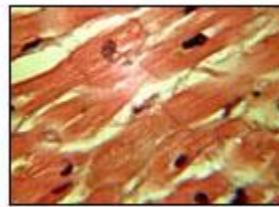
### **5.2.3Muscular**



Skeletal muscle



Smooth muscle

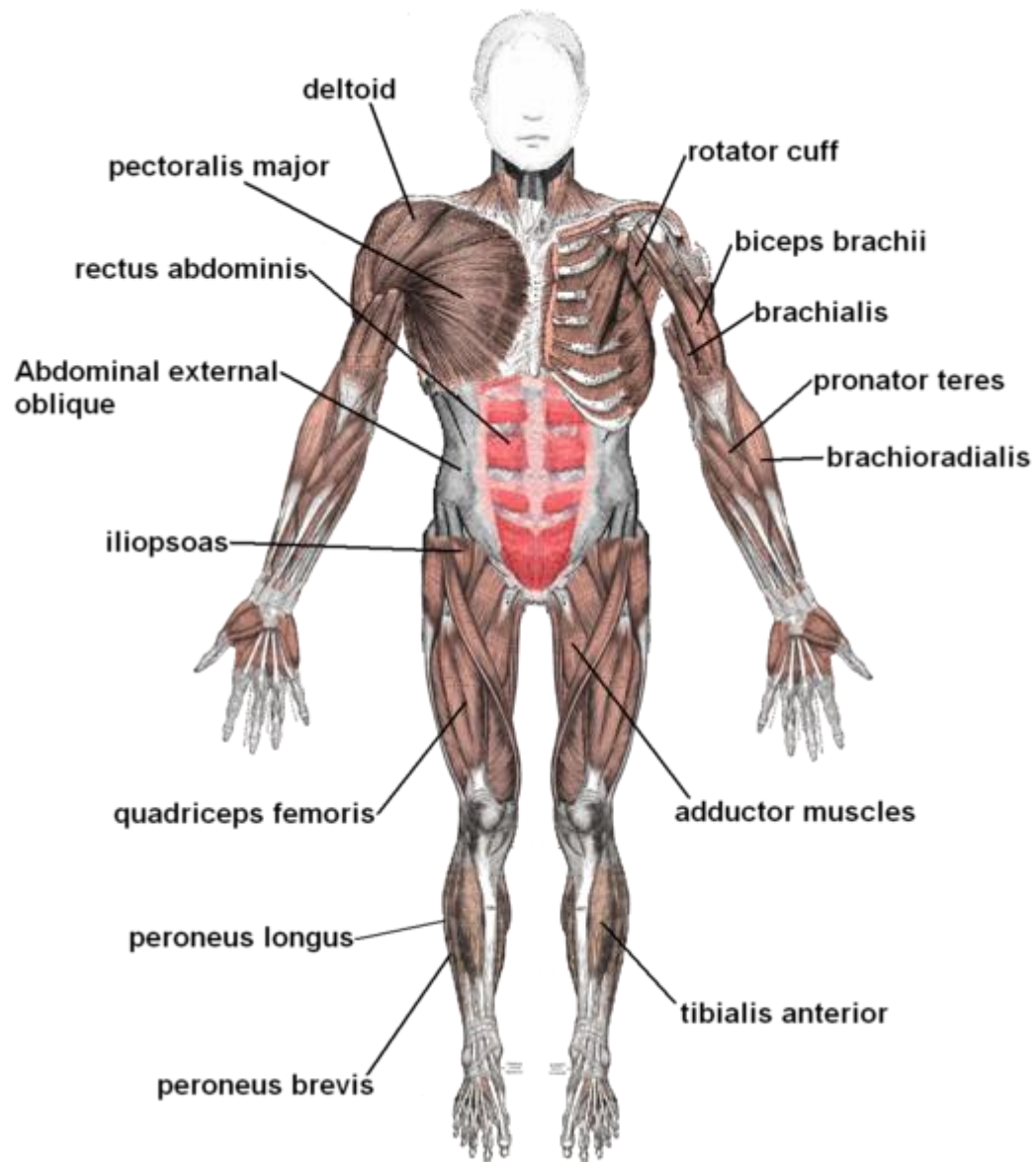


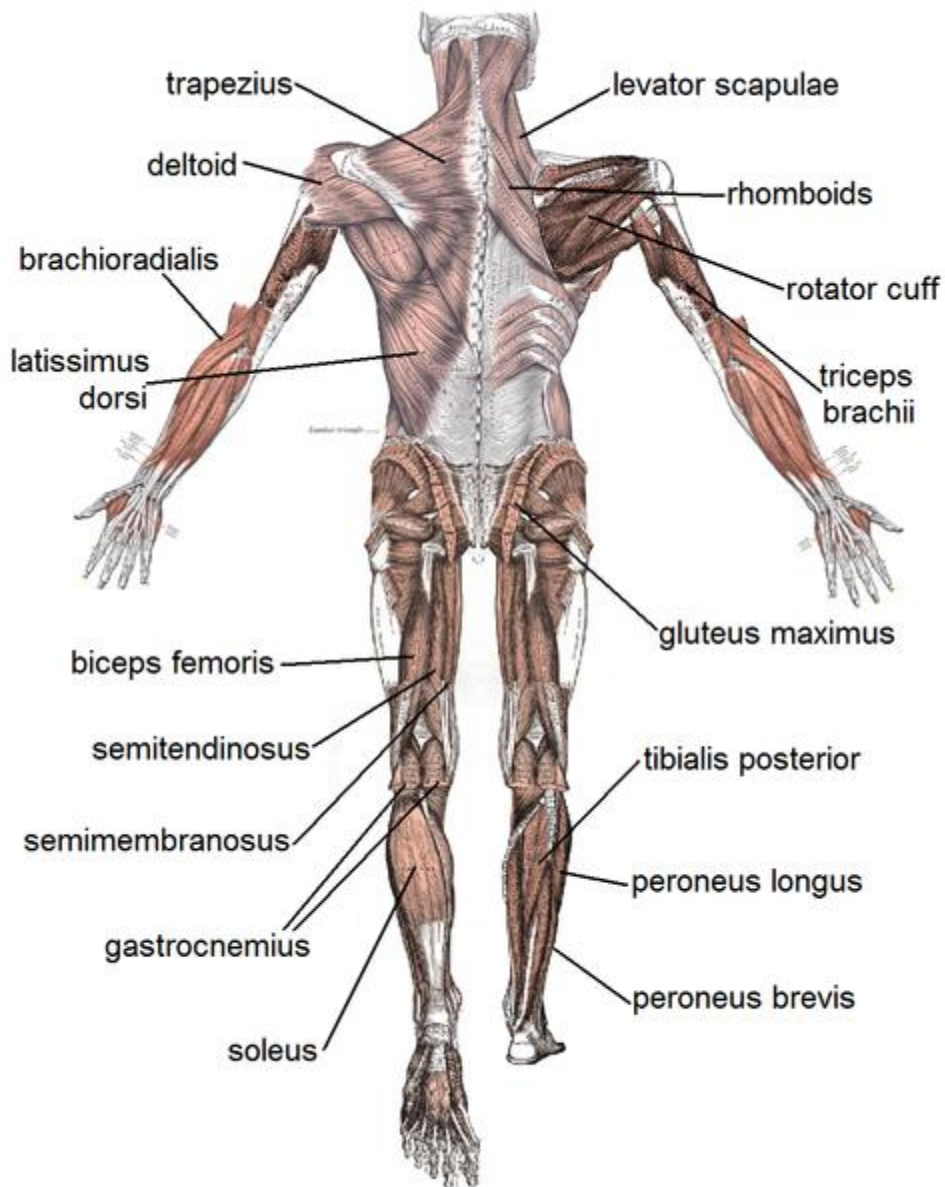
Cardiac muscle



Types of muscle and their appearance







There are three types of muscles—cardiac, skeletal, and smooth. Smooth muscles are used to control the flow of substances within the lumens of hollow organs, and are not consciously controlled. Skeletal and cardiac muscles have striations that are visible under a microscope due to the components within their cells. Only skeletal and smooth muscles are part of the musculoskeletal system and only the skeletal muscles can move the body. Cardiac muscles are found in the heart and are used only to circulate blood; like the smooth muscles, these muscles are not under conscious control. Skeletal muscles are attached to bones and arranged in opposing groups around joints. Muscles are innervated, to communicate nervous energy to, by nerves, which conduct electrical currents from the central nervous system and cause the muscles to contract.

#### **5.2.4 Contraction initiation**

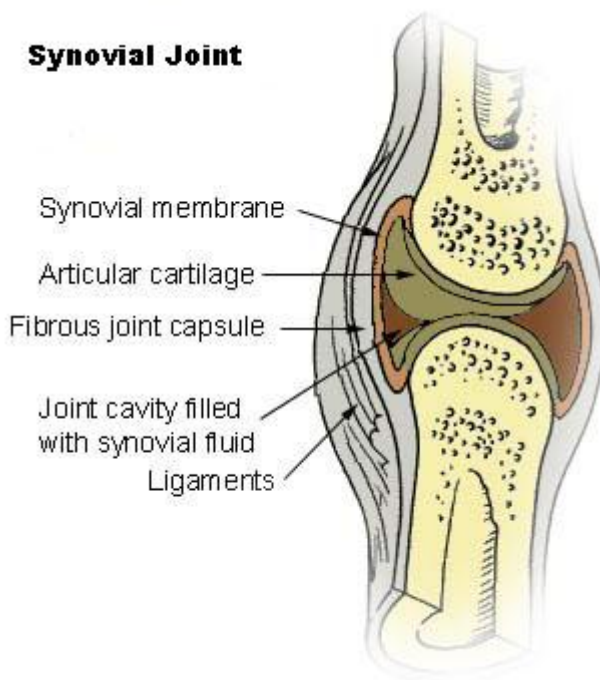
In mammals, when a muscle contracts, a series of reactions occur. Muscle contraction is stimulated by the motor neuron sending a message to the muscles from the somatic nervous system. Depolarization of the motor neuron results in neurotransmitters being released from the nerve terminal. The space between the nerve terminal and the muscle cell is called the neuromuscular junction. These neurotransmitters diffuse across the synapse and bind to specific receptor sites on the cell membrane of the muscle fiber. When enough receptors are stimulated, an action potential is generated and the permeability of the sarcolemma is altered. This process is known as initiation.

#### **5.2.5 Tendons**

A tendon is a tough, flexible band of fibrous connective tissue that connects muscles to bones. The extra-cellular connective tissue between muscle fibers binds to tendons at the distal & proximal ends, and the tendon binds to the periosteum of individual bones at the muscle's origin & insertion. As muscles contract, tendons transmit the forces to the relatively rigid bones, pulling on them and causing movement. Tendons can stretch substantially, allowing them to function as springs during locomotion, thereby saving energy.

#### **5.2.6 Joints, ligaments, and bursae**

##### **5.2.6.1 Joints**



Human synovial joint composition

Joints are structures that connect individual bones and may allow bones to move against each other to cause movement. There are two divisions of joints, diarthroses which allow extensive mobility between two or more articular heads, and false joints or synarthroses, joints that are immovable, that allow little or no movement and are predominantly fibrous. Synovial joints, joints that are not directly joined, are lubricated by a solution called synovial Fluid that is produced by the synovial membranes. This fluid lowers the friction between the articular surfaces and is kept within an articular capsule, binding the joint with its taut tissue.

#### **5.2.6.2 Ligaments**

A ligament is a small band of dense, white, fibrous elastic tissue. Ligaments connect the ends of bones together in order to form a joint. Most ligaments limit dislocation, or prevent certain movements that may cause breaks. Since they are only elastic they increasingly lengthen when under pressure. When this occurs the ligament may be susceptible to break resulting in an unstable joint.

Ligaments may also restrict some actions: movements such as hyper extension and hyper flexion are restricted by ligaments to an extent. Also ligaments prevent certain directional movement.

#### **5.2.6.3 Bursa**

A bursa is a small fluid-filled sac made of white fibrous tissue and lined with synovial membrane. Bursa may also be formed by a synovial membrane that extends outside of the joint capsule. It provides a cushion between bones and tendons and/or muscles around a joint; bursa are filled with synovial fluid and are found around almost every major joint of the body.

### **5.3 Diseases and disorders**

Because many other body systems, including the vascular, nervous, and integumentary systems, are interrelated, disorders of one of these systems may also affect the musculoskeletal system and complicate the diagnosis of the disorder's origin. Diseases of the musculoskeletal system mostly encompass functional disorders or motion discrepancies; the level of impairment depends specifically on the problem and its severity. Articular (of or pertaining to the joints) disorders are the most common. However, also among the diagnoses are: primary muscular diseases, neurologic (related to the medical science that deals with the nervous system and disorders affecting it) deficits, toxins, endocrine abnormalities, metabolic disorders, infectious diseases, blood and vascular disorders, and nutritional imbalances. Disorders of muscles from another body system can bring about irregularities such as: impairment of ocular motion and control, respiratory dysfunction, and bladder malfunction. Complete paralysis, paresis, or ataxia may be caused by primary muscular dysfunctions of infectious or toxic origin; however, the primary disorder is usually related to the nervous system, with the muscular system acting as the effector organ, an organ capable of responding to a stimulus, especially a nerve impulse. One understated disorder that begins during pregnancy is Pelvic girdle pain, it is complex and multi-factorial and likely to be also represented by a series of sub-groups driven by pain varying from peripheral or central nervous system, altered laxity/stiffness of muscles, laxity to injury of tendinous/ligamentous structures to 'mal-adaptive' body mechanics.

#### **Review Questions**

1. Define the Musculoskeletal system?
2. Explain the Muscular?

3. Explain the Joints, ligaments, and bursae?
4. Explain the Diseases and disorders related to Musculoskeletal system?

#### Discussion Questions

Discuss the Musculoskeletal system in details?

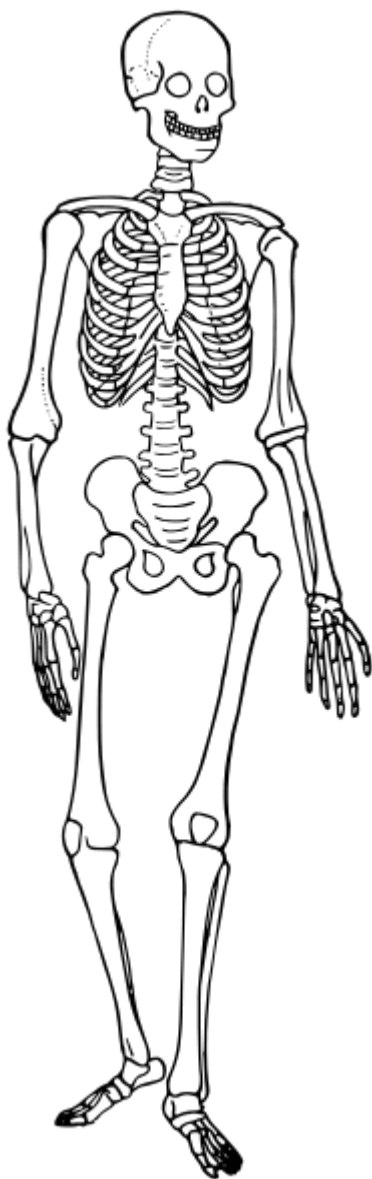
## Roots

### Lesson 1 – Common roots

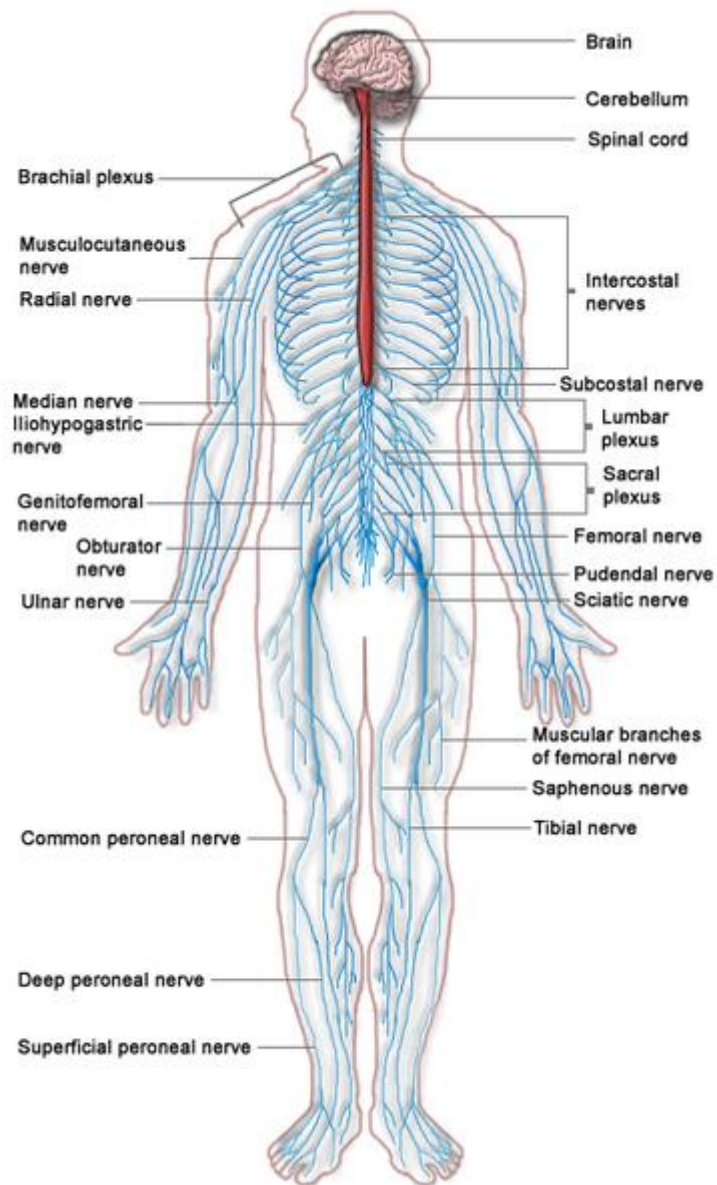
#### Learning Objectives

- To define the Human anatomy.
- To explain the Common Integument.
- To explain the Appendages of the Skin.
- To describe the Sweat Glands.

#### **1.1 Human anatomy**



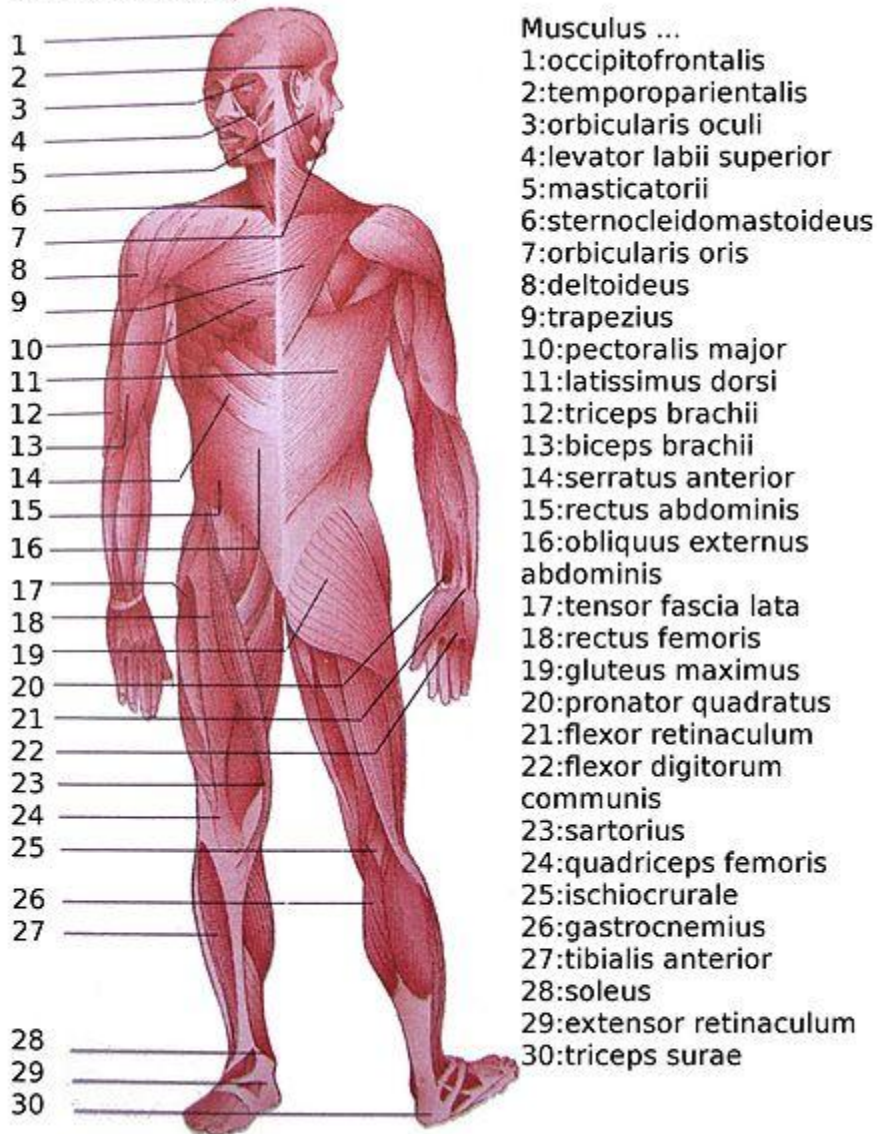
The skeleton



The nervous system

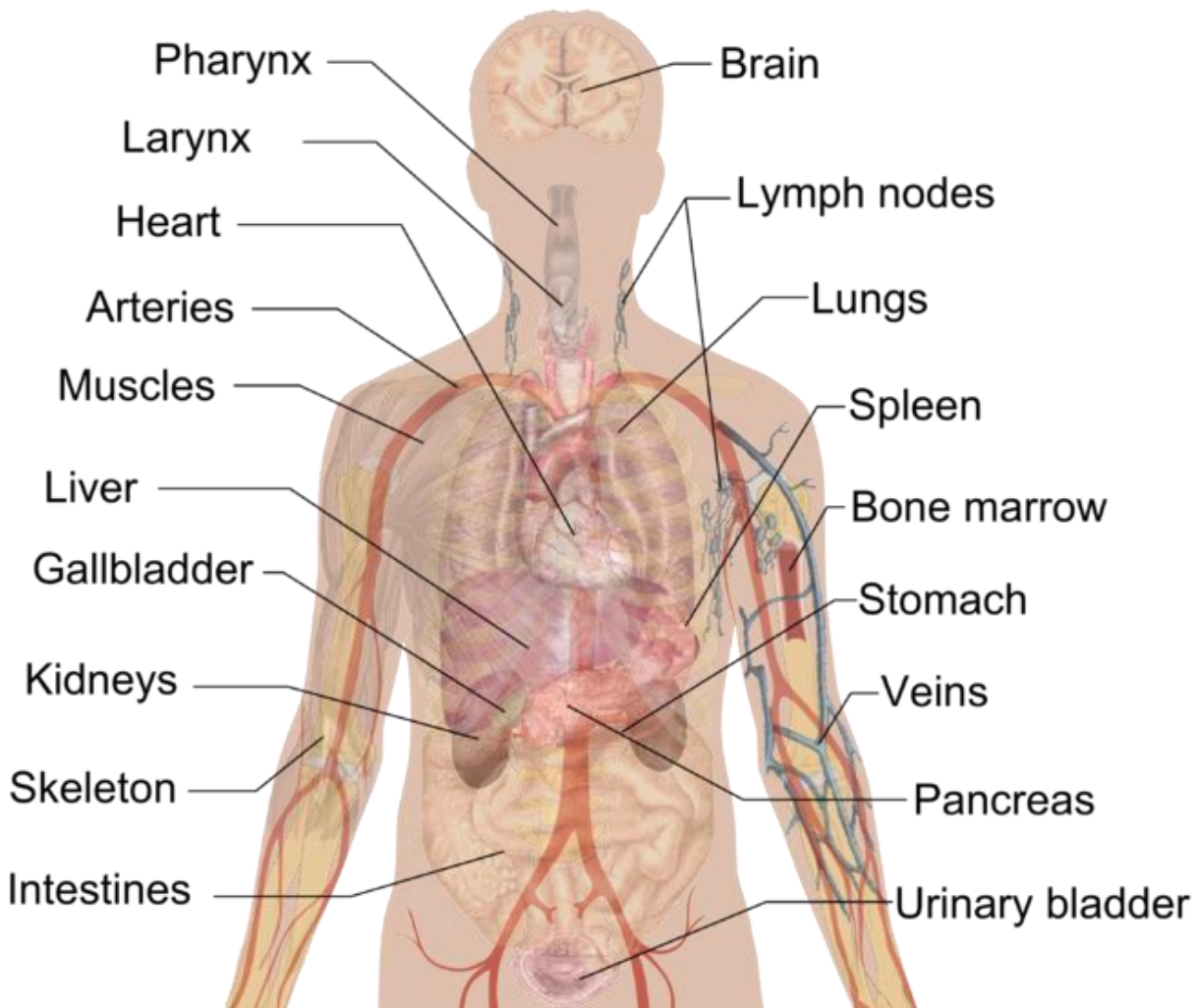


## Skeletal muscles



The muscles

# Human anatomy



The internal organs and their contents

**Human anatomy** (gr. ἀνατομία, "dissection", from ἀνά, "up", and τέμνειν, "cut") is primarily the scientific study of the morphology of the human body.<sup>[1]</sup> Anatomy is subdivided into gross anatomy and microscopic anatomy.<sup>[1]</sup> Gross anatomy (also called topographical anatomy, regional anatomy, or anthropotomy) is the study of anatomical structures that can be seen by the naked eye.<sup>[1]</sup> Microscopic anatomy is the study of minute anatomical structures assisted with microscopes, which includes histology (the study of the organization of tissues),<sup>[1]</sup> and cytology (the study of cells). Anatomy, human physiology (the study of function), and biochemistry (the study of the chemistry of living structures) are complementary basic medical sciences that are generally together (or in tandem) to students studying medical sciences.

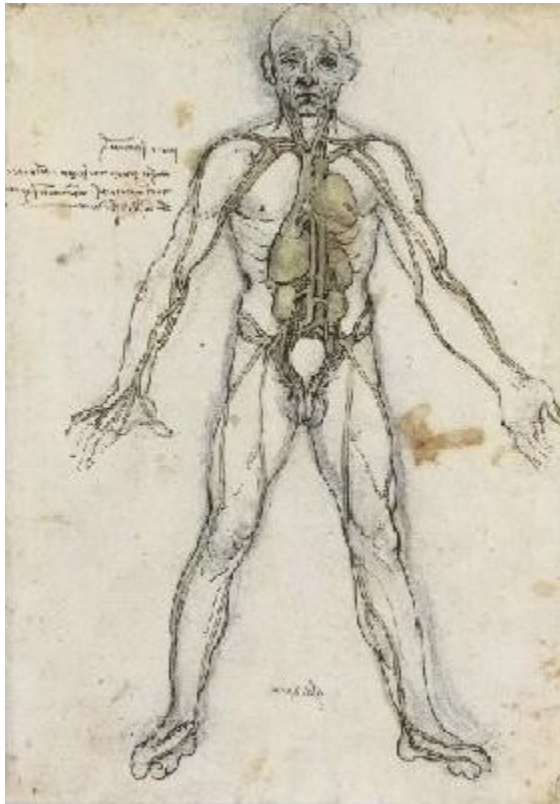
In some of its facets human anatomy is closely related to embryology, comparative anatomy and comparative embryology, through common roots in evolution; for example, much of the human body maintains the ancient segmental pattern that is present in all vertebrates with basic units being repeated,

which is particularly obvious in the vertebral column and in the ribcage, and can be traced from very early embryos.

The human body consists of biological systems, that consist of organs, that consist of tissues, that consist of cells and connective tissue.

The history of anatomy has been characterized, over a long period of time, by a continually developing understanding of the functions of organs and structures in the body. Methods have also advanced dramatically, advancing from examination of animals through dissection of fresh and preserved cadavers (dead human bodies) to technologically complex techniques developed in the 20th century.

### 1.1.1 Study



Anatomical study by Leonardo da Vinci

Generally, physicians, dentists, physiotherapists, nurses, paramedics, radiographers, and students of certain biological sciences, learn gross anatomy and microscopic anatomy from anatomical models, skeletons, textbooks, diagrams, photographs, lectures, and tutorials. The study of microscopic anatomy (or histology) can be aided by practical experience examining histological preparations (or slides) under a microscope; and in addition, medical and dental students generally also learn anatomy with practical experience of dissection and inspection of cadavers (dead human bodies). A thorough working knowledge of anatomy is required for all medical doctors, especially surgeons, and doctors working in some diagnostic specialities, such as histopathology and radiology.

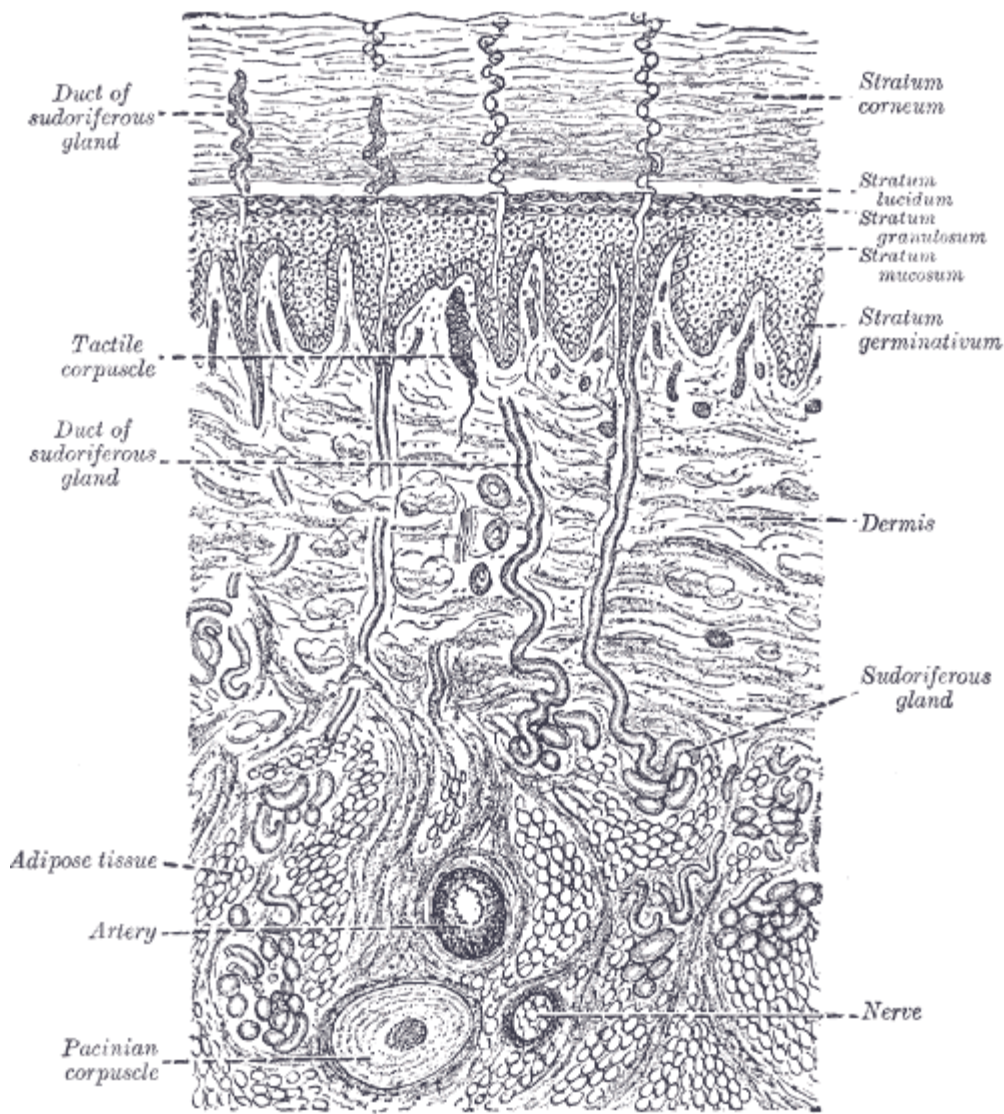
Human anatomy, physiology, and biochemistry are basic medical sciences, which are generally taught to medical students in their first year at medical school. Human anatomy can be taught regionally or systemically; that is, respectively, studying anatomy by bodily regions such as the head and chest, or studying by specific systems, such as the nervous or respiratory systems. The major anatomy textbook, Gray's Anatomy, has recently been reorganized from a systems format to a regional format, in line with modern teaching.

## 1.2 The Common Integument

The **integument** covers the body and protects the deeper tissues from injury, from drying and from invasion by foreign organisms; it contains the peripheral endings of many of the sensory nerves; it plays an important part in the regulation of the body temperature, and has also limited excretory and absorbing powers. It consists principally of a layer of vascular connective tissue, named the **corium** or **cutis vera**, and an external covering of epithelium, termed the **epidermis** or **cuticle**. On the surface of the former layer are sensitive and **vascular papillæ** within, or beneath it, are certain organs with special functions: namely, the **sudoriferous** and **sebaceous glands**, and the **hair follicles**.

The **epidermis, cuticle, or scarf skin** is non-vascular, and consists of stratified epithelium and is accurately moulded on the papillary layer of the corium. It varies in thickness in different parts. In some situations, as in the palms of the hands and soles of the feet, it is thick, hard, and horny in texture. This may be in a measure due to the fact that these parts are exposed to intermittent pressure, but that this is not the only cause is proved by the fact that the condition exists to a very considerable extent at birth. The more superficial layers of cells, called the **horny layer** (*stratum corneum*), may be separated by maceration from a deeper stratum, which is called the **stratum mucosum**, and which consists of several layers of differently shaped cells. The free surface of the epidermis is marked by a net-work of linear furrows of variable size, dividing the surface into a number of polygonal or lozenge-shaped areas. Some of these furrows are large, as opposite the flexures of the joints, and correspond to the folds in the corium produced by movements. In other situations, as upon the back of the hand, they are exceedingly fine, and intersect one another at various angles. Upon the palmar surfaces of the hands and fingers, and upon the soles of the feet, the epidermal ridges are very distinct, and are disposed in curves; they depend upon the large size and peculiar arrangements of the papillæ upon which the epidermis is placed. The function of these ridges is primarily to increase resistance between contact surfaces for the purpose of preventing slipping whether in walking or prehension. The direction of the ridges is at right angles with the force that tends to produce slipping or to the resultant of such forces when these forces vary in direction. In each individual the lines on the tips of the fingers and thumbs form distinct patterns unlike those of any other person. A method of determining the identity of a criminal is based on this fact, impressions ("finger-prints") of these lines being made on paper covered with soot, or on white paper after first covering the fingers with ink. The deep surface of the epidermis is accurately moulded upon the papillary layer of the corium, the papillæ being covered by a basement membrane; so that when the epidermis is removed by maceration, it presents on its under surface a number of pits or depressions corresponding to the papillæ, and ridges corresponding to the intervals between them. Fine tubular prolongations are continued from this layer into the ducts of the sudoriferous and sebaceous glands.





A diagrammatic sectional view of the skin (magnified).

The **stratum corneum** (*horny layer*) consists of several layers of horny epithelial scales in which no nuclei are discernible, and which are unaffected by acetic acid, the protoplasm having become changed into horny material or **keratin**. According to Ranvier they contain granules of a material which has the characteristics of beeswax.

The black color of the skin in the negro, and the tawny color among some of the white races, is due to the presence of pigment in the cells of the epidermis. This pigment is more especially distinct in the cells of the stratum mucosum, and is similar to that found in the cells of the pigmentary layer of the retina. As the cells approach the surface and desiccate, the color becomes partially lost; the disappearance of the pigment from the superficial layers of the epidermis is, however, difficult to

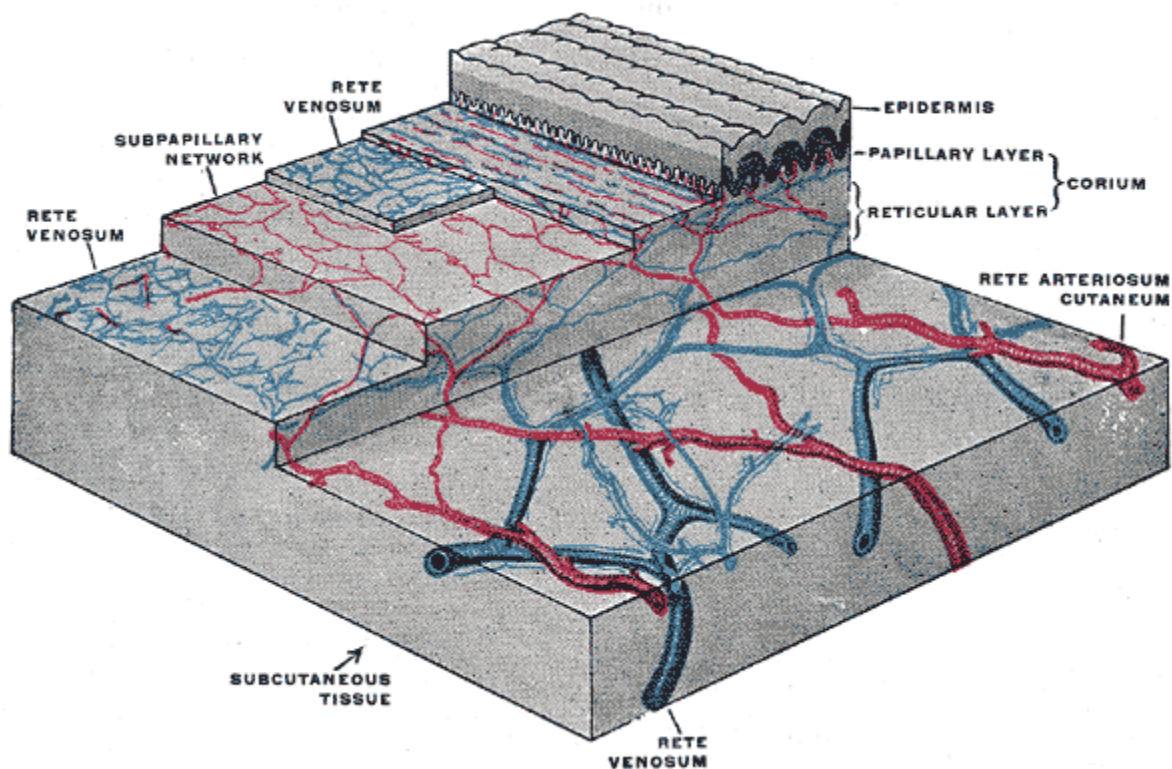
explain.

The pigment (**melanin**) consists of dark brown or black granules of very small size, closely packed together within the cells, but not involving the nucleus.

The main purpose served by the epidermis is that of protection, as the surface is worn away new cells are supplied and thus the true skin, the vessels and nerves which it contains are defended from damage.

The **Corium, Cutis Vera, Dermis, or True Skin** is tough, flexible, and highly elastic. It varies in thickness in different parts of the body. Thus it is very thick in the palms of the hands and soles of the feet; thicker on the posterior aspect of the body than on the front, and on the lateral than on the medial sides of the limbs. In the eyelids, scrotum, and penis it is exceedingly thin and delicate.

It consists of felted connective tissue, with a varying amount of elastic fibers and numerous bloodvessels, lymphatics, and nerves. The connective tissue is arranged in two layers: a **deeper** or **reticular**, and a **superficial** or **papillary**. Unstriated muscular fibers are found in the superficial layers of the corium, wherever hairs are present, and in the subcutaneous areolar tissue of the scrotum, penis, labia majora, and nipples. In the nipples the fibers are disposed in bands, closely reticulated and arranged in superimposed laminae.



The distribution of the bloodvessels in the skin of the sole of the foot. (Spalteholz.)

### 1.2.1 Reticular layer

The **reticular layer** (*stratum reticulare; deep layer*) consists of strong interlacing bands, composed chiefly of white fibrous tissue, but containing some fibers of yellow elastic tissue, which vary in number in different parts; and connective-tissue corpuscles, which are often to be found flattened against the white fibrous tissue bundles. Toward the attached surface the fasciculi are large and coarse, and the areolæ left by their interlacement are large, and occupied by adipose tissue and sweat glands. Below the reticular layer is the subcutaneous areolar tissue, which, except in a few situations, contains fat.

### 1.2.2 Papillary layer

The **papillary layer** (*stratum papillare; superficial layer; corpus papillare of the corium*) consists of numerous small, highly sensitive, and vascular eminences, the **papillæ**, which rise perpendicularly from its surface. The papillæ are minute conical eminences, having rounded or blunted extremities, occasionally divided into two or more parts, and are received into corresponding pits on the under surface of the cuticle. On the general surface of the body, more especially in parts endowed with slight sensibility, they are few in number, and exceedingly minute; but in some situations, as upon the palmar surfaces of the hands and fingers, and upon the plantar surfaces of the feet and toes, they are long, of large size, closely aggregated together, and arranged in parallel curved lines, forming the elevated ridges seen on the free surface of the epidermis. Each ridge contains two rows of papillæ, between which the ducts of the sudoriferous glands pass outward to open on the summit of the ridge. Each papilla consists of very small and closely interlacing bundles of finely fibrillated tissue, with a few elastic fibers; within this tissue is a capillary loop, and in some papillæ, especially in the palms of the hands and the fingers, there are tactile corpuscles.

### 1.2.3 Development

The epidermis and its appendages, consisting of the hairs, nails, sebaceous and sweat glands, are developed from the ectoderm, while the corium or true skin is of mesodermal origin. About the fifth week the epidermis consists of two layers of cells, the deeper one corresponding to the rete mucosum. The subcutaneous fat appears about the fourth month, and the papillæ of the true skin about the sixth. A considerable desquamation of epidermis takes place during fetal life, and this desquamated epidermis, mixed with sebaceous secretion, constitutes the **vernix caseosa**, with which the skin is smeared during the last three months of fetal life. The nails are formed at the third month, and begin to project from the epidermis about the sixth. The hairs appear between the third and fourth months in the form of solid downgrowths of the deeper layer of the epidermis, the growing extremities of which

become inverted by papillary projections from the corium. The central cells of the solid downgrowths undergo alteration to form the hair, while the peripheral cells are retained to form the lining cells of the hair-follicle. About the fifth month the fetal hairs (**lanugo**) appear, first on the head and then on the other parts; they drop off after birth, and give place to the permanent hairs. The cellular structures of the sudoriferous and sebaceous glands are formed from the ectoderm, while the connective tissue and bloodvessels are derived from the mesoderm. All the sweat-glands are fully formed at birth; they begin to develop as early as the fourth month.

The **arteries** supplying the skin form a net-work in the subcutaneous tissue, and from this net-work branches are given off to supply the sudoriferous glands, the hair follicles, and the fat. Other branches unite in a plexus immediately beneath the corium; from this plexus, fine capillary vessels pass into the papillæ, forming, in the smaller ones, a single capillary loop, but in the larger, a more or less convoluted vessel. The **lymphatic vessels** of the skin form two net-works, superficial and deep, which communicate with each other and with those of the subcutaneous tissue by oblique branches.

The **nerves** of the skin terminate partly in the epidermis and partly in the corium; their different modes of ending are described on pages 1059 to 1061.

#### 1.2.4 Appendages of the Skin

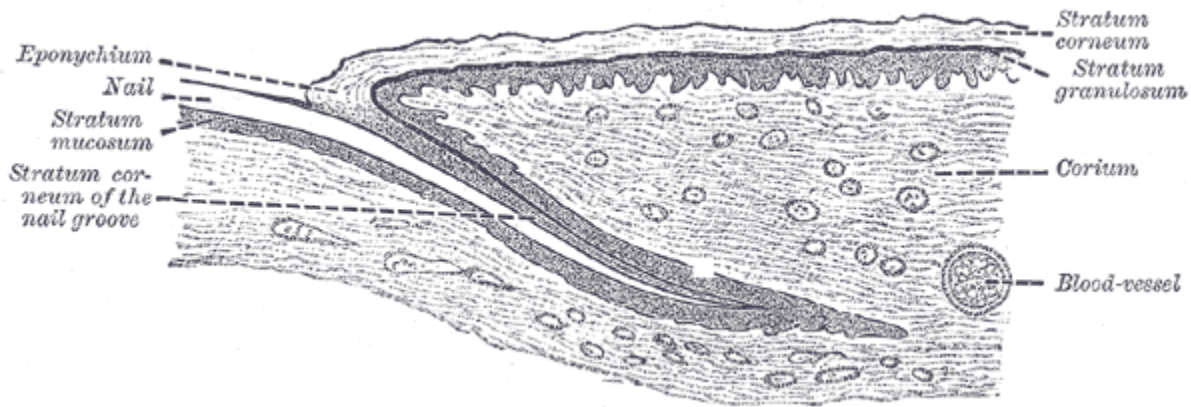
**The Appendages of the Skin**—The appendages of the skin are the **nails**, the **hairs**, and the **sudoriferous** and **sebaceous glands** with their ducts.

The **Nails** (*ungues*) are flattened, elastic structures of a horny texture, placed upon the dorsal surfaces of the terminal phalanges of the fingers and toes. Each nail is convex on its outer surface, concave within, and is implanted by a portion, called the **root**, into a groove in the skin; the exposed portion is called the **body**, and the distal extremity the **free edge**. The nail is firmly adherent to the corium, being accurately moulded upon its surface; the part beneath the body and root of the nail is called the **nail matrix**, because from it the nail is produced. Under the greater part of the body of the nail, the matrix is thick, and raised into a series of longitudinal ridges which are very vascular, and the color is seen through the transparent tissue. Near the root of the nail, the papillæ are smaller, less vascular, and have no regular arrangement, and here the tissue of the nail is not firmly adherent to the connective-tissue stratum but only in contact with it; hence this portion is of a whiter color, and is called the **lunula** on account of its shape.

The cuticle as it passes forward on the dorsal surface of the finger or toe is attached to the surface of the nail a little in advance of its root; at the extremity of the finger it is connected with the under surface of the nail a little behind its free edge. The cuticle and the horny substance of the nail (both epidermic structures) are thus directly continuous with each other. The superficial, horny part of the nail consists of a greatly thickened stratum lucidum, the stratum corneum forming merely the thin cuticular fold (**eponychium**) which overlaps the lunula; the deeper part consists of the stratum mucosum. The cells in contact with the papillæ of the matrix are columnar in form and arranged perpendicularly to the surface; those which succeed them are of a rounded or polygonal form, the more superficial ones becoming broad, thin, and flattened, and so closely packed as to make the limits



of the cells very indistinct. The nails grow in length by the proliferation of the cells of the stratum mucosum at the root of the nail, and in thickness from that part of the stratum mucosum which underlies the lunula.



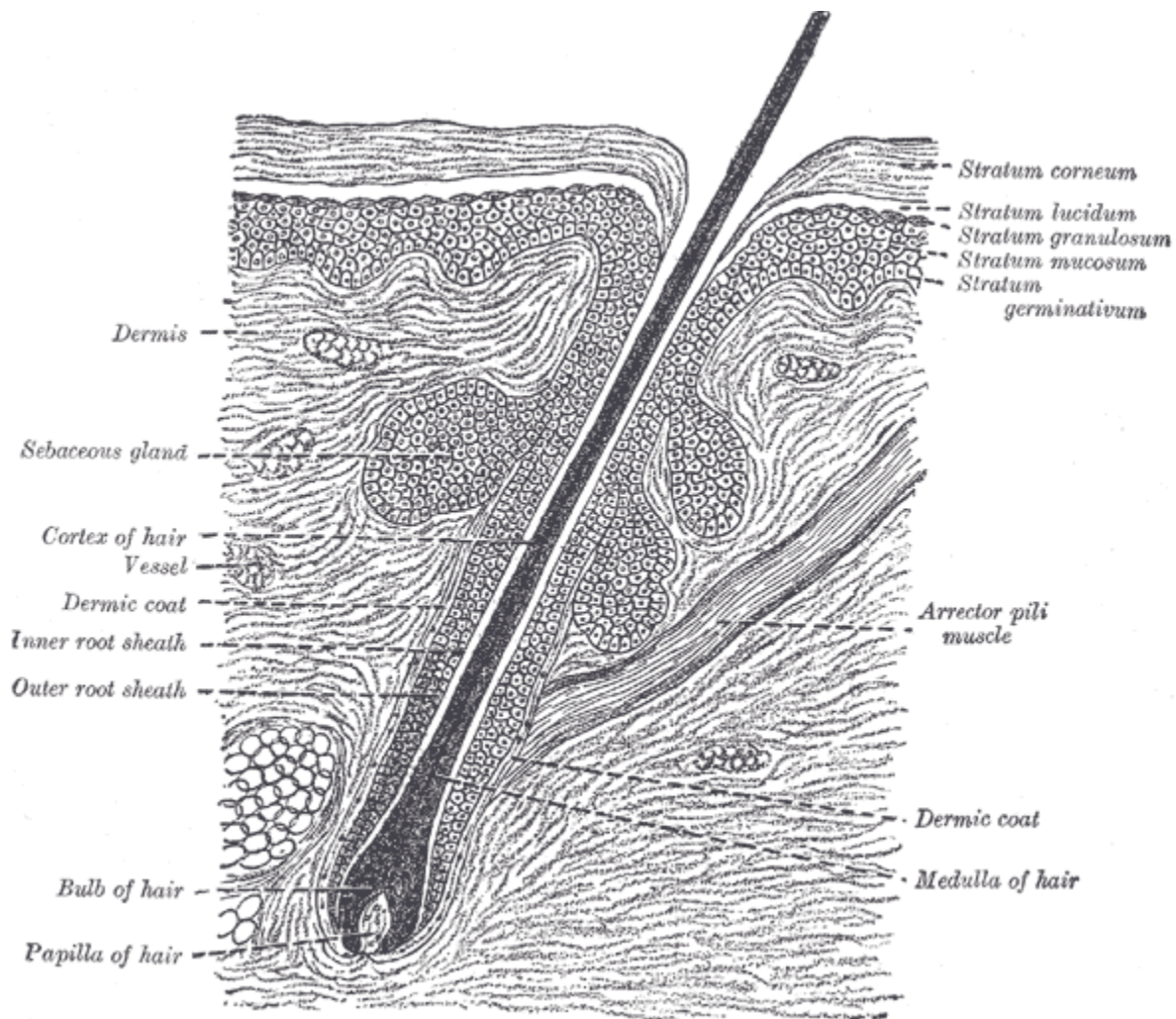
Longitudinal section through nail and its nail groove (sulcus).

**Hairs** (*pili*) are found on nearly every part of the surface of the body, but are absent from the palms of the hands, the soles of the feet, the dorsal surfaces of the terminal phalanges, the glans penis, the inner surface of the prepuce, and the inner surfaces of the labia. They vary much in length, thickness, and color in different parts of the body and in different races of mankind. In some parts, as in the skin of the eyelids, they are so short as not to project beyond the follicles containing them; in others, as upon the scalp, they are of considerable length; again, in other parts, as the eyelashes, the hairs of the pubic region, and the whiskers and beard, they are remarkable for their thickness. Straight hairs are stronger than curly hairs, and present on transverse section a cylindrical or oval outline; curly hairs, on the other hand, are flattened. A hair consists of a **root**, the part implanted in the skin; and a **shaft** or **scapus**, the portion projecting from the surface.

The **root of the hair** (*radix pili*) ends in an enlargement, the **hair bulb**, which is whiter in color and softer in texture than the shaft, and is lodged in a follicular involution of the epidermis called the **hair follicle**. When the hair is of considerable length the follicle extends into the subcutaneous cellular tissue. The hair follicle commences on the surface of the skin with a funnel-shaped opening, and passes inward in an oblique or curved direction—the latter in curly hairs—to become dilated at its deep extremity, where it corresponds with the hair bulb. Opening into the follicle, near its free extremity, are the ducts of one or more sebaceous glands. At the bottom of each hair follicle is a small conical, vascular eminence or papilla, similar in every respect to those found upon the surface of the skin; it is continuous with the dermic layer of the follicle, and is supplied with nerve fibrils. The hair

follicle consists of two coats—an **outer** or **dermic**, and an **inner** or **epidermic**.

The **outer** or **dermic coat** is formed mainly of fibrous tissue; it is continuous with the corium, is highly vascular, and supplied by numerous minute nervous filaments. It consists of three layers. The most internal is a hyaline basement membrane, which is well-marked in the larger hair follicles, but is not very distinct in the follicles of minute hairs; it is limited to the deeper part of the follicle. Outside this is a compact layer of fibers and spindle-shaped cells arranged circularly around the follicle; this layer extends from the bottom of the follicle as high as the entrance of the ducts of the sebaceous glands. Externally is a thick layer of connective tissue, arranged in longitudinal bundles, forming a more open texture and corresponding to the reticular part of the corium; in this are contained the bloodvessels and nerves.



Section of skin, showing the epidermis and dermis; a hair in its follicle; the Arrector pili muscle;

sebaceous glands.

The **inner** or **epidermic coat** is closely adherent to the root of the hair, and consists of two strata named respectively the **outer** and **inner root sheaths**; the former of these corresponds with the stratum mucosum of the epidermis, and resembles it in the rounded form and soft character of its cells; at the bottom of the hair follicle these cells become continuous with those of the root of the hair. The inner root sheath consists of (1) a delicate cuticle next the hair, composed of a single layer of imbricated scales with atrophied nuclei; (2) one or two layers of horny, flattened, nucleated cells, known as **Huxley's layer**; and (3) a single layer of cubical cells with clear flattened nuclei, called **Henle's layer**.

The hair bulb is moulded over the papilla and composed of polyhedral epithelial cells, which as they pass upward into the root of the hair become elongated and spindle-shaped, except some in the center which remain polyhedral. Some of these latter cells contain pigment granules which give rise to the color of the hair. It occasionally happens that these pigment granules completely fill the cells in the center of the bulb; this gives rise to the dark tract of pigment often found, of greater or less length, in the axis of the hair.

The **shaft of the hair** (*scapus pili*) consists, from within outward, of three parts, the medulla, the cortex, and the cuticle. The **medulla** is usually wanting in the fine hairs covering the surface of the body, and commonly in those of the head. It is more opaque and deeper colored than the cortex when viewed by transmitted light; but when viewed by reflected light it is white. It is composed of rows of polyhedral cells, containing granules of eleidin and frequently air spaces. The **cortex** constitutes the chief part of the shaft; its cells are elongated and united to form flattened fusiform fibers which contain pigment granules in dark hair, and air in white hair. The **cuticle** consists of a single layer of flat scales which overlap one another from below upward.

Connected with the hair follicles are minute bundles of involuntary muscular fibers, termed the **Arrectores pilorum**. They *arise* from the superficial layer of the corium, and are inserted into the hair follicle, below the entrance of the duct of the sebaceous gland. They are placed on the side toward which the hair slopes, and by their action diminish the obliquity of the follicle and elevate the hair. The sebaceous gland is situated in the angle which the Arrector muscle forms with the superficial portion of the hair follicle, and contraction of the muscle thus tends to squeeze the sebaceous secretion out from the duct of the gland.

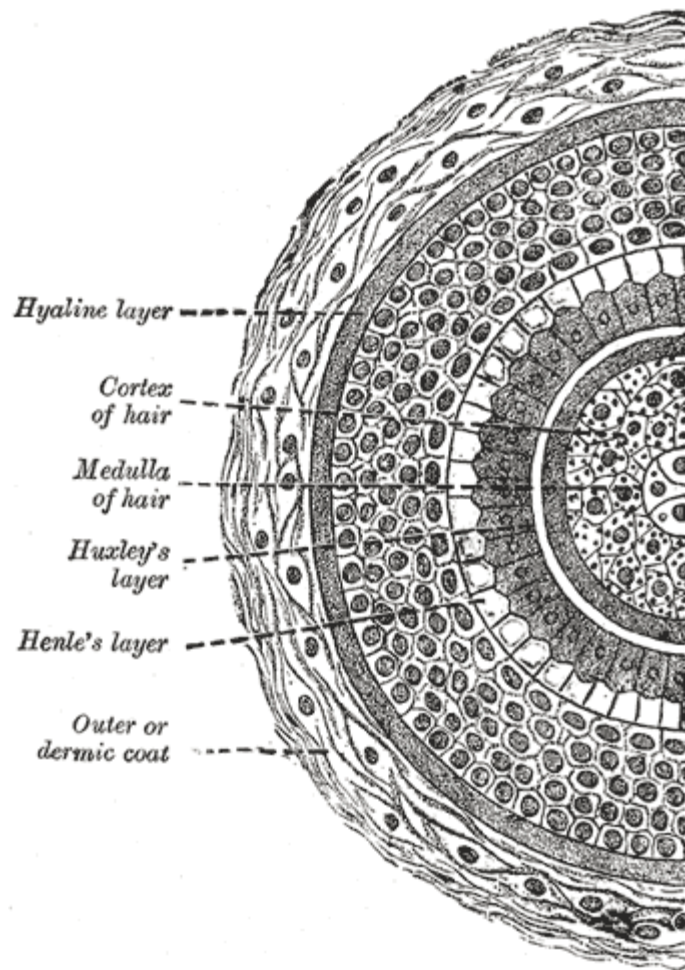


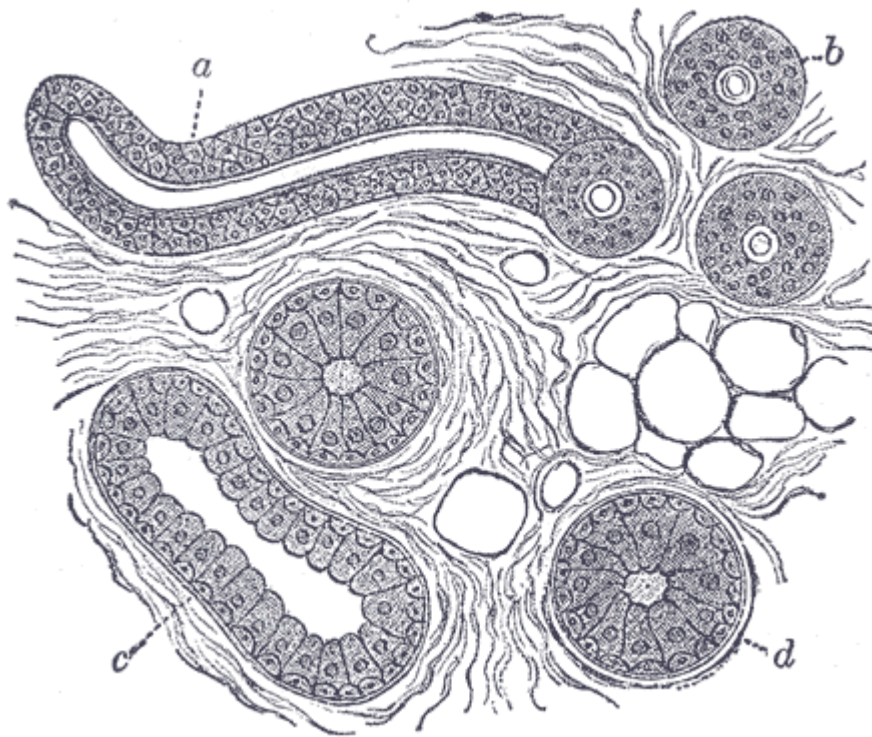
FIG. 945— Transverse section of hair follicle.

### 1.2.5 Sebaceous Glands

The **Sebaceous Glands** (*glandulae sebaceæ*) are small, sacculated, glandular organs, lodged in the substance of the corium. They are found in most parts of the skin, but are especially abundant in the scalp and face; they are also very numerous around the apertures of the anus, nose, mouth, and external ear, but are wanting in the palms of the hands and soles of the feet. Each gland consists of a single duct, more or less capacious, which emerges from a cluster of oval or flask-shaped alveoli which vary from two to five in number, but in some instances there may be as many as twenty. Each alveolus is composed of a transparent basement membrane, enclosing a number of epithelial cells. The outer or marginal cells are small and polyhedral, and are continuous with the cells lining the duct. The remainder of the alveolus is filled with larger cells, containing fat, except in the center, where the cells have become broken up, leaving a cavity filled with their debris and a mass of fatty matter,



which constitutes the **sebum cutaneum**. The ducts open most frequently into the hair follicles, but occasionally upon the general surface, as in the labia minora and the free margin of the lips. On the nose and face the glands are of large size, distinctly lobulated, and often become much enlarged from the accumulation of pent-up secretion. The tarsal glands of the eyelids are elongated sebaceous glands with numerous lateral diverticula.



Body of a sudoriferous-gland cut in various directions. *a*. Longitudinal section of the proximal part of the coiled tube. *b*. Transverse section of the same. *c*. Longitudinal section of the distal part of the coiled tube. *d*. Transverse section of the same. (Klein and Noble Smith.)

### 1.2.6 Sweat Glands

The **Sudoriferous** or **Sweat Glands** (*glandulae sudoriferae*) are found in almost every part of the skin, and are situated in small pits on the under surface of the corium, or, more frequently, in the subcutaneous areolar tissue, surrounded by a quantity of adipose tissue. Each consists of a single tube, the deep part of which is rolled into an oval or spherical ball, named the **body** of the gland, while the superficial part, or **duct**, traverses the corium and cuticle and opens on the surface of the skin by a funnel-shaped aperture. In the superficial layers of the corium the duct is straight, but in the deeper layers it is convoluted or even twisted; where the epidermis is thick, as in the palms of the hands and soles of the feet, the part of the duct which passes through it is spirally coiled. The size of the glands

varies. They are especially large in those regions where the amount of perspiration is great, as in the axillæ, where they form a thin, mammillated layer of a reddish color, which corresponds exactly to the situation of the hair in this region; they are large also in the groin. Their number varies. They are very plentiful on the palms of the hands, and on the soles of the feet, where the orifices of the ducts are exceedingly regular, and open on the curved ridges; they are least numerous in the neck and back. On the palm there are about 370 per square centimeter; on the back of the hand about 200; forehead 175, breast, abdomen and forearm 155, and on the leg and back from 60 to 80 per square centimeter. Krause estimates the total number at about 2,000,000. The average number of sweat glands per square centimeter of skin area in various races as shown by the fingers is as follows:

American (white)	558.2
American (negro)	597.2
Filipino	653.6
Moro	684.4
Negrito (adult)	709.2
Hindu	738.2
Negrito (youth)	950.0

They are absent in the deeper portion of the external auditory meatus, the prepuce and the glans penis. The tube, both in the body of the gland and in the duct consists of two layers—an outer, of fine **areolar tissue**, and an inner of **epithelium**. The outer layer is thin and is continuous with the superficial stratum of the corium. In body of the gland the epithelium consists of a single layer of cubical cells, between the deep ends of which and the basement membrane is a layer of longitudinally or obliquely arranged non-striped muscular fibers. The ducts are destitute of muscular fibers and are composed of a basement membrane lined by two or three layers of polyhedral cells; the lumen of the duct is coated by a thin cuticle. When the cuticle is carefully removed from the surface of the corium, the ducts may be drawn out in the form of short, thread-like processes on its under surface. The ceruminous glands of the external acoustic meatus and the ciliary glands at the margins of the eyelids are modified sudoriferous glands.

### *Review Questions*

1. Define the Human anatomy?
2. Explain the Common Integument?
3. Explain the Appendages of the Skin?
4. Explain the Sweat Glands?

## Discussion Questions

Discuss the Common roots in details?

## Lesson 2 – General healthcare

### Learning Objectives

- To define the General healthcare.
- To explain the Primary healthcare.
- To explain the Secondary healthcare.
- To describe the Health care industry.

### 2.1 Healthcare

**Health care** (or **healthcare**) is the diagnosis, treatment, and prevention of disease, illness, injury, and other physical and mental impairments in humans. Health care is delivered by practitioners in medicine, optometry, dentistry, nursing, pharmacy, allied health, and other care providers. It refers to the work done in providing primary care, secondary care and tertiary care, as well as in public health.

Access to health care varies across countries, groups and individuals, largely influenced by social and economic conditions as well as the health policies in place. Countries and jurisdictions have different policies and plans in relation to the personal and population-based health care goals within their societies. Health care systems are organizations established to meet the health needs of target populations. Their exact configuration varies from country to country. In some countries and jurisdictions, health care planning is distributed among market participants, whereas in others planning is made more centrally among governments or other coordinating bodies. In all cases, according to the World Health Organization (WHO), a well-functioning health care system requires a robust financing mechanism; a well-trained and adequately-paid workforce; reliable information on which to base decisions and policies; and well maintained facilities and logistics to deliver quality medicines and technologies.

Health care can form a significant part of a country's economy. In 2008, the health care industry consumed an average of 9.0 percent of the gross domestic product (GDP) across the most developed OECD countries. The United States (16.0%), France (11.2%), and Switzerland (10.7%) were the top three spenders.

Health care is conventionally regarded as an important determinant in promoting the general health and well-being of people around the world. An example of this is the worldwide eradication of smallpox in 1980—declared by the WHO as the first disease in human history to be completely eliminated by deliberate health care interventions.

### 2.2 Health care delivery

The delivery of modern health care depends on groups of trained professionals and paraprofessionals coming together as interdisciplinary teams. This includes professionals in medicine, nursing, dentistry and allied health, plus many others such as public health practitioners, community health workers and



assistive personnel, who systematically provide personal and population-based preventive, curative and rehabilitative care services.

While the definitions of the various types of health care vary depending on the different cultural, political, organizational and disciplinary perspectives, there appears to be some consensus that primary care constitutes the first element of a continuing health care process, that may also include the provision of secondary and tertiary levels of care. Healthcare can be defined as either public or private.

## 2.3 Primary health care

**Primary health care**, often abbreviated as "PHC", has been defined as "essential health care based on practical, scientifically sound and socially acceptable methods and technology made universally accessible to individuals and families in the community through their full participation and at a cost that the community and the country can afford to maintain at every stage of their development in the spirit of self-reliance and self-determination". In other words, PHC is an approach to health beyond the traditional health care system that focuses on health equity-producing social policy. PHC includes all areas that play a role in health, such as access to health services, environment and lifestyle.

This ideal model of health care was adopted in the declaration of the International Conference on Primary Health Care held in Alma Ata, Kazakhstan in 1978 (known as the "Alma Ata Declaration"), and became a core concept of the World Health Organization's goal of *Health for all*. The Alma-Ata Conference mobilized a "Primary Health Care movement" of professionals and institutions, governments and civil society organizations, researchers and grassroots organizations that undertook to tackle the "politically, socially and economically unacceptable" health inequalities in all countries. There were many factors that inspired PHC; a prominent example is the Barefoot doctors of China.

### 2.3.1 Goals and principles

The ultimate goal of primary health care is better health for all. The WHO has identified five key elements to achieving that goal:

- reducing exclusion and social disparities in health (universal coverage reforms);
- organizing health services around people's needs and expectations (service delivery reforms);
- integrating health into all sectors (public policy reforms);
- pursuing collaborative models of policy dialogue (leadership reforms); and
- increasing stakeholder participation.

Behind these elements lies a series of basic principles identified in the Alma Ata Declaration that should be formulated in national policies in order to launch and sustain PHC as part of a comprehensive health system and in coordination with other sectors:

- Equitable distribution of health care – according this principle, primary care and other services to meet the main health problems in a community must be provided equally to all individuals irrespective of their gender, age, caste, color, urban/rural location and social class.
- Community participation – in order to make the fullest use of local, national and other available resources. Community participation was considered sustainable due to its grass roots nature and emphasis on self-sufficiency, as opposed to targeted (or vertical) approaches dependent on international development assistance.

- Health workforce development – comprehensive health care relies on adequate numbers and distribution of trained physicians, nurses, allied health professions, community health workers and others working as a health team and supported at the local and referral levels.
- Use of appropriate technology – medical technology should be provided that is accessible, affordable, feasible and culturally acceptable to the community. Examples of appropriate technology include refrigerators for vaccine cold storage. Less appropriate could include, in many settings, body scanners or heart-lung machines, which benefit only a small minority concentrated in urban areas, are generally not accessible to the poor, but draw a large share of resources.
- Multi-sectional approach – recognition that health cannot be improved by intervention within just the formal health sector; other sectors are equally important in promoting the health and self-reliance of communities. These sectors include, at least: agriculture (e.g. food security); education; communication (e.g. concerning prevailing health problems and the methods of preventing and controlling them); housing; public works (e.g. ensuring an adequate supply of safe water and basic sanitation); rural development; industry; community organizations (including Panchayats or local governments, voluntary organizations, etc.).

In sum, PHC recognizes that health care is not a short-lived intervention, but an ongoing process of improving people's lives and alleviating the underlying socioeconomic conditions that contribute to poor health. The principles link health and development, advocating political interventions, rather than passive acceptance of economic conditions.

### **2.3.2 Approaches**

The primary health care approach has seen significant gains in health were applied even when adverse economic and political conditions prevail.

Although the declaration made at the Alma-Ata conference deemed to be convincing and plausible in specifying goals to PHC and achieving more effective strategies, it generated numerous criticisms and reactions worldwide. Many argued the declaration did not have clear targets, was too broad, and was not attainable because of the costs and aid needed. As a result, PHC approaches have evolved in different contexts to account for disparities in resources and local priority health problems; this is alternatively called the Selective Primary Health Care (SPHC) approach.

### **2.3.3 Selective PHC**

After the 1978 Alma-Ata Conference, the Rockefeller Foundation held a conference in 1979 at its Bellagio conference center in Italy to address several concerns. Here, the idea of Selective Primary Health Care was introduced as a strategy to complement comprehensive PHC. It was based on a paper by Julia Walsh and Kenneth S. Warren entitled “Selective Primary Health Care, an Interim Strategy for Disease Control in Developing Countries”. This new framework advocated a more economical feasible approach to PHC by only targeting specific areas of health, and choosing the most effective treatment plan in terms of cost and effectiveness. One of the foremost examples of SPHC is "GOBI" (growth monitoring, oral rehydration, breastfeeding, and immunization), focusing on combating the main diseases in developing nations.

#### **2.3.3.1 GOBI-FFF**

Selective PHC approach consists of techniques known collectively under the acronym "GOBI-FFF". It focuses on severe population health problems in certain developing countries, where a few diseases are

responsible for high rates of infant and child mortality. Health care planning is employed to see which diseases require most attention and, subsequently, which intervention can be most effectively applied as part of primary care in a least-cost method. The targets and effects of Selective PHC are specific and measurable. The approach aims to prevent most health and nutrition problems before they begin:

- **Growth monitoring:** the monitoring of how much infants grow within a period, with the goal to understand needs for better early nutrition.
- **Oral rehydration therapy:** to combat dehydration associated with diarrhoea
- **Breastfeeding**
- **Immunization**
- **Family planning** (birth spacing)
- **Female education**
- **Food supplementation:** for example, iron and folic acid fortification/supplementation to prevent deficiencies in pregnant women.

### **2.3.3.2PHC and population aging**

Given global demographic trends, with the numbers of people age 60 and over expected to double by 2025, PHC approaches have taken into account the need for countries to address the consequences of population ageing. In particular, in the future the majority of older people will be living in developing countries that are often the least prepared to confront the challenges of rapidly ageing societies, including high risk of having at least one chronic non-communicable disease, such as diabetes and osteoporosis. According to WHO, dealing with this increasing burden requires health promotion and disease prevention intervention at community level as well as disease management strategies within health care systems.

### **2.3.3.3PHC and mental health**

Some jurisdictions apply PHC principles in planning and managing their health care services for the detection, diagnosis and treatment of common mental health conditions at local clinics, and organizing the referral of more complicated mental health problems to more appropriate levels of mental health care.

## **2.3.4 Background and controversies**

### **2.3.4.1 Barefoot Doctors**

The "Barefoot doctors" of China were an important inspiration for PHC because they illustrated the effectiveness of having a health care professional at the community level with community ties. Barefoot doctors were a diverse array of village health workers who lived in rural areas and received basic health care training. They stressed rural rather than urban health care, and preventive rather than curative services. They also provided a combination of western and traditional medicines. They had close community ties, were relatively low-cost, and perhaps most importantly they encouraged self-reliance through advocating prevention and hygiene practices. The program experienced a massive expansion of rural medical services in China, with the number of barefoot doctors increasing dramatically between the early 1960s and the Cultural Revolution (1964-1976).

### **2.3.4.2 Criticisms**

Although many countries were keen on the idea of primary health care after the Alma Ata conference, the Declaration itself was criticized for being too "idealistic" and "having an unrealistic time table". More

specific approaches to prevent and control diseases - based on evidence of prevalence, morbidity, mortality and feasibility of control (cost-effectiveness) - were subsequently proposed. The best known model was the Selective PHC approach (described above). Selective PHC favoured short-term goals and targeted health investment, but it did not address the social causes of disease. As such, the SPHC approach has been criticized as not following Alma Ata's core principle of everyone's entitlement to health care and health system development.

In Africa, the PHC system has been extended into isolated rural areas through construction of health posts and centers that offer basic maternal-child health, immunization, nutrition, first aid, and referral services. Implementation of PHC was said to be affected after the introduction of structural adjustment programs by the World Bank.

## **2.4 Secondary Care**

**Secondary care** is the health care services provided by medical specialists and other health professionals who generally do not have first contact with patients, for example, cardiologists, urologists and dermatologists.

It includes acute care: necessary treatment for a short period of time for a brief but serious illness, injury or other health condition, such as in a hospital emergency department. It also includes skilled attendance during childbirth, intensive care, and medical imaging services.

The "secondary care" is sometimes used synonymously with "hospital care". However many secondary care providers do not necessarily work in hospitals, such as psychiatrists, clinical psychologists, occupational therapists or physiotherapists, and some primary care services are delivered within hospitals. Depending on the organization and policies of the national health system, patients may be required to see a primary care provider for a referral before they can access secondary care.

For example in the United States, which operates under a mixed market health care system, some physicians might voluntarily limit their practice to secondary care by requiring patients to see a primary care provider first, or this restriction may be imposed under the terms of the payment agreements in private/group health insurance plans. In other cases medical specialists may see patients without a referral, and patients may decide whether self-referral is preferred.

In the United Kingdom and Canada, patient self-referral to a medical specialist for secondary care is rare as prior referral from another physician (either a primary care physician or another specialist) is considered necessary, regardless of whether the funding is from private insurance schemes or national health insurance.

Allied health professionals, such as physical therapists, respiratory therapists, occupational therapists, speech therapists, and dietitians, also generally work in secondary care, accessed through either patient self-referral or through physician referral.

### **2.4.1 Tertiary care**

**Tertiary care** is specialized consultative health care, usually for inpatients and on referral from a primary or secondary health professional, in a facility that has personnel and facilities for advanced medical investigation and treatment, such as a tertiary referral hospital.

Examples of tertiary care services are cancer management, neurosurgery, cardiac surgery, plastic surgery, treatment for severe burns, advanced neonatology services, palliative, and other complex medical and surgical interventions.

#### ***2.4.2 Quaternary care***

The term **quaternary care** is also used sometimes as an extension of tertiary care in reference to medicine of advanced levels which are highly specialized and not widely accessed. Experimental medicine and some types of uncommon diagnostic or surgical procedures are considered quaternary care. These services are usually only offered in a limited number of regional or national health care centres. This term is more prevalent in the United Kingdom, but just as applicable in the United States. It can be thought as a hospital where virtually any procedure is available where as there may not be sub-specialist with that training at a given tertiary care hospital.

#### **2.4.3 Home and community care**

Many types of health care interventions are delivered outside of health facilities. They include many interventions of public health interest, such as food safety surveillance, distribution of condoms and needle-exchange programmes for the prevention of transmissible diseases.

They also include the services of professionals in residential and community settings in support of self care, home care, long-term care, assisted living, treatment for substance use disorders and other types of health and social care services.

Community rehabilitation services can assist with mobility and independence after loss of limbs or loss of function. This can include prosthesis, orthotics or wheelchairs.

Many countries, especially in the west are dealing with aging populations, and one of the priorities of the health care system is to help seniors live full, independent lives in the comfort of their own homes. There is an entire section of health care geared to providing seniors with help in day to day activities at home, transporting them to doctor's appointments, and many other activities that are so essential for their health and well-being.

With obesity in children rapidly becoming a major concern, health services often set up programs in schools aimed at educating children in good eating habits; making physical education compulsory in school; and teaching young adolescents to have positive self-image.

#### **2.4.4 Related sectors**

Health care extends beyond the delivery of services to patients, encompassing many related sectors, and set within a bigger picture of financing and governance structures.

### **2.5 Health system**

A **health system**, also sometimes referred to as **health care system** or **healthcare system** is the organization of people, institutions, and resources to deliver health care services to meet the health needs of target populations.

## **2.6 Health care industry**

The health care industry incorporates several sectors that are dedicated to providing health care services and products. As a basic framework for defining the sector, the United Nations' International Standard Industrial Classification categorizes health care as generally consisting of hospital activities, medical and dental practice activities, and "other human health activities". The last class involves activities of, or under the supervision of, nurses, midwives, physiotherapists, scientific or diagnostic laboratories, pathology clinics, residential health facilities, or other allied health professions, e.g. in the field of optometry, hydrotherapy, medical massage, yoga therapy, music therapy, occupational therapy, speech therapy, chiroprody, homeopathy, chiropractics, acupuncture, etc.

In addition, according to industry and market classifications, such as the Global Industry Classification Standard and the Industry Classification Benchmark, health care includes many categories of medical equipment, instruments and services as well as biotechnology, diagnostic laboratories and substances, and drug manufacturing and delivery.

For example, pharmaceuticals and other medical devices are the leading high technology exports of Europe and the United States. The United States dominates the biopharmaceutical field, accounting for three-quarters of the world's biotechnology revenues.

## **2.7 Health care research**

The quantity and quality of many health care interventions are improved through the results of science, such as advanced through the medical model of health which focuses on the eradication of illness through diagnosis and effective treatment. Many important advances have been made through health research, including biomedical research and pharmaceutical research. They form the basis of evidence-based medicine and evidence-based practice in health care delivery.

For example, in terms of pharmaceutical research and development spending, Europe spends a little less than the United States (€22.50bn compared to €27.05bn in 2006). The United States accounts for 80% of the world's research and development spending in biotechnology.

In addition, the results of health services research can lead to greater efficiency and equitable delivery of health care interventions, as advanced through the social model of health and disability, which emphasizes the societal changes that can be made to make population healthier. Results from health services research often form the basis of evidence-based policy in health care systems. Health services research is also aided by initiatives in the field of AI for the development of systems of health assessment that are clinically useful, timely, sensitive to change, culturally sensitive, low burden, low cost, involving for the patient and built into standard procedures.

## **2.8 Health care financing**

There are generally five primary methods of funding health care systems:

1. general taxation to the state, county or municipality
2. social health insurance
3. voluntary or private health insurance
4. out-of-pocket payments
5. donations to health charities

In most countries, the financing of health care services features a mix of all five models, but the exact distribution varies across countries and over time within countries. In all countries and jurisdictions, there are many topics in the politics and evidence that can influence the decision of a government, private sector business or other group to adopt a specific health policy regarding the financing structure.

For example, social health insurance is where a nation's entire population is eligible for health care coverage, and this coverage and the services provided are regulated. In almost every jurisdiction with a government-funded health care system, a parallel private, and usually for-profit, system is allowed to operate. This is sometimes referred to as two-tier health care or universal health care.

## **2.9 Health care administration and regulation**

The management and administration of health care is another sector vital to the delivery of health care services. In particular, the practice of health professionals and operation of health care institutions is typically regulated by national or state/provincial authorities through appropriate regulatory bodies for purposes of quality assurance.<sup>[22]</sup> Most countries have credentialing staff in regulatory boards or health departments who document the certification or licensing of health workers and their work history.

## **2.10 Health information technology**

Health information technology (HIT) is “the application of information processing involving both computer hardware and software that deals with the storage, retrieval, sharing, and use of health care information, data, and knowledge for communication and decision making” (Brailer, & Thompson, 2004). Technology is a broad concept that deals with a species' usage and knowledge of tools and crafts, and how it affects a species' ability to control and adapt to its environment. However, a strict definition is elusive; "technology" can refer to material objects of use to humanity, such as machines, hardware or utensils, but can also encompass broader themes, including systems, methods of organization, and techniques. For HIT, technology represents computers and communications attributes that can be networked to build systems for moving health information. Informatics is yet another integral aspect of HIT.

### *Review Questions*

1. Define the General healthcare?
2. Explain the Primary and Secondary healthcare?
3. Explain the Health care industry?
4. Explain the Health care reserach?

### *Discussion Questions*

Discuss the Healthcare in details?

## Lesson 3 – Routes of medication and laboratory

### Learning Objectives

- To define the Routes of medication.
- To explain the different types of Routes of medication.
- To explain the Injection Independent Routes.
- To describe the Ophthalmics.

### 3.1 Routes of Administration Requiring Sterile Formulations

Some routes of administration demand that products do not bring microbial contamination with them into the body. This is required because some routes of administration by-pass the body's natural defense mechanisms, or some tissues or organs are so sensitive and vital that such contamination could be serious.

All of these "sterility demanding" routes are parenteral routes.

But not all parenteral routes are "sterility demanding" routes.

The term *parenteral* means next to or beside the enteral. *Enteral* refers to the alimentary tract, so parenteral means sites that are outside of or beside the alimentary tract. Since oral, sublingual, and rectal comprise the enteral routes of administration, any other route is considered a parenteral administration site. Topical administration is a parenteral route that does not require sterile formulations.

#### 3.1.1 The parenteral routes of administration are used for various reasons.

- If a drug is poorly absorbed when orally administered or is degraded by stomach acid or the gastrointestinal enzymes, then a parenteral route would be indicated.
- The parenteral routes are also preferred when a rapid and predictable drug response is desired as in an emergency situation.
- Parenteral routes of administration are also useful when a patient is uncooperative, unconscious, or unable to take drug via an enteral route.
- Parenteral routes are used when localized drug therapy is desired.

#### 3.1.2 But there are major disadvantages.

- Most of these parenteral formulations are more expensive than enteral route formulations.
- There is the requirement that these parenteral formulations must be sterile.
- Most of these formulations require that a skilled or trained person administer them.



- Once the drug is administered, it may be difficult to remove the dose if an adverse or toxic reaction.

### 3.2 Injection Dependent Routes

Several of the "sterility demanding" routes require that a needle (or catheter) and some type of propelling



device (e.g., syringe, pump, gravity fed bag) be used to place the formulation in the desired anatomical site. These can be said to be **injection dependent** routes.

These injection dependent routes have several characteristics in common. The formulations that can be used with injectibles are limited to solutions, suspensions, and emulsions. Many of the routes have limited volumes of formulation that can be injected; excessive injection volumes will cause pain and cell necrosis.

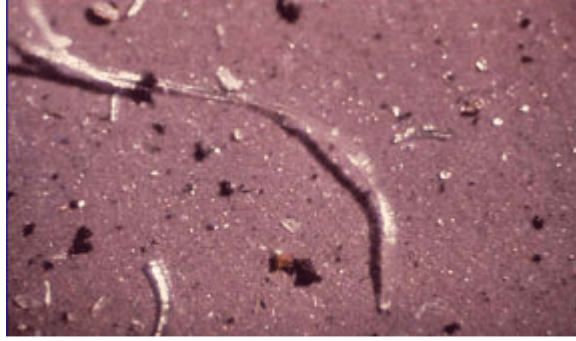
#### 3.2.1 Intravenous

Several sites on the body are used to intravenously administer drugs: the veins of the antecubital area (in front of the elbow), the back of the hand, and some of the larger veins in the foot. On some occasions, a vein must be exposed by a surgical cut down.

Intravenous administration will provide the most rapid onset of action of any parenteral route because there is no barrier to absorption. The drug is completely available to the body. Drugs that are too irritating for intramuscular or subcutaneous administration (e.g., chemotherapy agents) can be given by this route. Many different types of catheters (an indwelling soft tube) or needles are used to administer intravenous formulations. Placement of these devices is crucial to avoid problems of extravasation or infiltration.

There are several complications that can occur from intravenous administration.

- **Thrombosis** formation can result from many factors: extremes in solution pH, particulate



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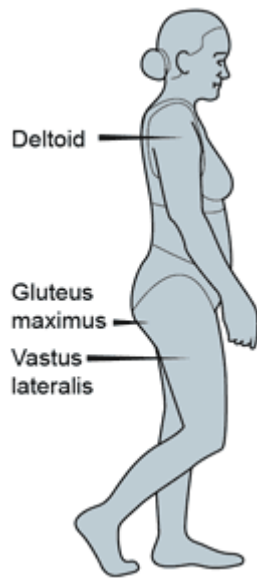
material, irritant properties of the drug, needle or catheter trauma, and selection of too small a vein for the volume of solution injected.

- **Phlebitis**, or inflammation of the vein, can be caused by the same factors that cause thrombosis.
- **Air emboli** occur when air is introduced into the vein. The human body is not harmed by small amounts of air, but a good practice is to purge all air bubbles from the formulation and administration sets before use.
- **Particulate material** is generally small pieces of glass that chip from the formulation vial or rubber that comes from the rubber closure on injection vials. Although great care is taken to eliminate the presence of particulate material, a final filter in the administration line just before entering the venous system is a typical precaution.

Solutions are the most commonly administered intravenous formulation. They are usually aqueous but may also have glycols, alcohols, or other nonaqueous solvents in them. injectable suspensions are difficult to formulate because they must possess syringeability and injectability. Syringeability refers to the ease at which the suspension can be withdrawn from a container into a syringe. Injectability refers to the properties of the suspension while being injected, properties such as flow evenness, freedom from clogging, etc. Intravenously administered emulsions are heterogeneous formulations that contain both aqueous and non-aqueous components. Fat emulsions and total parenteral nutrition (TPN) emulsions are used to provide triglycerides, fatty acids, and calories for patients who cannot absorb them from the gastrointestinal tract.

### 3.2.2 Intramuscular

This route of administration is generally considered less hazardous and easier to use than the intravenous route. The onset of action is typically longer than with intravenous administration, but shorter than with subcutaneous administration. Patients generally experience more pain via intramuscular administration compared to intravenous administration.



Intramuscular (IM) injections are made into the striated muscle fibers that are under the subcutaneous layer of the skin. Thus needles used for the injections are generally 1 inch to 1.5 inches long and are generally 19 to 22 gauge in size. The principal sites of injection are the gluteal (buttocks), deltoid (upper arm), and vastus lateralis (thigh) muscles. When administering intramuscular injections into the gluteus maximus, the size of the needle must be chosen based on the patient's deposits of fat. If a needle is used that is too short to pass all the way through the fat into the muscle, then the injection will be made into the fat. Women tend to have more fat in this region than men, so the possibility of a intralipomatous injection is significant. It is estimated that few women and about 15% of men actually receive the intended intramuscular injection because an improper needle length was used.

If a series of injections are to be given, the injection site is usually varied or rotated. Generally only limited injection volumes can be given by intramuscular injection: 2 ml in the deltoid and thigh muscles, and up to 5 ml in the gluteus maximus.

The point of injection should be as far as possible from major nerves and blood vessels to avoid neural damage and accidental intravenous administration. To insure that a blood vessel has not been entered, the syringe should be slightly aspirated after insertion and before injection to see if blood enters the syringe. Other injuries that can occur following intramuscular injection are abscesses, cysts, embolism, hematoma, skin sloughing, and scar formation.

Intramuscular injections generally result in lower but more sustained blood concentrations than after intravenous administration. Part of the reason is that intramuscular injections require an absorption step which delays the time to peak concentrations. When a formulation is injected, a "depot" forms inside the muscle tissue which acts as a repository for the drug. The absorption rate from this depot is dependent on many physiological factors such as muscle exercise, depth of injection, local blood flow supply, etc.

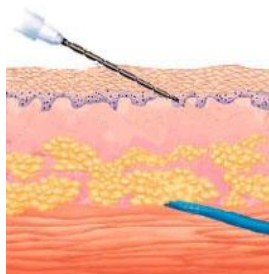
The absorption rate from the depot is also influenced by many formulation factors. Aqueous solutions typically provide the fastest absorption possible from the IM depot and oleaginous solutions provide slightly slower absorption. But to further alter the absorption rate, drugs are formulated as suspension or colloids in aqueous and oleaginous solvents or as oil-in-water emulsions and water-in-oil emulsions. Different salt forms of the drug may also be used to take advantage of a slower dissolution rate or a lower solubility inherent with the salt. All of these factors can be varied to achieve the desired absorption rate. For example, to achieve a very slow absorption rate, a low solubility salt form of the drug could be placed

as a suspension in an oleaginous solvent. Here the salt would slowly dissolve due to its limited solubility, and then slowly diffuse through the oleaginous solvent.

Or another approach could be to make large particles of the drug (which will dissolve slowly) and put them in the oil phase of an oil in water emulsion. In this case, the drug would dissolve slowly, but would also diffuse slowly out of the oil phase, and would still need more time to diffuse through the water phase of the emulsion. Thus, there are three processes that influence the absorption rate of this type of formulation.

### 3.2.3 Intradermal

The dermis is the more vascular layer of the skin just beneath the epidermis. The usual site for



intradermal injections is the anterior surface of the forearm. Needles are generally 3/8 inches long and 25 to 26 gauge. Drugs that are intradermally injected are agents for diagnostic determinations, desensitization, or immunization. For this route of administration, 0.1 ml of solution is the maximum volume that can be administered.

### 3.2.4 Subcutaneous

The subcutaneous (SC, SQ) route is one of the most versatile routes of administration in that it can be used for both short term and very long term therapies. The injection of a drug or the implantation of a device beneath the surface of the skin is made in the loose interstitial tissues of the upper arm, the anterior surface of the thigh, or the lower portion of the abdomen. The upper back also can be used as a site of subcutaneous administration. The site of injection is usually rotated when injections are frequently given. The maximum amount of medication that can be subcutaneously injected is about 2 ml. Needles are generally 3/8 to 1 inch in length and 24 to 27 gauge.

Absorption of drugs from the subcutaneous tissue is influenced by the same factors that determine the rate of absorption from intramuscular sites; however, the vascularity in the subcutaneous tissue is less than that of muscle tissue, and therefore absorption may be slower than after intramuscular administration. But absorption after subcutaneous administration is generally more rapid and predictable than after oral administration. There are several ways to change the absorption rate:

- use heat or massage the site to increase the absorption rates of many drugs.
  - co-administer vasodilators or hyaluronidase to increase absorption rates of some drugs.
- Conversely, epinephrine decreases blood flow which can decrease the absorption rate.

Many different solution and suspension formulations are given subcutaneously. Heparin and insulin are the most important drugs routinely administered by this route. Drugs that are administered by the route must be soluble and potent in small concentrations since only a very small volume can be injected. The rate of drug release is controlled by the same factors used for intramuscular formulations: slowly soluble salt forms, suspensions versus solutions, differences in particle size, viscosity of the injection vehicle, etc.

In spite of the advantages of this route of administration, there are some precautions to observe.

- Drugs which are irritating or those in very viscous (thick) suspensions may produce induration, sloughing, or abscess formation and may be painful to the patient.
- Irritating drugs and vasoconstrictors can lead to abscesses or necrosis.
- If frequent injections are required, the injection sites must be rotated.

One of the most obvious ways to achieve very long term drug release is to place the drug in a delivery system or device that can be implanted into a body tissue. The subcutaneous tissue is the ideal site for implantation of such devices. Implantation often requires a surgical procedure or a specialized injection device. The fact that the device will be in constant contact with the subcutaneous tissue requires that the device materials be biocompatible (e.g., not irritating) and do not promote infection or sterile abscess. Another advantage is that the device can be easily removed if necessary. Examples of implantable devices are Norplant, Oreton, Percorten and an osmotically driven mini-pump which can deliver drug solutions for up to twenty-one days. Other devices include degradable microspheres, vapor pressure devices for morphine release, osmotic pressure devices to deliver insulin, and magnetically or ultrasonically activated pellets.

Sometimes ports and pumps are placed in the subcutaneous space and the attached delivery catheter is placed in a vein, cavity, or artery.

### **3.2.5 Epidural**

The brain and spinal cord are covered by three membranes called meninges. The dura mater is the outermost of these protective membranes. The spinal cord is protected from injury as it goes down the back by passing through the central cavities of the vertebrae in the vertebral column. The epidural space is the space in the central cavities between the dura mater (covering the spinal cord) and the vertebral column.

Epidural administration is an effective means of controlling and relieving chronic pain. It is commonly used in the labor and delivery settings, and in postoperative settings. The advantage of this route of administration is that drug dosages are generally much lower than when given by other routes and typically produce fewer side effects. Studies have shown that epidural administration produces longer lasting pain relief, increased patient alertness, and earlier ambulation.

When epidural administration will be temporary or short-term, a catheter is inserted in the epidural space but is generally not sutured into place. The catheter exits from the insertion site on the back. If the administration will be permanent or long-term, the catheter is "tunneled" and exits on the side of the body or on the abdomen. A variation of the technique is to subcutaneously implant a Port-a-cath® and connect that device to the indwelling catheter.

It is obvious why sterile compounded formulations must be used via this route of administration. Preservatives are strictly contraindicated in epidural formulations to prevent nerve damage.

### **3.2.6 Intrathecal**

The dura mater is the outermost meninge and the arachnoid mater is the intermost meninge. Intrathecal injections place formulations in the subarachnoid space, e.g., underneath the arachnoid mater. This space is filled with the cerebral spinal fluid that circulates around the spinal cord and the brain. Intrathecal

injections allow dosages that may be about one-tenth those given by epidural administration. However, intrathecal administration carries a greater risk and consequence of bacterial contamination than epidural administration because the cerebral spinal fluid is a good medium for bacteria growth. These injections may also cause "spinal headaches." Spinal headaches occur when the needle puncture does not seal off and cerebral spinal fluid continually leaks out into the epidural space.

Intrathecal administration is often used to give single injections of narcotics for postoperative pain management. Implantable infusion pumps are used to chronically administer medications to the intrathecal space. These administration techniques allow for very low doses of medications to be given in a controlled manner and reduces the incidence of side effects. The reservoirs in these pumps typically hold between 18 - 50 ml of solution; therefore, the solution concentrations will be high. Formulating high concentration solutions may entail problems with solubility, pH, buffering, etc. Also, these solutions must be preservative free to avoid nerve damage.

### 3.3 Injection Independent Routes

The demand for sterility to protect tissues or organs comes with the intranasal, inhalation, and ophthalmic routes of administration. These can be said to be **injection independent** since a needle or catheter is not required to administered formulations via these routes.

#### 3.3.1 Intranasal

The adult nasal cavity has a capacity of about 20 ml, a very large surface area for absorption, and a very rich blood supply. Intranasal administration has typically been used to administer drugs to the upper respiratory tract. However, the absorption of some drugs give blood concentrations that are very similar to concentrations seen when the drug is intravenously administered. Because of this favorable absorption, intranasal administration has been investigated as a possible route of systemic administration for drugs such as insulin, glucagon, progesterone, propranolol, and narcotic analgesics (to mention a few).

The drug can be lost following intranasal administration by three mechanisms:

- ***Metabolism in the nasal mucosa.*** The nasal mucosa is an enzymatically active tissue and some drugs are significantly degraded when administered by this route.
- ***Mucus flow and ciliary movement.*** The normal physiology of the nasal cavity is to move mucus and inhaled contaminants up and away from the lungs and toward the orifice of the nose. So some drug loss will occur as the drug is swept outward by these processes.
- ***Swallowing.*** Intranasal administration can also cause the drug to be swallowed and in some cases enough drug will be swallowed to be equal to an oral dose. This may lead to a systemic effect from the drug even though it is intranasally administered.

There are several different compounded formulations for intranasal administration: solutions, suspensions, and gels. The liquids are typically sterile, isotonic, weakly buffered, and preserved so as to not interfere with the nasal cilia. The buffered products are generally at pH between 4 and 8 and optimally at the pH of maximum stability of the active drug if it is in that range. Although isotonicity is 300 mOsmol/L, osmotic pressures ranging from 200 to 600 mOsmol/L are acceptable for intranasal administration.



Generally solutions and suspensions are administered as drops; solutions can also be administered as a fine mist from a nasal spray bottle. Nasal sprays are preferred to drops because drops are more likely to drain into the back of the mouth and throat and be swallowed. If the drug is sufficiently volatile, it can be administered as a nasal inhaler. The inhaler is a cylindrical tube with a cap that contains fibrous material impregnated with a volatile drug. The patient removes the cap, and the inhaler tip is placed just inside the nostril. As the patient inhales, air is pulled through the tube and the vaporized drug is pulled into the nasal cavity. Gels are generally dispensed in small syringes containing the required dosage for one application.

If drops or sprays are used, the quantity of drug administered in each drop or each spray should be calibrated.

### 3.3.2 To calibrate a dropper:

- drop the formulation into a small graduated cylinder (5 ml or 10 ml) using the dropper the patient will use
- count the number of drops required to dispense 3 ml of solution
- divide the number of drops by 3; this will give the number of drops per ml
- calculate the number of drops needed to dispense the volume of formulation in one dose

### 3.3.3 To calibrate a spray bottle:

- weigh the spray bottle when filled with the formulation
- deliver 10 sprays into a plastic bag
- re-weigh the spray bottle
- divide the difference in the two weights by 10; this will give a "approximate" volume delivered with each spray
- calculate the number of sprays needed to dispense the volume of formulation in one dose (assume specific gravity = 1)

Keep in mind that the patient's manner of squeezing the spray bottle may be different. The pharmacist may want to calibrate the spray bottle with the patient using the spray bottle.

### 3.3.4 How to Use Intranasal Drops



1. Blow your nose gently to clear the nostrils.
2. Wash your hands with soap and warm water.
3. Lie down on a bed with your head tilted back and the neck supported (allow the head to hang over the edge of the bed or place a small pillow under your shoulders). Tilt your head back so that it is hanging lower than your shoulders. Note: If putting drops into the nose of a child, lie the child on his or her back over your lap. The head should be tilted back.
4. Draw up a small amount of medication into the medicine dropper.
5. Breathe through your mouth.
6. Place the tip of the medicine dropper just inside your nostril (about 1/3 inch). Avoid touching the dropper against the nostril or anything else.
7. Place the directed number of drops into your nostril.
8. Repeat steps 3 - 7 for the other nostril if directed to do so.
9. Remain lying down for about 5 minutes, so the medication has a chance to spread throughout your nasal passages.
10. Replace the medicine dropper to its container and tightly close the bottle.
11. Wash your hands.

### 3.3.5 Comments:

- Some of the solution may drain down into your mouth. If the taste is unpleasant, you may cough out the excess solution into a tissue.
- It may be much easier to have someone help you instill your nose drops.

### 3.3.6 How to Use Intranasal Sprays or Pumps



1. Blow your nose gently to clear the nostrils.
2. Wash your hands with soap and warm water.



3. Hold your head in an upright position.
4. Close one nostril with one finger.
5. With the mouth closed, insert the tip of the spray or pump into the open nostril. Sniff in through the nostril while quickly and firmly squeezing the spray container or activating the pump.
6. Hold your breath for a few seconds and then breathe out through your mouth.
7. Repeat this procedure for the other nostril only if directed to do so.
8. Rinse the spray or pump tip with hot water and replace the cap tightly on the container.
9. Wash your hands.

### 3.3.7 Inhalation

Inhalation dosage forms are intended to deliver drugs to the lungs. The lungs have a large surface area and a rich blood supply to the alveolar epithelium both of which favor rapid absorption. However, there is considerable variability in the absorption of drugs from the lungs so that this route is not considered an alternative to intravenous administration. Drugs administered via this route are to affect pulmonary function or treat allergic symptoms. Examples of drugs administered by inhalation include adrenocorticoid steroids (e.g., beclomethasone), bronchodilators (e.g., isoproterenol, metaproterenol, albuterol), and antiallergics (e.g., cromolyn).

Administering drugs via this route is dependent on factors which involve the formulation, the administration device, and the anatomy of the lungs.



Inhalation formulations are generally solutions, suspensions, and powders. These formulations are administered via an aerosol or a dry powder inhaler. Aerosols are devices where liquid or suspension droplets are the internal phase and a gas is the external phase. Commercial aerosols are typically metered dose inhalers (MDI) that deliver a fixed dose in a spray with each actuation of the device. For compounded inhalation solutions, atomizers, nebulizers, and vaporizers are the aerosol devices.



Atomizers (right) are devices that break up a liquid into a aerosol. A squeeze bulb is used to blow air into the device. The air causes the drug solution to rise in a small dip tube and vaporizes the liquid in the air stream. To produce even smaller droplets, the air stream is directed into a baffle or bead which breaks the droplets as they collide with the device. The air and liquid then exit the atomizer.



A nebulizer (left) contains an atomizing unit within a chamber. When the rubber bulb is depressed, the medication solution is drawn up a dip tube and aerosolized by the passing air stream. Baffles or beads may also be present in the chamber. The fine droplets exit the nebulizer. The larger droplets collect on the chamber and fall back into the reservoir where they can be used again.



Vaporizers produce a fine mist of steam. Volatile medication is added to the water in the vaporizer or to a special medication cup present in some models. The medication volatilizes and is inhaled by the patient as they breathe.

Commercially available dry powder inhalers contain their dry powders in manufactured cartridges or disks. When the

### 3.4 Ophthalmics

Drugs are administered to the eye for local effects such as miosis, mydriasis, anesthesia, or reduction of intraocular pressure (i.e., glaucoma). Formulations that are used include aqueous solutions, aqueous suspensions, ointments, and implants. Every ophthalmic product must be sterile in its final container and the pH, buffer capacity, viscosity, and tonicity of the formulation must be carefully controlled.

There are three unique ways that drug can be lost following ophthalmic administration:

- ***Immediate loss due to spillage.*** The normal volume of tears in the eye is estimated to be 7 microliters, and if blinking occurs, the eye can hold up to 10 microliters without spillage. The normal commercial eye dropper dispenses 50 microliters of solution; thus, more than half of the dose will be lost from the eye by overflow. The ideal volume of drug solution to administer would be 5 to 10 microliters; however, there are no microliter dosing eye droppers generally available to patients.
- ***Lacrimal drainage.*** Tears wash the eyeball as they flow from the lacrimal gland across the eye and drain into the lacrimal canalicula. In man, the rate of tear production is approximately 2 microliters per minute; thus, the entire tear volume in the eye turns over every 2 to 3 minutes. This rapid washing and turnover also accounts for loss of an ophthalmic dose in a relatively short period of time.
- ***Drug absorption into the conjunctiva*** and its rapid removal from the ocular tissues by the peripheral blood flow.

Ophthalmic administration is to deliver a drug on the eye, into the eye, or onto the conjunctiva. Transcorneal transport (i.e., drug penetration into the eye) is not an effective process. It is estimated that

only one-tenth of a dose penetrates into the eye. Following ophthalmic administration, it is possible to get systemic effects. Drug can enter the systemic circulation by two ways:

- Drug that enters the lacrimal canalicula is emptied into the gastrointestinal tract
- Drug can be absorbed through the conjunctiva

Most compounded ophthalmic solutions and suspensions are packaged in eye dropper bottles. Patients should be shown how to properly instill the drops in their eyes, and every effort should be made to emphasize the need for instilling only one drop per administration, not two or three.

In an effort to maintain longer contact between the drug and the surrounding tissue, suspensions, ointments, and inserts have been developed. When aqueous suspensions are used, the particle size is kept to a minimum to prevent irritation of the eye. It is possible to find particles adhering to the conjunctiva after administration of this dosage form. Ointments tend to keep the drug in contact with the eye longer than suspensions. Most ophthalmic ointment bases are a mixture of mineral oil and white petrolatum and have a melting point close to body temperature. But ointments tend to blur patient vision as they remain viscous and are not removed easily by the tear fluid. Therefore, ointments are generally used at night as adjunctive therapy to eye drops which are used during the day. Ophthalmic ointment tubes are typically small holding approximately 3.5 g of ointment and fitted with narrow gauge tips which permit the extrusion of narrow bands of ointment.

### 3.4.1 How To Use Ophthalmic Drops



1. Wash your hands carefully with soap and warm water.
2. If the product container is transparent, check the solution before use. If it is discolored or has changed in any way since it was purchased (e.g., particles in the solution, color change), do not use the solution.
3. If the product container has a depressible rubber bulb, draw up a small amount of medication into the eye dropper by first squeezing, then relieving pressure on the bulb.
4. Tilt the head back with chin tilted up and look toward the ceiling.
5. With both eyes open, gently draw down the lower lid of the affected eye with your index finger.
6. In the "gutter" formed, place one drop of the solution.

**IMPORTANT:** The dropper or administration tip should be held as near as possible to the lid

without actually touching the eye. DO NOT allow the dropper or administration tip to touch any surface.

7. If possible, hold the eyelid open and do not blink for 30 seconds.
8. You may want to press your finger against the inner corner of your eye for one minute. This will keep the medication in your eye.
9. Tightly cap the bottle.

### 3.4.2 Comments

- This is a sterile solution. Contamination of the dropper or eye solution can lead to a serious eye infection.
- If irritation persists or increases, discontinue use immediately.
- Generally, eye makeup should be avoided while using eye solutions.
- You may want to use a mirror when applying the drops, or it may be much easier to have someone help you instill your eye drops.

### 3.4.3 How To Administer An Ophthalmic Ointment



1. Wash your hands carefully with soap and warm water.
2. You may want to hold the ointment tube in your hand for a few minutes to warm and soften the ointment.
3. Gently cleanse the affected eyelid with warm water and a soft cloth before applying the ointment.
4. In front of a mirror, with the affected eye looking upward, gently pull the lower eyelid downward with your index finger to form a pouch.
5. Squeeze a thin line (approximately  $\frac{1}{4}$  -  $\frac{1}{2}$  inch) of the ointment along the pouch.  
**IMPORTANT:** Be very careful when applying this ointment. DO NOT allow the tip of the ointment tube to touch the eyelid, the eyeball, your finger, or any surface.
6. Close the eye gently and rotate the eyeball to distribute the ointment. You may blink several times to evenly spread the ointment.

7. Replace the cap on the ointment tube.

After you apply the ointment, your vision may be blurred temporarily. Do not be alarmed. This will clear up in a short while, but do not drive a car or operate machinery until your vision has cleared.

#### 3.4.4 Comments

- This is a sterile ointment. Contamination of the tip or the cap of the tube can lead to a serious eye infection.
- If irritation persists or increases, discontinue use immediately.
- Generally, eye makeup should be avoided while using eye ointments.
- It may be much easier to have someone help you apply your eye ointment

### 3.5 Guidelines, Equipment, and Supplies for Sterile Compounding

#### 3.5.1 Introduction

Pharmacists have been providing sterile compounding services in institutions for decades. These services have provided parenteral therapies, infusion services, and complex infusion administration devices and supplies. However, in the past two decades, compounding sterile formulations and providing administration services has expanded beyond the institution. These additional areas include home care agencies, infusion service agencies, outpatient clinics, and community pharmacies. Pharmacists are also providing patient and caregiver assessments, education, and skills, and are taking the responsibility for coordinating patient care through an interdisciplinary team.

Pharmacists will compound a wide variety of sterile formulations in these different settings. These formulations will include products administered by injection (IV, IM, SQ, ID, intrathecal, epidural) or via inhalation, intranasal, or ophthalmic routes of administration. Sterile formulations for either institutional or home care use have a number of special requirements such as:

- sterility
- particulate material
- pyrogen-free
- stability
- pH
- osmotic pressure

**Sterility** is the freedom from bacteria and other microorganisms. Formulations must be sterile, which is not a relative term; an item is either sterile or not sterile.

If the sterile formulation is a solution, it must be free of all visible **particulate material**. Particulate materials refer to the mobile, undissolved substances unintentionally present in parenteral products. Examples of such material are cellulose, glass, rubber cores from vials, cloth or cotton fibers, metal, plastic, rust, diatoms, and dandruff. Sterile suspensions and ointments may have particulate material, but these are usually the active drug or an ingredient, not contaminants.

Particles measuring 50 microns or larger can be detected by visual inspection. Specialized equipment is needed to detect particles less than 50 microns in size. The USP 24/NF19 Section <788> sets limits on the number and size of particulates that are permissible in parenteral formulations. For large volume parenterals, the limit is not more than 12 particles/ml that are equal to or larger than 10 microns, and not

more than 2 particles/ml that are equal to or larger than 25 microns. For small volume parenterals, the limit is 3000 particles/container that are equal to or larger than 10 microns, and not more than 300/container that are equal to or larger than 25 microns.

The potential sources of particulate material are:

1. The product itself
2. Manufacturing and such variables as the environment, equipment, and personnel
3. The packaging components
4. The administration sets and devices used to administer the product
5. The manipulations and environment of the product at the time of administration.

Sterile formulations must be **pyrogen-free**. Pyrogens are metabolic by-products of living microorganisms. So if pyrogens are detected in a sterile product, that means that bacteria have proliferated somewhere along during the formulation process. In humans, pyrogens cause significant discomfort but are rarely fatal. Symptoms include fever and chills, cutaneous vasoconstriction, increased arterial blood pressure, increased heart workload, pupillary dilation, piloerection, decreased respiration, nausea and malaise, severe diarrhea, or pain in the back and legs.

The **stability** of drugs in sterile formulations is an important consideration. In institutional settings, most admixtures are prepared hours in advance of when they are to be administered, and are generally utilized within a short period of time. In home health care settings, admixtures are prepared days in advance of when they are to be administered, and are generally utilized over longer periods of time compared to the clinical setting. Therefore, the stability of a particular drug in a particular sterile formulation must be known.

**Physiological pH** is about 7.4, and an effort should be made to provide sterile formulations that do not vary significantly from that normal pH. Of course, there are situations in which this becomes a secondary consideration because acidic or alkaline solutions may be needed to solubilize drugs or used as a therapeutic treatment themselves.

**Osmotic pressure** is a characteristic of any solution that results from the number of dissolved particles in the solution. Blood has an osmolarity of approximately 300 milliosmoles per liter (mOsmol/L), and ideally any sterile solution would be formulated to have the same osmolarity. The most commonly used large volume parenteral solutions have osmolarities similar to that of blood; for example, 0.9% sodium chloride solution (308 mOsmol/L) and 5% dextrose solution (252 mOsmol/L).

Intravenous solutions that have larger osmolarity values (hypertonic) or smaller osmolarity values (hypotonic) may cause damage to red blood cells, pain, and tissue irritation. However, there are some therapeutic situations where it may be necessary to administer hypertonic or hypotonic solutions. In these cases, the solutions are usually given slowly through large veins to minimize the reactions.

### *Review Questions*

1. Define the Routes of medication?
2. Explain the different types of Routes of medication?
3. Explain the Injection Independent Routes?

4. Explain the Ophthalmics?

#### Discussion Questions

Discuss the Routes of medication in details?

# Illness

## Lesson 1 – Illness : Direct and indirect causes

### Learning Objectives

- To define the Illness.
- To explain the Root Causes of Illness .
- To explain the different types of Illness.
- To describe the Mental Illness.

### 1.1 Illness

Few people manage to go through life without getting sick. Many sicknesses are fleeting and really nothing to worry about, while others are serious and have long-lasting effects. Disease itself isn't linked to perception; it can be pathologically identified in an objective way. It's important to recognize, however, that the way an individual perceives physical or emotional discomfort is not as easily measured. Illness perception might reflect cultural beliefs, psychological needs, or something else that may have little to do with measurable disease.

An understanding of a patient's illness perception is necessary to help in a diagnosis. This can be difficult because perception is highly subjective, and there's no absolute method of measuring it, either from individual to individual, or even within one person's perspective through time. Researchers have determined that reducing illness perception to its most basic elements can help patients describe what it is they are feeling. By organizing these components into a structure, patients can reconstruct the architecture of their beliefs about their illnesses.

The first area of focus is *identity*. This component contains what the patient believes is true of the disease, including cause and symptoms. A patient who lists a number of experiences such as confusion, nausea, and anxiety as symptomatic of a particular disease may be more likely to experience those symptoms while simultaneously failing to recognize others that are just as likely to be part of the cluster.

The element of *cause* indicates what the patient believes was the initiating factor. For example, some diseases are genetic, while others are triggered by a virus. Other causes that patients might identify include allergic responses to the environment, emotional stress, or physical damage. Cause can have social or cultural contexts; some patients are more willing to accept a cause of illness or spiritual imbalance, for example, than others.

The patient's sense of *timeline* describes the third component. This area is concerned with the perceived illness's initial appearance, its trajectory, and its conclusion. Patients with the illness perception that a sickness is or will become chronic are less likely to recover from it quickly than those who believe it is temporary.



The fourth area of concern is *consequences*. Patients whose illness perception leads them to believe that it will have a profound and negative effect on the quality of life are more likely to become discouraged or depressed than those who don't have this particular perception. Patients who, in fact, do have a serious disorder but lack a strong sense of consequences might be better able to fight it or less equipped to handle the effects.

The final category is *cure-control*. This element of illness perception is concerned with the degree to which the patient believes a cure is possible. This can range from a fully negative position in which there is no hope of a cure to a fully positive one, in which the patient firmly believes a cure will be found.

## **1.2 Root Causes of Illness**

Treating physical symptoms (pain, injury, infection, etc.) is the appropriate action to take to ease dis-ease. However, after a level of comfort or ease has been attained it is helpful to explore the possible root cause that led you to succumb to a specific illness. With this information you will be better equipped to squash or eliminate vulnerabilities and susceptibilities that could affect recurrence. Our mental, emotional, and spiritual bodies are also vulnerable to root issues erupting and causing energetic imbalances.

Mowing the lawn and cutting down the flower or leaf at the stem of a weed will not stop the offending plant from returning. You need to burrow down into the earth and eradicate the whole plant in order to kill it off completely, otherwise it will reappear. Cutting it will likely slow down its growth, but that's all. This is the same concept with dealing with physical illness and energetic imbalances, treating the "showy" symptoms is not enough. We must dig deeper, discover the cause, and treat the root issue in order to bring about a complete healing. Depending on how deep a root cause is, healing can take a while. It may take months or years, and in some cases, a lifetime. Just remember, healing is a journey.

It is actually best to treat imbalances in the early stages before they have had the opportunity to take root and manifest into the physical body. For example in the case of hereditary dis-eases, taking life style precautions (i.e. healthy diet, regular exercise) is an appropriate preventative measure.

Even in the event of "catching a germ" root causes cannot be overlooked entirely. One might ask himself why he caught the bug from a co-worker when other employees in his work place were unscathed by their exposure to the same influenza virus. What's up with that? Immune deficiencies have root causes too.

## **1.3 Terminal Illness?**

A terminal illness is an infection or disease which is considered ultimately fatal or incurable. Usually a patient is considered to have a terminal illness if he or she seems likely to die despite diagnosis and treatment, although it is possible for people with a terminal illness to live for years before succumbing to the medical condition. Some cancers are terminal, as are the end stages of diseases like Acquired Immunodeficiency Syndrome (AIDS). Diagnosis with a terminal illness can be a traumatic event for a patient and his or her family, and is usually accompanied by offers of psychological counseling and similar assistance.

Medical professionals strive to identify and treat diseases and infections in their early stages. However, sometimes an illness goes undetected, a patient cannot afford proper care, or the illness is virulent enough that it will resist medical intervention. Once a doctor recognizes that he or she can no longer reasonably expect to cure the disease or infection, attention turns to comfort for the dying patient.

Usually, once a patient is diagnosed with a terminal illness, treatment efforts are withdrawn. Often, the treatment for a serious disease can be as painful and uncomfortable as the disease itself. If the treatment is no longer effective, there is no clear reason for a patient to continue taking it. Usually the decision to end treatment is reached by the patient and his or her doctor, and most terminal patients have an active role in their medical treatment. Terminal patients often write directives indicating how they would like to be cared for at the end of their lives, and ask a family member to ensure that their wishes are followed.

Patients with a terminal illness are often placed in palliative care, which provides pain relief and other measures designed to make the end stages of terminal illness as comfortable as possible. Palliative care facilities do not usually engage in life saving measures such as resuscitating patients or emotionally and physically draining treatments like chemotherapy. The staff of palliative care facilities try to ensure that their patients have dignified, comfortable deaths without fear and pain.

Being informed that your medical condition is terminal can be a very intense experience. Most doctors are aware of this and exercise care when informing patients and family members. In addition, grief counseling is highly recommended both for the patient and his or her family. A terminal illness gives everyone involved a period of time to come to terms with death, which can be very valuable. Terminal patients need the support and love of their friends and family members-giving comfort for the dying is one of the most important compassionate acts that anyone can perform.

#### **1.4 Catastrophic Illness?**

A catastrophic illness is a serious health condition that requires extensive medical care and hospitalization. This type of illness usually imposes a significant financial burden on the patient and/or his medical insurance provider. Examples of catastrophic illness include coma, various cancers, stroke, and debilitating heart conditions. A medical condition falls into the category of catastrophic illnesses if it prevents the individual from working, functioning normally, and meeting his financial responsibilities.

Cancer is one example of a catastrophic illness. Some cancer patients require a wide range of treatments, such as surgery for tumor removal, chemotherapy, and radiation to eliminate the cancer cells. In terminal cases of the disease, the patient sometimes needs hospitalization and 24-hour care. A cancer patient with good health insurance might have coverage for much of his treatment costs. For the cancer patient without insurance, he must find a way to pay for extensive treatments or allow the disease to go untreated.

The challenges of catastrophic illnesses are numerous. A patient who has suffered a stroke might possibly have lost the use of important bodily functions. The inability to move one side of the body, for example, can be debilitating for the individual's chances of working and supporting himself financially. He may possibly need assistance to carry out day-to-day tasks, requiring the full-time attention of a nurse or relative. His challenges and burdens might be physical, work-related, and financial.

Being in a coma is considered a catastrophic illness because the patient requires extensive monitoring and hospitalization. The condition can continue indefinitely and, in some cases, there is no indication of recovery. Comas are brought on unexpectedly and can result from excessive alcohol intake, drug abuse, stroke, or accidents causing head injuries. Some coma patients recover quickly but others can remain in a coma for years. Extensive care and costs are associated with comas in all cases because patients must be fed and monitored continuously.

Health insurance for catastrophic illness is designed to ease the financial burden on individuals and their families in the event of unexpected illness. Insurance premiums for these types of policies usually cost less for younger age groups and for those with no existing health issues. Individuals who are older and

have pre-existing cancer or heart-related conditions generally pay more for this type of insurance. Catastrophic illness insurance typically covers some portion of hospitalization expenses, in-home care, doctor's visits, and lab exams. The cost and extent of this type of coverage varies by insurance company and by policy.

### **1.5 Acute Illness?**

An acute illness is an illness that onsets very rapidly and is of short duration. A classic example is the so-called "stomach flu." While acute illnesses may not last long, they can be very dangerous and in some cases are deadly. Management of acute illnesses requires determining what is making someone sick so that a treatment plan can be developed. Many people recover from acute illness with self care at home but in other cases treatment in a hospital is necessary.

Signs of acute illness onset rapidly. Someone may feel very healthy and abruptly experience symptoms like nausea, vomiting, diarrhea, headache, coughing, aches and pains, confusion, skin rash, and so forth. Clusters of symptoms appearing together can provide information about the nature of an acute illness. Causes can include allergies, drug reactions, infections with microorganisms, and autoimmune disorders.

In some cases, the illness runs its course on its own. Supportive therapy such as rest and fluids can help the patient feel more comfortable while recovering. Other cases require medical intervention. Acute illness can cause severe dehydration, for example, which can cause permanent damage. Some people may also develop infections that could lead to death or disability if left untreated.

There are some signs that can help people differentiate between an acute illness like a cold that can be managed at home and an acute illness like flesh-eating disease that requires medical attention. As a general rule, if a patient develops a high fever, has difficulty breathing, or experiences neurological symptoms like confusion, slurred speech, or extreme fatigue, the patient needs to see a doctor. Severe pain can also be a sign of a serious disease that needs to be treated at a hospital.

Doctors prefer patients to be safe rather than sorry. If someone has an acute illness and there are concerns that medical treatment is needed, it is better to take the patient to a clinic or hospital for evaluation than to sit at home wondering if a doctor is needed. The best case scenario is that the doctor will examine the patient, determine that he or she will recover independently, and send the patient home.

The opposite of an acute illness is a chronic illness. Chronic illnesses have a slow onset and long duration. Some can eventually lead to death. Chronic illnesses require long term management with lifestyle, medication, diet, and other changes.

### **1.6 Psychosomatic Illnesses?**

Psychosomatic illnesses are caused by mental and emotional stresses that manifest as physical diseases without biological causes. This includes things like irritable bowel syndrome, upset stomach, muscle aches, tension headaches, chronic fatigue syndrome, hyperventilation or panic attacks, colitis and ulcers, and even infertility. The skill with which a person handles stress affects the potential appearance and severity of psychosomatic symptoms.

Before these conditions can be properly diagnosed, tests must be administered to rule out possible physical reasons for the illness. This step is often frustrating for patient and doctor alike, as test after test comes back negative. This has led some physicians to tell their patients that psychosomatic illnesses are

“all in their head.” Today, most doctors know better. Though the root may be mental or emotional, the disease and symptoms are very real.

Psychosomatic illnesses are not faked illnesses, but patients often require treatment for the underlying psychological root. Unfortunately, many people with these illnesses resist psychological counseling as a form of treatment, believing this discounts the disease. Though these illnesses respond to drugs, painkillers and other medical help, symptoms are likely to return unless the underlying cause is addressed.

If not chronic, psychosomatic illnesses might only crop up when a person goes through a particularly stressful time. In these cases, symptoms subside on their own when stress levels fall. These conditions might accompany the death of a loved one, the loss of a job, or cyclic pressures at work or home. Aside from creating an illness, emotional stress might also make an existing illness worse. Psychological stress can reduce the effectiveness of the immune system, lower energy levels, and exacerbate a weakened condition.

While psychosomatic illnesses are real, they can be avoided. Learning to handle stress and replace negative thinking patterns through cognitive behavioral changes can provide relief. People with these types of illnesses do not intentionally make themselves sick, nor are they aware they are causing the illnesses. In the case of chronic patterns, it is likely that therapy will be necessary to replace existing unhealthy patterns with new healthier coping mechanisms.

### **1.7 Different Types of Mental Illness?**

There are numerous types of mental illness, such as psychotic disorders, which are often incurable. Some people have mood disorders, which affect how they feel. Then there are the types of mental illness, such as personality disorders and dissociative disorders, that are characterized by an inability to deal with people normally. Furthermore, it may be surprising to know that even eating disorders are considered to be a form of mental illness.

Schizophrenia is a condition that the general public may believe they are slightly familiar with due to publicity from the media and film industry. This condition belongs to a group known as psychotic disorders. The National Institutes of Health (NIH) describes psychotic diseases as severe mental disorders that cause abnormal thinking and perceptions. People suffering with these conditions may be delusional and experience hallucinations. These types of mental illness are often deemed incurable.

Mood disorders are conditions characterized by abnormal changes in the way a person feels. These changes often reach an extreme that is unhealthy and debilitating. Examples of this type of mental illness include depression and bipolar disorder, which is sometimes referred to as manic depression.

Personality disorders are conditions that are long-term and may exist throughout a person's life. According to Mental Health America (MHA), people with these conditions tend to be inflexible, rigid, and unable to respond to the changes and demands of life. Due to this, individuals with these types of mental illness often display abnormal behaviors that stress or damage social and intimate relationships. Examples of conditions that are categorized in this group include narcissism and borderline personality disorder.

Dissociative disorders, although generally considered different from personality disorders, are conditions that also make relationships and social interaction difficult. Sufferers often lose touch with reality. Symptoms may include depersonalization, amnesia, and unrealistic perceptions of personal identity. The

positive aspect of these conditions is that sufferers are commonly able, with proper treatment, to develop healthy habits that allow them to lead seemingly normal lives.

Many people may be unaware that eating disorders, such as anorexia nervosa and binge eating, are generally included among the types of mental illness. These conditions have not historically and still may not be accepted as widely as some other mental conditions, but increasing amounts of research show that these disorders have complex psychological causes. Although medical attention is usually required, it is believed that complete treatment cannot exist without mental health care.

#### *Review Questions*

1. Define the Illness?
2. Explain the Root Causes of Illness?
3. Explain the different types of Illness?
4. Explain the Mental Illness?

#### *Discussion Questions*

Discuss the Illness in details?

## Lesson 2 – Classification and description of disease

### Learning Objectives

- To define the disease.
- To explain the types and stages of disease.
- To explain the causes and transmissibility of disease .
- To describe the Prevention Treatments of disease.

### 2.1 Disease

A **disease** is an abnormal condition that affects the body of an organism. It is often construed as a **medical condition** associated with specific symptoms and signs. It may be caused by factors originally from an external source, such as infectious disease, or it may be caused by internal dysfunctions, such as autoimmune diseases. In humans, "disease" is often used more broadly to refer to any condition that causes pain, dysfunction, distress, social problems, or death to the person afflicted, or similar problems for those in contact with the person. In this broader sense, it sometimes includes injuries, disabilities, disorders, syndromes, infections, isolated symptoms, deviant behaviors, and atypical variations of structure and function, while in other contexts and for other purposes these may be considered distinguishable categories. Diseases usually affect people not only physically, but also emotionally, as contracting and living with many diseases can alter one's perspective on life, and their personality.

Death due to disease is called death by natural causes. There are four main types of disease: pathogenic disease, deficiency disease, hereditary disease, and physiological disease. Diseases can also be classified as communicable and non-communicable disease.

### 2.2 Terminology

#### 2.2.1 Concepts

In many cases, the terms *disease*, *disorder*, *morbidity* and *illness* are used interchangeably.<sup>[2]</sup> In some situations, specific terms are considered preferable.

#### 2.2.2 Disease

The term *disease* broadly refers to any condition that impairs normal function, and is therefore associated with dysfunction of normal homeostasis. Commonly, term *disease* is used to refer specifically to infectious diseases, which are clinically evident diseases that result from the presence of pathogenic microbial agents, including viruses, bacteria, fungi, protozoa, multicellular organisms, and aberrant proteins known as prions. An infection that does not and will not produce clinically evident impairment of normal functioning, such as the presence of the normal bacteria and yeasts in the gut, or of a passenger virus, is not considered a disease. By

contrast, an infection that is asymptomatic during its incubation period, but expected to produce symptoms later, is usually considered a disease. Non-infectious diseases are all other diseases, including most forms of cancer, heart disease, and genetic disease.

### 2.2.3 Illness

*Illness* and *sickness* are generally used as synonyms for *disease*. However, this term is occasionally used to refer specifically to the patient's personal experience of their disease.<sup>1</sup>

In this model, it is possible for a person have a disease without being ill (to have an objectively definable, but asymptomatic, medical condition), and to be *ill* without being *diseased* (such as when a person perceives a normal experience as a medical condition, or medicalizes a non-disease situation their life). Illness is often not due to infection, but to a collection of evolved responses—sickness behavior by the body—that helps clear infection. Such aspects of illness can include lethargy, depression, anorexia, sleepiness, hyperalgesia, and inability to concentrate.

### 2.2.4 Disorder

In medicine, a **disorder** is a functional abnormality or disturbance. Medical disorders can be categorized into mental disorders, physical disorders, genetic disorders, emotional and behavioral disorders, and functional disorders. The term *disorder* is often considered more value-neutral and less stigmatizing than the terms *disease* or *illness*, and therefore is preferred terminology in some circumstances. In mental health, the term mental disorder is used as a way of acknowledging the complex interaction of biological, social, and psychological factors in psychiatric conditions. However, the term *disorder* is also used in many other areas of medicine, primarily to identify physical disorders that are not caused by infectious organisms, such as metabolic disorders.

### 2.2.5 Medical condition

A **medical condition** is a broad term that includes all diseases and disorders. While the term *medical condition* generally includes mental illnesses, in some contexts the term is used specifically to denote any illness, injury, or disease except for mental illnesses. The Diagnostic and Statistical Manual of Mental Disorders (DSM), the widely used psychiatric manual that defines all mental disorders, uses the term *general medical condition* to refer to all diseases, illnesses, and injuries except for mental disorders. This usage is also commonly seen in the psychiatric literature. Some health insurance policies also define a *medical condition* as any illness, injury, or disease except for psychiatric illnesses.

As it is more value-neutral than terms like *disease*, the term *medical condition* is sometimes preferred by people with health issues that they do not consider deleterious. On the other hand, by emphasizing the medical nature of the condition, this term is sometimes rejected, such as by proponents of the autism rights movement.

The term *medical condition* is also a synonym for *medical state*, in which case it describes an individual patient's current state from a medical standpoint. This usage appears in statements that describe a patient as being *in critical condition*, for example.

### 2.2.6 Morbidity

**Morbidity** (from Latin *morbidus*, meaning "sick, unhealthy") is a diseased state, disability, or poor health due to any cause. The term may be used to refer to the existence of any form of disease, or to the degree that the health condition affects the patient. Among severely ill patients, the level of morbidity is often measured by ICU scoring systems. Comorbidity is the simultaneous presence of two or more medical conditions, such as schizophrenia and substance abuse.

In epidemiology and actuarial science, the term "morbidity rate" can refer to either the incidence rate, or the prevalence of a disease or medical condition. This measure of sickness is contrasted with the mortality rate of a condition, which is the proportion of people dying during a given time interval.

### 2.2.7 Syndrome

A syndrome is the association of several medical signs, symptoms, and or other characteristics that often occur together. Some syndromes, such as Down syndrome, have only one cause; others, such as Parkinsonian syndrome, have multiple possible causes. In other cases, the cause of the syndrome is unknown. A familiar syndrome name often remains in use even after an underlying cause has been found, or when there are a number of different possible primary causes.

### 2.2.8 Predisease

**Predisease** is a type of disease creep or medicalization in which currently healthy people with risk factors for disease, but no evidence of actual disease, are told that they are sick. Prediabetes and prehypertension are common examples. Labeling a healthy person with predisease can result in overtreatment, such as taking drugs that only help people with severe disease, or in useful preventive measures, such as motivating the person to get a healthful amount of physical exercise.<sup>[13]</sup>

## 2.3 Types

### 2.3.1 Foodborne illness

Foodborne illness or food poisoning is any illness resulting from the consumption of food contaminated with pathogenic bacteria, toxins, viruses, prions or parasites.

### 2.3.2 Lifestyle diseases

A lifestyle disease is any disease that appears to increase in frequency as countries become more industrialized and people live longer, especially if the risk factors include behavioral choices like a sedentary lifestyle or a diet high in unhealthful foods such as refined carbohydrates, trans fats, or alcoholic beverages.

### 2.3.3 Mental disorders

Mental illness is a broad, generic label for a category of illnesses that may include affective or emotional instability, behavioral dysregulation, and/or cognitive dysfunction or impairment.



Specific illnesses known as mental illnesses include major depression, generalized anxiety disorder, schizophrenia, and attention deficit hyperactivity disorder, to name a few. Mental illness can be of biological (e.g., anatomical, chemical, or genetic) or psychological (e.g., trauma or conflict) origin. It can impair the affected person's ability to work or school and harm interpersonal relationships. The term insanity is used technically as a legal term.

#### **2.3.4 Organic disease**

An organic disease is one caused by a physical or physiological change to some tissue or organ of the body. The term sometimes excludes infections. It is commonly used in contrast with mental disorders. It includes emotional and behavioral disorders if they are due to changes to the physical structures or functioning of the body, such as after a stroke or a traumatic brain injury, but not if they are due to psychosocial issues.

### **2.4 Stages**

In an infectious disease, the incubation period is the time between infection and the appearance of symptoms. The latency period is the time between infection and the ability of the disease to spread to another person, which may precede, follow, or be simultaneous with the appearance of symptoms. Some viruses also exhibit a dormant phase, called viral latency, in which the virus hides in the body in an inactive state. For example, varicella zoster virus causes chickenpox in the acute phase; after recovery from chickenpox, the virus may remain dormant in nerve cells for many years, and later cause herpes zoster (shingles).

#### **2.4.1 Acute disease**

An acute disease is a short-lived disease, like the common cold.

#### **2.4.2 Chronic disease**

A chronic disease is one that lasts for a long time, usually at least six months. During that time, it may be constantly present, or it may go into remission and periodically relapse. A chronic disease may be stable (does not get any worse) or it may be progressive (gets worse over time). Some chronic diseases can be permanently cured. Most chronic diseases can be beneficially treated, even if they cannot be permanently cured.

#### **2.4.3 Flare-up**

A flare-up can refer to either the recurrence of symptoms or an onset of more severe symptoms.

#### **2.4.4 Refractory disease**

A refractory disease is a disease that resists treatment, especially an individual case that resists treatment more than is normal for the specific disease in question.

#### **2.4.5 Progressive disease**

Progressive disease is a disease whose typical natural course is the worsening of the disease until death, serious debility, or organ failure occurs. Slowly progressive diseases are also chronic

diseases; many are also degenerative diseases. The opposite of progressive disease is *stable disease* or *static disease*: a medical condition that exists, but does not get better or worse.

#### **2.4.6 Cure**

A cure is the end of a medical condition or a treatment that is very likely to end it, while remission refers to the disappearance, possibly temporarily, of symptoms. Complete remission is the best possible outcome for incurable diseases.

### **2.5 Scope**

#### **2.5.1 Localized disease**

A localized disease is one that affects only one part of the body, such as athlete's foot or an eye infection.

#### **2.5.2 Disseminated disease**

A disseminated disease has spread to other parts; with cancer, this is usually called metastatic disease.

#### **2.5.3 Systemic disease**

A systemic disease is a disease that affects the entire body, such as influenza or high blood pressure.

### **2.6 Causes and transmissibility**

Only some diseases such as influenza are contagious and commonly believed infectious. The micro-organisms that cause these diseases are known as pathogens and include varieties of bacteria, viruses, protozoa and fungi. Infectious diseases can be transmitted, e.g. by hand-to-mouth contact with infectious material on surfaces, by bites of insects or other carriers of the disease, and from contaminated water or food (often via faecal contamination), etc. In addition, there are sexually transmitted diseases. In some cases, micro-organisms that are not readily spread from person to person play a role, while other diseases can be prevented or ameliorated with appropriate nutrition or other lifestyle changes.

Some diseases, such as most (but not all) forms of cancer, heart disease and mental disorders, are non-infectious diseases. Many non-infectious diseases have a partly or completely genetic basis and may thus be transmitted from one generation to another.

Social determinants of health are the social conditions in which people live that determine their health. Illnesses are generally related to social, economic, political, and environmental circumstances. Social determinants of health have been recognized by several health organizations such as the Public Health Agency of Canada and the World Health Organization to greatly influence collective and personal well-being. The World Health Organization's Social Determinants Council also recognizes Social determinants of health in poverty.

When the cause of a disease is poorly understood, societies tend to mythologize the disease or use it as a metaphor or symbol of whatever that culture considers evil. For example, until the bacterial cause of

tuberculosis was discovered in 1882, experts variously ascribed the disease to heredity, a sedentary lifestyle, depressed mood, and overindulgence in sex, rich food, or alcohol—all the social ills of the time.

## 2.7 Burdens of disease

Disease burden is the impact of a health problem in an area measured by financial cost, mortality, morbidity, or other indicators.

There are several measures used to quantify the burden imposed by diseases on people. The years of potential life lost (YPLL) is a simple estimate of the number of years that a person's life was shortened due to a disease. For example, if a person dies at the age of 65 from a disease, and would probably have lived until age 80 without that disease, then that disease has caused a loss of 15 years of potential life. YPLL measurements do not account for how disabled a person is before dying, so the measurement treats a person who dies suddenly and a person who died at the same age after decades of illness as equivalent. In 2004, the World Health Organization calculated that 932 million years of potential life were lost to premature death.<sup>[16]</sup>

The quality-adjusted life year (QALY) and disability-adjusted life year (DALY) metrics are similar, but take into account whether the person was healthy after diagnosis. In addition to the number of years lost due to premature death, these measurements add part of the years lost to being sick. Unlike YPLL, these measurements show the burden imposed on people who are very sick, but who live a normal lifespan. A disease that has high morbidity, but low mortality, has a high DALY and a low YPLL. In 2004, the World Health Organization calculated that 1.5 billion disability-adjusted life years were lost to disease and injury. In the developed world, heart disease and stroke cause the most loss of life, but neuropsychiatric conditions like major depressive disorder cause the most years lost to being sick.

Disease category	Percent of all YPLLs lost, worldwide	Percent of all DALYs lost, worldwide	Percent of all YPLLs lost, Europe	Percent of all DALYs lost, Europe	Percent of all YPLLs lost, US and Canada	Percent of all DALYs lost, US and Canada
Infectious and parasitic diseases, especially lower respiratory tract infections, diarrhea, AIDS, tuberculosis, and malaria	37%	26%	9%	6%	5%	3%
Neuropsychiatric conditions, e.g. depression	2%	13%	3%	19%	5%	28%
Injuries, especially motor vehicle accidents	14%	12%	18%	13%	18%	10%
Cardiovascular diseases, principally heart attacks and stroke	14%	10%	35%	23%	26%	14%

Disease category	Percent of all YPLLs lost, worldwide	Percent of all DALYs lost, worldwide	Percent of all YPLLs lost, Europe	Percent of all DALYs lost, Europe	Percent of all YPLLs lost, US and Canada	Percent of all DALYs lost, US and Canada
Premature birth and other perinatal deaths	11%	8%	4%	2%	3%	2%
Cancer	8%	5%	19%	11%	25%	13%

## 2.8 Prevention

Many diseases and disorders can be prevented through a variety of means. These include sanitation, proper nutrition, adequate exercise, vaccinations, circumcision of male infants, and other self-care and public health measures.

## 2.9 Treatments

Medical therapies or treatments are efforts to cure or improve a disease or other health problem. In the medical field, therapy is synonymous with the word *treatment*. Among psychologists, the term may refer specifically to psychotherapy or "talk therapy". Common treatments include medications, surgery, medical devices, and self-care. Treatments may be provided by an organized health care system, or informally, by the patient or family members.

A prevention or preventive therapy is a way to avoid an injury, sickness, or disease in the first place. A treatment or cure is applied after a medical problem has already started. A treatment attempts to improve or remove a problem, but treatments may not produce permanent cures, especially in chronic diseases. Cures are a subset of treatments that reverse diseases completely or end medical problems permanently. Many diseases that cannot be completely cured are still treatable. Pain management (also called pain medicine) is that branch of medicine employing an interdisciplinary approach to the relief of pain and improvement in the quality of life of those living with pain

Treatment for medical emergencies must be provided promptly, often through an emergency department or, in less critical situations, through an urgent care facility.

## 2.10 Epidemiology

Epidemiology is the study of the factors that cause or encourage diseases. Some diseases are more common in certain geographic areas, among people with certain genetic or socioeconomic characteristics, or at different times of the year.

Epidemiology is considered a cornerstone methodology of public health research, and is highly regarded in evidence-based medicine for identifying risk factors for disease. In the study of communicable and non-communicable diseases, the work of epidemiologists ranges from outbreak investigation to study design, data collection and analysis including the development of statistical models to test hypotheses and the documentation of results for submission to peer-reviewed journals. Epidemiologists also study the

interaction of diseases in a population, a condition known as a syndemic. Epidemiologists rely on a number of other scientific disciplines such as biology (to better understand disease processes), biostatistics (the current raw information available), Geographic Information Science (to store data and map disease patterns) and social science disciplines (to better understand proximate and distal risk factors). Epidemiology can help identify causes as well as guide prevention efforts.

In studying diseases, epidemiology faces the challenge of defining them. Especially for poorly understood diseases, different groups might use significantly different definitions. Without an agreed-on definition, different researchers may report different numbers of cases and characteristics of the disease.

## **2.11 Social and cultural responses**

How a society responds to diseases is the subject of medical sociology.

A condition may be considered a disease in some cultures or eras but not in others. For example, obesity can represent wealth and abundance, and is a status symbol in famine-prone areas and some places hard-hit by HIV/AIDS.<sup>[21]</sup> Epilepsy is considered a sign of spiritual gifts among the Hmong people.<sup>[22]</sup>

Sickness confers the social legitimization of certain benefits, such as illness benefits, work avoidance, and being looked after by others. The person who is sick takes on a social role called the sick role. A person who responds to a dreaded disease, such as cancer, in a culturally acceptable fashion may be publicly and privately honored with higher social status. In return for these benefits, the sick person is obligated to seek treatment and work to become well once more. As a comparison, consider pregnancy, which is not interpreted as a disease or sickness, even if the mother and baby may both benefit from medical care.

Most religions grant exceptions from religious duties to people who are sick. For example, one whose life would be endangered by fasting on Yom Kippur or during Ramadan is exempted from the requirement, or even forbidden from participating. People who are sick are also exempted from social duties. For example, ill health is the only socially acceptable reason for an American to refuse an invitation to the White House.

The identification of a condition as a disease, rather than as simply a variation of human structure or function, can have significant social or economic implications. The controversial recognitions as diseases of repetitive stress injury (RSI) and post-traumatic stress disorder (also known as "Soldier's heart", "shell shock", and "combat fatigue") has had a number of positive and negative effects on the financial and other responsibilities of governments, corporations and institutions towards individuals, as well as on the individuals themselves. The social implication of viewing aging as a disease could be profound, though this classification is not yet widespread.

Lepers were people who were historically shunned because they had an infectious disease, and the term "leper" still evokes social stigma. Fear of disease can still be a widespread social phenomenon, though not all diseases evoke extreme social stigma.

Social standing and economic status affect health. Diseases of poverty are diseases that are associated with poverty and low social status; diseases of affluence are diseases that are associated with high social and economic status. Which diseases are associated with which states varies according to time, place, and technology. Some diseases, such as diabetes mellitus, may be associated with both poverty (poor food choices) and affluence (long lifespans and sedentary lifestyles), through different mechanisms. The term diseases of civilization describes diseases that are more common among older people. For example,

cancer is far more common in societies in which most members live until they reach the age of 80 than in societies in which most members die before they reach the age of 50.

## **2.12 Language of disease**

An illness narrative is a way of organizing a medical experience into a coherent story that illustrates the sick individual's personal experience.

People use metaphors to make sense of their experiences with disease. The metaphors move disease from an objective thing that exists to an affective experience. The most popular metaphors draw on military concepts: Disease is an enemy that must be feared, fought, battled, and routed. The patient or the healthcare provider is a warrior, rather than a passive victim or bystander. The agents of communicable diseases are invaders; non-communicable diseases constitute internal insurrection or civil war. Because the threat is urgent, perhaps a matter of life and death, unthinkable radical, even oppressive, measures are society's and the patient's moral duty as they courageously mobilize to struggle against destruction. The War on Cancer is an example of this metaphorical use of language.

Another class of metaphors describes the experience of illness as a journey: The person travels to or from a place of disease, and changes himself, discovers new information, or increases his experience along the way. He may travel "on the road to recovery" or make changes to "get on the right track". Some are explicitly immigration-themed: the patient has been exiled from the home territory of health to the land of the ill, changing identity and relationships in the process.

Some metaphors are disease-specific. Slavery is a common metaphor for addictions: The alcoholic is enslaved by drink, and the smoker is captive to nicotine. Some cancer patients treat the loss of their hair from chemotherapy as a metonymy or metaphor for all the losses caused by the disease.

Some diseases are used as metaphors for social ills: "Cancer" is a common description for anything that is endemic and destructive in society, such as poverty, injustice, or racism. AIDS was seen as a divine judgment for moral decadence, and only by purging itself from the "pollution" of the "invader" could society become healthy again. Authors in the 19th century commonly used tuberculosis as a symbol and a metaphor for transcendence. Victims of the disease were portrayed in literature as having risen above daily life to become ephemeral objects of spiritual or artistic achievement. In the 20th century, after its cause was better understood, the same disease became the emblem of poverty, squalor, and other social problems.

## **2.13 Classification of Disease**

Classifications of diseases become extremely important in the compilation of statistics on causes of illness (morbidity) and causes of death (mortality). It is obviously important to know what kinds of illness and disease are prevalent in an area and how these prevalence rates vary with time. Classifying diseases made it apparent, for example, that the frequency of lung cancer was entering a period of alarming increase in the mid-20th century. Once a rare form of cancer, it had become the single most important form of cancer in males. With this knowledge a search was instituted for possible causes of this increased prevalence. It was concluded that the occurrence of lung cancer was closely associated with cigarette smoking. Classification of disease had helped to ferret out an important, frequently causal, relationship.

The most widely used classifications of disease are (1) topographic, by bodily region or system, (2) anatomic, by organ or tissue, (3) physiological, by function or effect, (4) pathological, by the nature of the

disease process, (5) etiologic (causal), (6) juristic, by speed of advent of death, (7) epidemiological, and (8) statistical. Any single disease may fall within several of these classifications.

In the topographic classification, diseases are subdivided into such categories as gastrointestinal disease, vascular disease, abdominal disease, and chest disease. Various specializations within medicine follow such topographic or systemic divisions, so that there are physicians who are essentially vascular surgeons, for example, or clinicians who are specialized in gastrointestinal disease. Similarly, some physicians have become specialized in chest disease and concentrate principally on diseases of the heart and lungs.

In the anatomic classification, disease is categorized by the specific organ or tissue affected; hence, heart disease, liver disease, and lung disease. Medical specialties such as cardiology are restricted to diseases of a single organ, in this case the heart. Such a classification has its greatest use in identifying the various kinds of disease that affect a particular organ. The heart is a good example to consider. By the segregation of cardiac disease it has been made apparent that heart disease is now the most important cause of death in the United States and in most other industrialized nations. Moreover, it has become apparent that disease caused by atherosclerosis of the coronary arteries is by far the most important form of heart disease. In making a diagnosis of cardiac disease in an elderly patient, the cardiologist must first determine whether this disease of the coronary arteries is responsible for the heart's failure to function normally.

The physiological classification of disease is based on the underlying functional derangement produced by a specific disorder. Included in this classification are such designations as respiratory and metabolic disease. Respiratory diseases are those that interfere with the intake and expulsion of air and the exchange of oxygen for carbon dioxide in the lungs. Metabolic diseases are those in which disturbances of the body's chemical processes are a basic feature. Diabetes and gout are examples.

The pathological classification of disease considers the nature of the disease process. Neoplastic and inflammatory disease are examples. Neoplastic disease includes the whole range of tumours, particularly cancers, and their effect on human beings.

The etiologic classification of disease is based on the cause, when known. This classification is particularly important and useful in the consideration of biotic disease. On this basis disease might be classified as staphylococcal or rickettsial or fungal, to cite only a few instances. It is important to know, for example, what kinds of disease staphylococci produce in human beings. It is well known that they cause skin infections and pneumonia, but it is also important to note how often they cause meningitis, abscesses in the liver, and kidney infections. The sexually transmitted diseases syphilis and gonorrhea are further examples of diseases classified by etiology.

The juristic basis of the classification of disease is concerned with the legal circumstances in which death occurs. It is principally involved with sudden death, the cause of which is not clearly evident. Thus, on a juristic basis some deaths and diseases are classified as medical-legal and fall within the jurisdiction of coroners and medical examiners. A person living alone is found dead in bed—dead of natural causes or killed? Had the person who dropped dead on the street been given some poison that took a short time to act? Much less dramatic, but perhaps more common, are disease and death caused by exposure of the individual to some unrecognized danger to health in working or living conditions. Could the illness or disease be attributable to fumes or dusts in a factory? These are examples of the many types of disease and death that fall properly in this classification.

The epidemiological classification of disease deals with the incidence, distribution, and control of disorders in a population. To use the example of typhoid, a disease spread through contaminated food and

water, it first becomes important to establish that the disease observed is truly caused by *Salmonella typhi*, the typhoid organism. Once the diagnosis is established, it is obviously important to know the number of cases, whether the cases were scattered over the course of a year or occurred within a short period, and what the geographic distribution is. It is critically important that the precise address and activities of the patients be established. Two widely separated locations within the same city might be found to have clusters of cases of typhoid all arising virtually simultaneously. It might be found that each of these clusters revolved about a family unit including cousins, grandparents, aunts and uncles, and friends, suggesting that in some way personal relationships might be important. Further investigation might disclose that all the infected persons had dined at one time or at short intervals in a specific home. It might further be found that the person who had prepared the meal had recently visited some rural area and had suffered a mild attack of the disease and was now spreading it to family and friends by unknowing contamination of food. This hypothetical case suggests the importance of the etiologic, as well as the epidemiological, classification of disease.

Epidemiology is one of the important sciences in the study of nutritional and biotic diseases around the world. The United Nations supports, in part, the World Health Organization, whose chief function is the worldwide investigation of the distribution of disease. In the course of this investigation, many observations have been made that help to explain the cause and provide approaches to the control of many diseases.

The statistical basis of classification of disease employs analysis of the incidence (the numbers of new cases of a specific disease that occur during a certain period) and the prevalence rate (number of cases of a disease in existence at a certain time) of diseases. If, for example, a disease has an incidence rate of 100 cases per year in a given locale and, on the average, the affected persons live three years with the disease, it is obvious that the prevalence of the disease is 300. Statistical classification is an additional important tool in the study of possible causes of disease. These studies, as well as epidemiological, nutritional, and pathological analyses, have made it clear, for example, that diet is an important consideration in the possible causation of atherosclerosis. The statistical analyses drew attention to the role of high levels of fats and carbohydrates in the diet in the possible causation of atherosclerosis. The analyses further drew attention to the fact that certain populations that do not eat large quantities of animal fats and subsist largely on vegetable oils and fish have a much lower incidence of atherosclerosis. Thus, statistical surveys are of great importance in the study of human disease.

#### *Review Questions*

1. Define the disease?
2. Explain the types and stages of disease?
3. Explain the Social and cultural responses of disease?
4. Explain the Language of disease ?

#### *Discussion Questions*

Discuss the disease and how it affects people?



## Lesson 3 – Infection control

### Learning Objectives

- To define the infection control.
- To explain the Infection control in healthcare facilities.
- To explain the Personal protective equipment.
- To describe the surveillance for emerging infections .

### 3.1 Infection control

**Infection control** is the discipline concerned with preventing nosocomial or healthcare-associated infection, a practical (rather than academic) sub-discipline of epidemiology. It is an essential, though often underrecognized and undersupported, part of the infrastructure of health care. Infection control and hospital epidemiology are akin to public health practice, practiced within the confines of a particular health-care delivery system rather than directed at society as a whole.

Infection control addresses factors related to the spread of infections within the health-care setting (whether patient-to-patient, from patients to staff and from staff to patients, or among-staff), including prevention (via hand hygiene/hand washing, cleaning/disinfection/sterilization, vaccination, surveillance), monitoring/investigation of demonstrated or suspected spread of infection within a particular health-care setting (surveillance and outbreak investigation), and management (interruption of outbreaks). It is on this basis that the common title being adopted within health care is "Infection Prevention & Control."

### 3.2 Infection control in healthcare facilities

Aseptic technique is a key component of all invasive medical procedures. Similarly, infection control measures are most effective when Standard Precautions (health care) are applied because undiagnosed infection is common.

#### 3.2.1 Hand hygiene

Independent studies by Ignaz Semmelweis in 1847 in Vienna and Oliver Wendell Holmes in 1843 in Boston established a link between the hands of health care workers and the spread of hospital-acquired disease. The Centers for Disease Control and Prevention (CDC) has stated that "It is well documented that the most important measure for preventing the spread of pathogens is effective handwashing." In the United States, hand washing is mandatory in most health care settings and required by many different state and local regulations.

In the United States, Occupational Safety and Health Administration (OSHA) standards require that employers must provide readily accessible hand washing facilities, and must ensure that employees wash hands and any other skin with soap and water or flush mucous membranes with water as soon as feasible after contact with blood or other potentially infectious materials (OPIM).

Mean percentage changes in bacterial numbers

Method used	Change in bacteria present
Paper towels (2-ply 100% recycled).	- 48.4%
Paper towels (2-ply through-air dried, 50% recycled)	- 76.8%
Warm air dryer	+ 254.5%
Jet air dryer	+ 14.9%

Drying is an essential part of the hand hygiene process. In November 2008, a non-peer-reviewed study was presented to the European Tissue Symposium by the University of Westminster, London, comparing the bacteria levels present after the use of paper towels, warm air hand dryers, and modern jet-air hand dryers. Of those three methods, only paper towels reduced the total number of bacteria on hands, with "through-air dried" towels the most effective.

The presenters also carried out tests to establish whether there was the potential for cross-contamination of other washroom users and the washroom environment as a result of each type of drying method. They found that:

- the jet air dryer, which blows air out of the unit at claimed speeds of 400 mph, was capable of blowing micro-organisms from the hands and the unit and potentially contaminating other washroom users and the washroom environment **up to 2 metres away**
- use of a warm air hand dryer spread micro-organisms **up to 0.25 metres** from the dryer
- paper towels showed **no significant spread** of micro-organisms.

In 2005, in a study conducted by TUV Produkt und Umwelt, different hand drying methods were evaluated. The following changes in the bacterial count after drying the hands were observed:

Drying method	Effect on bacterial count
Paper towels and roll	Decrease of 24%
Hot-air drier	Increase of 117%

### 3.2.2 Cleaning, disinfection and sterilization

Sterilization is a process intended to kill all microorganisms and is the highest level of microbial kill that is possible. Sterilizers may be heat only, steam, or liquid chemical. Effectiveness of the sterilizer (e.g., a steam autoclave) is determined in three ways. First, mechanical indicators and gauges on the machine itself indicate proper operation of the machine. Second heat sensitive indicators or tape on the sterilizing bags change color which indicate proper levels of heat or steam. And, third (most importantly) is biological testing in which a highly heat and chemical resistant microorganism (often the bacterial endospore) is selected as the standard challenge. If the process kills this microorganism, the sterilizer is considered to be effective. It should be noted that in order to be effective, instruments must be cleaned, otherwise the debris may form a protective barrier, shielding the microbes from the lethal process. Similarly care must be taken after sterilization to ensure sterile instruments do not become contaminated prior to use.

Disinfection refers to the use of liquid chemicals on surfaces and at room temperature to kill disease causing microorganisms. Disinfection is a less effective process than sterilization because it does not kill bacterial endospores.

Sterilization, if performed properly, is an effective way of preventing bacteria from spreading. It should be used for the cleaning of the medical instruments or gloves, and basically any type of medical item that comes into contact with the blood stream and sterile tissues.

There are four main ways in which such items can be sterilized: autoclave (by using high-pressure steam), dry heat (in an oven), by using chemical sterilants such as glutaraldehydes or formaldehyde solutions or by radiation (with the help of physical agents). The first two are the most used methods of sterilizations mainly because of their accessibility and availability. Steam sterilization is one of the most effective types of sterilizations, if done correctly which is often hard to achieve. Instruments that are used in health care facilities are usually sterilized with this method. The general rule in this case is that in order to perform an effective sterilization, the steam must get into contact with all the surfaces that are meant to be disinfected. On the other hand, dry heat sterilization, which is performed with the help of an oven, is also an accessible type of sterilization, although it can only be used to disinfect instruments that are made of metal or glass. The very high temperatures needed to perform sterilization in this way are able to melt the instruments that are not made of glass or metal.

Steam sterilization is done at a temperature of 121 C (250 F) with a pressure of 106 kPa (15 lbs/in<sup>2</sup>). In these conditions, unwrapped items must be sterilized for 20 minutes, and wrapped items for 30 minutes. The time is counted once the temperature that is needed has been reached. Steam sterilization requires four conditions in order to be efficient: adequate contact, sufficiently high temperature, correct time and sufficient moisture. Sterilization using steam can also be done at a temperature of 132 C (270 F), at a double pressure. Dry heat sterilization is performed at 170 C (340 F) for one hour or two hours at a temperature of 160 C (320 F). Dry heat sterilization can also be performed at 121 C, for at least 16 hours.

Chemical sterilization, also referred to as cold sterilization, can be used to sterilize instruments that cannot normally be disinfected through the other two processes described above. The items sterilized with cold sterilization are usually those that can be damaged by regular sterilization. Commonly, glutaraldehydes and formaldehyde are used in this process, but in different ways. When using the first type of disinfectant, the instruments are soaked in a 2-4% solution for at least 10 hours while a solution of 8% formaldehyde will sterilize the items in 24 hours or more. Chemical sterilization is generally more expensive than steam sterilization and therefore it is used for instruments that cannot be disinfected otherwise. After the instruments have been soaked in the chemical solutions, they are mandatory to be

rinsed with sterile water which will remove the residues from the disinfectants. This is the reason why needles and syringes are not sterilized in this way, as the residues left by the chemical solution that has been used to disinfect them cannot be washed off with water and they may interfere with the administered treatment. Although formaldehyde is less expensive than glutaraldehydes, it is also more irritating to the eyes, skin and respiratory tract and is classified as a potential carcinogen.

Other sterilization methods exist, though their efficiency is still controversial. These methods include gas sterilization, UV sterilization, and sterilization with other chemical agents such as peroxyacetic acid, paraformaldehyde and gas plasma sterilization.

Infections can be prevented from occurring in homes as well. In order to reduce their chances to contract an infection, individuals are recommended to maintain a good hygiene by washing their hands after every contact with questionable areas or bodily fluids and by disposing the garbage at regular intervals to prevent germs from growing.

### **3.2.3 Personal protective equipment**

Personal protective equipment (PPE) is specialized clothing or equipment worn by a worker for protection against a hazard. The hazard in a health care setting is exposure to blood, saliva, or other bodily fluids or aerosols that may carry infectious materials such as Hepatitis C, HIV, or other blood borne or bodily fluid pathogen. PPE prevents contact with a potentially infectious material by creating a physical barrier between the potential infectious material and the healthcare worker.

In the United States, the Occupational Safety and Health Administration (OSHA) requires the use of Personal protective equipment (PPE) by workers to guard against blood borne pathogens if there is a reasonably anticipated exposure to blood or other potentially infectious materials.

Components of Personal protective equipment (PPE) include gloves, gowns, bonnets, shoe covers, face shields, CPR masks, goggles, surgical masks, and respirators. How many components are used and how the components are used is often determined by regulations or the infection control protocol of the facility in question. Many or most of these items are disposable to avoid carrying infectious materials from one patient to another patient and to avoid difficult or costly disinfection. In the United States, OSHA requires the immediate removal and disinfection or disposal of worker's PPE prior to leaving the work area where exposure to infectious material took place.

### **3.2.4 Antimicrobial surfaces**

Microorganisms are known to survive on non-antimicrobial inanimate 'touch' surfaces (e.g., bedrails, over-the-bed trays, call buttons, bathroom hardware, etc.) for extended periods of time. This can be especially troublesome in hospital environments where patients with immunodeficiencies are at enhanced risk for contracting nosocomial infections.

Products made with antimicrobial copper alloy (brasses, bronzes, cupronickel, copper-nickel-zinc, and others) surfaces destroy a wide range of microorganisms in a short period of time. The United States Environmental Protection Agency has approved the registration of 355 different antimicrobial copper alloys that kill *E. coli*, methicillin-resistant *Staphylococcus aureus* (MRSA), *Staphylococcus*, *Enterobacter aerogenes*, and *Pseudomonas aeruginosa* in less than 2 hours of contact. Other investigations have demonstrated the efficacy of antimicrobial copper alloys to destroy *Clostridium difficile*, influenza A virus, adenovirus, and fungi. As a public hygienic measure in addition to regular

cleaning, antimicrobial copper alloys are being installed in healthcare facilities in the U.K., Ireland, Japan, Korea, France, Denmark, and Brazil.

### **3.3 Vaccination of health care workers**

Health care workers may be exposed to certain infections in the course of their work. Vaccines are available to provide some protection to workers in a healthcare setting. Depending on regulation, recommendation, the specific work function, or personal preference, healthcare workers or first responders may receive vaccinations for hepatitis B; influenza; measles, mumps and rubella; Tetanus, diphtheria, pertussis; N. meningitidis; and varicella. In general, vaccines do not guarantee complete protection from disease, and there is potential for adverse effects from receiving the vaccine.

### **3.4 Post exposure prophylaxis**

In some cases where vaccines do not exist Post Exposure prophylaxis is another method of protecting the health care worker exposed to a life threatening infectious disease. For example, the viral particles for HIV-AIDS can be precipitated out of the blood through the use of an antibody injection if given within 4 hours of a significant exposure.

### **3.5 Surveillance for emerging infections**

Surveillance is the act of infection investigation using the CDC definitions. Determining an infection requires an Infection Control Practitioner (ICP) to review a patient's chart and see if the patient had the signs and symptom of an infection. Surveillance definition cover infections of the bloodstream, urinary tract, pneumonia, and surgical sites.

Surveillance traditionally involved significant manual data assessment and entry in order to assess preventative actions such as isolation of patients with an infectious disease. Increasingly, integrated computerised software solutions, such as Formic Fusion are becoming available that assess incoming risk messages from microbiology and other online sources. By reducing the need for data entry, this software significantly reduces the data workload of ICPs, freeing them to concentrate on clinical surveillance.

As approximately one third of healthcare acquired infections are preventable, surveillance and preventative activities are increasingly a priority for hospital staff. In the United States, a study on the Efficacy of Nosocomial Infection Control Project (SENIC) by the CDC found that hospitals reduced their nosocomial infection rates by approximately 32 per cent by focusing on surveillance activities and prevention efforts.

### **3.6 Isolation**

In the health care context, isolation refers to various physical measures taken to interrupt nosocomial spread of contagious diseases. Various forms of isolation exist, and are applied depending on the type of infection and agent involved, to address the likelihood of spread via airborne particles or droplets, by direct skin contact, or via contact with body fluid

### **3.7 Outbreak investigation**

When an unusual cluster of illness is noted, infection control teams undertake an investigation to determine whether there is a true outbreak, a pseudo-outbreak (a result of contamination within the

diagnostic testing process), or just random fluctuation in the frequency of illness. If a true outbreak is discovered, infection control practitioners try to determine what permitted the outbreak to occur, and to rearrange the conditions to prevent ongoing propagation of the infection. Often, breaches in good practice are responsible, although sometimes other factors (such as construction) may be the source of the problem.

Outbreak investigations have more than a single purpose. These investigations are carried out in order to prevent additional cases in the current outbreak, prevent future outbreaks, learn about a new disease or learn something new about an old disease. Reassuring the public, minimizing the economic and social disruption as well as teaching epidemiology are some other obvious objectives of outbreak investigations.

According to the WHO, outbreak investigations are meant to detect what is causing the outbreak, how the pathogenic agent is transmitted, where it all started from, what is the carrier, what is the population at risk of getting infected and what are the risk factors.

The results of outbreak investigations are always made public in the means of a report in which the findings are communicated to the authorities, media, scientific community and so on. These reports are commonly used as pedagogical tools.

### **3.8 Training in infection control and health care epidemiology**

Practitioners can come from several different educational streams. Many begin as nurses, some as medical technologists (particularly in clinical microbiology), and some as physicians (typically infectious disease specialists). Specialized training in infection control and health care epidemiology are offered by the professional organizations described below. Physicians who desire to become infection control practitioners often are trained in the context of an infectious disease fellowship.

In the United States, Certification Board of Infection Control and Epidemiology is a private company that certifies infection control practitioners based on their educational background and professional experience, in conjunction with testing their knowledge base with standardized exams. The credential awarded is CIC, Certification in Infection Control and Epidemiology. It is recommended that one has 2 years of Infection Control experience before applying for the exam. Certification must be renewed every five years.

A course in hospital epidemiology (infection control in the hospital setting) is offered jointly each year by the Centers for Disease Control and Prevention (CDC) and the Society for Healthcare Epidemiology of America.

The Association for Professionals in Infection Control and Epidemiology, Inc. (APIC) offers training and courses in infection control.

#### *Review Questions*

1. Define the infection control?
2. Explain the infection control in healthcare facilities?
3. Explain the Personal protective equipment?
4. Explain the surveillance for emerging infections?

## Discussion Questions

What Is infection? How to control it?

## Lesson 4 – Carrier and mode of transmission of infection

### Learning Objectives

- To define the transmission of infection.
- To explain Horizontal and vertical infection.
- To explain the transmission, symptoms and survival.
- To describe the routes of transmission.

### 4.1 Transmission (medicine)

In medicine and biology, **transmission** is the passing of a communicable disease from an infected host individual or group to a conspecific individual or group, regardless of whether the other individual was previously infected. Sometimes transmission can specifically mean infection of a previously uninfected host.

The term usually refers to the transmission of microorganisms directly from one person to another by one or more of the following means:

- droplet contact – coughing or sneezing on another person
- direct physical contact – touching an infected person, including sexual contact
- indirect physical contact – usually by touching soil contamination or a contaminated surface
- airborne transmission – if the microorganism can remain in the air for long periods
- fecal-oral transmission – usually from contaminated food or water sources

Transmission can also be indirect, via another organism, either a vector (e.g. a mosquito) or an intermediate host (e.g. tapeworm in pigs can be transmitted to humans who ingest improperly cooked pork). Indirect transmission could involve zoonoses or, more typically, larger pathogens like macroparasites with more complex life cycles.

### 4.2 Horizontal and vertical

#### 4.2.1 Horizontal transmission

Horizontal transmission is a term used to describe one of the ways a disease passes from one organism to another. It is specific to infectious disease and basically describes the movement of a pathogen from one organism to the next through direct or indirect contact. Horizontal transmission and vertical transmission are the two ways infection occurs.



Infectious diseases are mostly caused by viruses, bacteria, and fungi. Prions, such as in the case of mad cow disease, or Creutzfeld-Jakob Disease (CJD), are another, less common cause. These pathogens all need the ability to jump from one person to another in order to multiply.

More common than vertical transmission is horizontal transmission. Vertical transmission only covers those cases where a parent passes a disease onto her child through reproduction. The child can become infected during his or her time in the womb, during the labor process from the vaginal wall, or through breast milk. A father can pass a genetic disease on to his child through vertical transmission but not an infectious disease.

All other cases of infectious disease transfer from person to person are caused by horizontal transmission. Horizontal transmission from animal to human and vice versa are also possible, and sometimes, a human can contract a disease from an animal host that is not adversely affected by the disease it carries. The horizontal mode of transmission can be indirect or direct.

Direct transmission occurs when the infection moves from one person to another without using an intermediate step. Direct contact examples include touching, kissing, and sexual intercourse. Although some pathogens spread through the air from one person to another, technically using the air between them as an indirect step, airborne transmission is also regarded as direct transmission.

An infection that a person picks up by touching contaminated surfaces is indirectly transmitted. An airborne disease that lands on a surface from whence the infection is picked up is included in the definition of indirect contact. The object the pathogen contaminates is known as a fomite. Food or waterborne diseases are other examples of indirect disease transmission.

Another manner of indirect transmission is through a vector. A vector is a living thing as opposed to an inanimate object. The vector picks up a disease from one person and indirectly gives it to another person. One such vector is the mosquito, which carries malaria by biting an infected person and then biting another person, thereby spreading the malaria parasite.

#### **4.2.2 Vertical Transmission**

Vertical transmission is the passage of disease from a mother to a child during the perinatal period that starts shortly before birth and extends to the time just after birth. Pathogenic organisms can pass from mother to child in a number of ways, and they are a concern in pregnancy. Women with conditions known to be transmitted vertically may need to take special precautions, especially in labor and delivery, to protect their babies.

Placental transmission is one potential way for an organism to leap between mother and child. The placenta provides vital nutrients to the baby and can also harbor disease if the mother is carrying an organism known to cause prenatal infections. During labor and delivery, vertical transmission can occur as a result of exposure to the mother's blood and other body fluids. Breast milk can also potentially be a vector of disease transmission.

Some organisms with a history of vertical transmission include the human immunodeficiency virus (HIV) and hepatitis C. Conditions like toxoplasmosis can cause birth defects if a mother becomes infected during pregnancy. When a woman gets pregnant, the doctor may recommend some testing to check for common risks, as well as precautions to prevent contraction of infections and subsequent vertical transmission. If a mother has a disease of concern, the doctor will discuss how best to manage the pregnancy and delivery.

In some cases, concerns about vertical transmission may lead a doctor to recommend a Cæsarian section for delivery. This will limit stress during labor and delivery and reduce the chances of passing an infection on during this period. If a mother's breast milk is not safe, milk banking is an option to provide the baby with breast milk, or the doctor can discuss formula feeding. The best approach will depend on the situation and the infection at hand, and it can be helpful to consult a nutritionist to discuss feeding options.

Expectant mothers with worries about vertical transmission can take some steps to protect their babies. In mothers without any known infections, avoiding obvious sources of infection like badly handled food can reduce the chances of getting sick and passing the infection on to the baby. Mothers with active infections may be able to take medications to suppress them and protect their developing fetuses for as long as possible. It can also help to work with an obstetrician who has experience in this area for labor and delivery.

### **4.3 Transmission, symptoms and survival**

Pathogens must have a way to be transmitted from one host to another to ensure their species' survival. Infectious agents are generally specialized for a particular method of transmission. Taking an example from the respiratory route, from an evolutionary perspective a virus or bacteria that causes its host to develop coughing and sneezing symptoms has a great survival advantage – it is much more likely to be ejected from one host and carried to another. This is also the reason that many microorganisms cause diarrhea.

#### **4.3.1 Locus**

In transmission, a locus is the point on the body where a pathogen enters.

- In droplet contact and other airborne transmission it is generally the respiratory system.
- In direct physical and indirect contact it is generally through a wound in the skin or through a mucous membrane.
- In fecal-oral transmission, it is through the mouth.
- In vector borne transmission, it is at the bite or sting of the vector.

### **4.4 Routes of transmission**

#### **4.4.1 Droplet contact**

Also known as the *respiratory route*, it is a typical mode of transmission among many infectious agents. If an infected person coughs or sneezes on another person the microorganisms, suspended in warm, moist droplets, may enter the body through the nose, mouth or eye surfaces. Diseases that are commonly spread by coughing or sneezing include:

- Bacterial Meningitis
- Chickenpox
- Common cold
- Influenza
- Mumps
- Strep throat
- Tuberculosis

- Measles
- Rubella
- Whooping cough

#### 4.4.2 Viral droplet nuclei transmission

Droplet nuclei are an important mode of transmission among many infectious viruses such as Influenza A. When viruses are shed by an infected person through coughing or sneezing into the air, the mucus coating on the virus starts to evaporate. Once this mucus shell evaporates the remaining viron is called a droplet nucleus or quanta. The mucus evaporation rate is determined by the temperature and humidity inside the room. The lower the humidity, the quicker the mucus shell evaporates thus allowing the droplet nuclei to stay airborne and not drop to the ground. The low indoor humidity levels in wintertime buildings ensure that higher levels of droplet nuclei will survive: droplet nuclei are so microscopic that they are able to stay airborne indefinitely on the air currents present within indoor spaces. The Wells-Riley equation predicts the infection rates of persons who shed quanta within a building and is used to calculate indoor infection outbreaks within buildings.

An infected person can release viruses by talking, sneezing, coughing and breathing, though less are released by just breathing. Some of viruses will become droplet nuclei. If these droplet nuclei are breathed into nose or mouth of an uninfected person (known as a susceptible)<sup>[5]</sup> – then the droplet nuclei may penetrate into the deep recesses of their lungs. Viral diseases that are commonly spread by coughing or sneezing droplet nuclei include (at least):

- Common cold
- Influenza A & B
- Mumps
- Measles
- Rubella
- SARS

#### 4.4.3 Fecal-oral transmission

Direct contact is rare in this route, for humans at least. More common are the indirect routes; foodstuffs or water become contaminated (by people not washing their hands before preparing food, or untreated sewage being released into a drinking water supply) and the people who eat and drink them become infected. In developing countries most sewage is discharged into the environment or on cropland as of 2006; even in developed countries there are periodic system failures resulting in a sanitary sewer overflow. This is the typical mode of transmission for the infectious agents of (at least):

- Cholera
- Hepatitis A
- Polio
- Rotavirus
- Salmonella
- Parasites e.g. *Ascaris lumbricoides*

#### **4.4.4 Sexual transmission**

This refers to any disease that can be caught during sexual activity with another person, including vaginal or anal sex or (less commonly) through oral sex. Transmission is either directly between surfaces in contact during intercourse (the usual route for bacterial infections and those infections causing sores) or from secretions (semen or the fluid secreted by the excited female) which carry infectious agents that get into the partner's blood stream through tiny tears in the penis, vagina or rectum (this is a more usual route for viruses). In this second case, anal sex is considerably more hazardous since penis opens more tears in the rectum than the vagina, as the vagina is more elastic and more accommodating.

Some diseases transmissible by the sexual route include (at least):

- HIV/AIDS
- Chlamydia
- Genital warts
- Gonorrhea
- Hepatitis B
- Syphilis
- Herpes
- Trichomoniasis

#### **4.4.5 Oral sexual transmission**

Sexually Transmitted Diseases such as HIV and Hepatitis B are thought to not normally be transmitted through mouth-to-mouth contact, although it is possible to transmit some STDs between the genitals and the mouth, during oral sex. In the case of HIV this possibility has been established. It is also responsible for the increased incidence of herpes simplex virus 1 (which is usually responsible for oral infections) in genital infections and the increased incidence of the type 2 virus (more common genitally) in oral infections.

#### **4.4.6 Oral transmission**

Diseases that are transmitted primarily by oral means may be caught through direct oral contact such as kissing, or by indirect contact such as by sharing a drinking glass or a cigarette.

Diseases that are known to be transmissible by kissing or by other direct or indirect oral contact include all of the diseases listed above as transmissible by droplet contact and also (at least):

- Cytomegalovirus infections
- Herpes simplex virus (especially HSV-1)
- Infectious mononucleosis

(Notice these are all forms of herpes virus.)

#### **4.4.7 Transmission by direct contact**

Diseases that can be transmitted by direct contact are called contagious (contagious is not the same as infectious; although all contagious diseases are infectious, not all infectious diseases are contagious). These diseases can also be transmitted by sharing a towel (where the towel is rubbed vigorously on both

bodies) or items of clothing in close contact with the body (socks, for example) if they are not washed thoroughly between uses. For this reason, contagious diseases often break out in schools, where towels are shared and personal items of clothing accidentally swapped in the changing rooms.

Some diseases that are transmissible by direct contact include:

- Athlete's foot
- Impetigo
- Syphilis (on rare occasions, if an uninfected person touches a chancre)
- Warts
- Conjunctivitis

#### **4.4.8 Iatrogenic transmission**

Transmission due to medical procedures, such as injection or transplantation of infected material.

Some diseases that can be transmitted iatrogenically include:

- Creutzfeldt-Jakob Disease by injection of contaminated human growth hormone.
- MRSA infection is often acquired as a result of a stay in hospital

#### **4.4.9 Vector-borne transmission**

A *vector* is an organism that does not cause disease itself but that transmits infection by conveying pathogens from one host to another.<sup>[6]</sup>

The route of transmission is important to epidemiologists because patterns of contact vary between different populations and different groups of populations depending on socio-economic, cultural and other features. For example, low personal and food hygiene due to the lack of a clean water supply may result in increased transmission of diseases by the fecal-oral route, such as cholera. Differences in incidence of such diseases between different groups can also throw light on the routes of transmission of the disease. For example, if it is noted that polio is more common in cities in underdeveloped countries, without a clean water supply, than in cities with a good plumbing system, we might advance the theory that polio is spread by the fecal-oral route. It can be minimised to a certain extent if we all consider being sure of what we do.

#### *Review Questions*

1. Define the transmission of infection?
2. Explain the Horizontal and vertical infection?
3. Explain the transmission, symptoms and survival?
4. Explain the routes of transmission?

#### **Discussion Questions**

Discuss the different types of transmission of infection?

## Hospital services intensive care unit

### Lesson 1 – Coronary care unit

#### Learning Objectives

- To define the Coronary care unit.
- To explain the characteristics of Coronary care unit.
- To explain the Acute coronary care.
- To describe the history of Coronary care unit.

#### 1.1 Coronary care unit

A **coronary care unit (CCU)** or **cardiac intensive care unit (CICU)** is a hospital ward specialized in the care of patients with heart attacks, unstable angina, Cardiac dysrhythmia and (in practice) various other cardiac conditions that require continuous monitoring and treatment.

##### 1.1.1 Characteristics

The main feature of coronary care is the availability of telemetry or the continuous monitoring of the cardiac rhythm by electrocardiography. This allows early intervention with medication, cardioversion or defibrillation, improving the prognosis. As arrhythmias are relatively common in this group, patients with myocardial infarction or unstable angina are routinely admitted to the coronary care unit. For other indications, such as atrial fibrillation, a specific indication is generally necessary, while for others, such as heart block, coronary care unit admission is standard.

##### 1.1.2 Local differences

In the United States, coronary care units are usually subsets of intensive care units (ICU) dedicated to the care of critically ill cardiac patients. These units are usually present in hospitals that routinely engage in cardiothoracic surgery. Invasive monitoring such as with pulmonary artery catheters is common, as are supportive modalities such as mechanical ventilation and intra-aortic balloon pumps (IABP).

Certain hospitals, such as Johns Hopkins, maintain mixed units consisting of both Acute care units for the critically ill, and intermediate care units for patients who are not critical.

##### 1.1.3 Acute coronary care

Acute coronary care units (ACCU), also called "critical coronary care units" (CCCU) is equivalent to intensive care in the level of service provided. Patients with acute myocardial infarction, cardiogenic shock, or post-operative "open-heart" patients commonly abide here.

#### **1.1.4 Subacute coronary care**

Subacute coronary care units (SCCU), also called Progressive care units (PCU), Intermediate coronary care units (ICCU), or stepdown units, and provide a level of care intermediate to that of the intensive care unit and that of the general medical floor. These units typically serve patients who require cardiac telemetry such as those with unstable angina.

#### **1.1.5 History**

Coronary care units developed in the 1960s when it became clear that close monitoring by specially trained staff, cardiopulmonary resuscitation and medical measures could reduce the mortality from complications of cardiovascular disease. The first description of a CCU was given in 1961 to the British Thoracic Society, and early CCUs were located in Sydney, Kansas City and Philadelphia. Studies published in 1967 revealed that those observed in a coronary care setting had consistently better outcomes. The first coronary care unit was opened at Bethany Medical Center in Kansas City, Kansas by Dr Hugh Day, and he coined the term. Bethany Medical Center is also where the first "crash carts" were developed.

#### *Review Questions*

1. Define the Coronary care unit?
2. Explain the characteristics of Coronary care unit?
3. Explain the Acute coronary care?
4. Explain the history of Coronary care unit?

#### *Discussion Questions*

Discuss the Coronary care unit?

## Lesson 2 – Paraplegic and malignant disease treatment

### Learning Objectives

- To define the Paraplegia.
- To explain the Difference Between Paraplegia and Quadraplegia.
- To explain the Malignant.
- To describe the Benign vs Malignant.

### 2.1 Paraplegia

**Paraplegia** is an impairment in motor or sensory function of the lower extremities. The word comes from Ionic Greek: "half-striking". It is usually caused by spinal cord injury or a congenital condition such as spina bifida that affects the neural elements of the spinal canal. The area of the spinal canal that is affected in paraplegia is either the thoracic, lumbar, or sacral regions. If all four limbs are affected by paralysis, quadriplegia is the proper terminology. If only one limb is affected, the correct term is monoplegia.

**Spastic paraplegia** is a form of paraplegia defined by spasticity of the affected muscles, rather than flaccid paralysis.

#### 2.1.1 Complications

Due to the decrease or loss of feeling or function in the lower extremities, paraplegia can contribute to a number of medical complications including pressure sores (decubitus), thrombosis, and pneumonia. Physiotherapy and various assistive technology, such as a standing frame, as well as vigilant self-observation and -care, may aid in helping to prevent future complications and mitigate existing complications.

As paraplegia is most often the result of a traumatic injury to the spinal cord tissue and the resulting inflammation, other nerve-related complications can and do occur. Cases of chronic nerve pain in the areas surrounding the point of injury are not uncommon. There is speculation that the "phantom pains" experienced by individuals suffering from paralysis could be a direct result of these collateral nerve injuries misinterpreted by the brain.

#### 2.1.2 Treatment

Individuals with paraplegia can range in their level of disability, requiring treatments to vary from case to case. From a rehabilitation standpoint, the most important factor is to gain as much functionality and independence back as possible. Physiotherapists spend many hours within a rehabilitation setting working on strength, range of motion/stretching and transfer skills. Wheelchair mobility is also an important skill to learn. Most paraplegics will be dependent on a wheelchair as a mode of transportation. Thus it is



extremely important to teach them the basic skills to gain their independence. Activities of daily living (ADLs) can be quite challenging at first for those with a spinal cord injury (SCI). With the aid of physiotherapists and occupational therapists, individuals with an SCI can learn new skills and adapt previous ones to maximize independence, often living independently within the community.

### **2.1.3 Difference Between Paraplegia and Quadraplegia?**

Paraplegia and quadriplegia are both serious conditions which involve partial paralysis of the body. In the case of paraplegia, the patient is paralyzed from the waist down, while a quadriplegic has paralysis which affects the body from the neck down. The paralysis is caused by an injury to the spinal cord, and it may be partial or total, depending on the nature of the injury and how it was treated. American President Franklin D. Roosevelt is a well-known example of a paraplegic; scientist Steven Hawking is a quadriplegic.

Three things can lead to paraplegia or quadriplegia: disease, trauma, and congenital diseases. A paraplegic has a spinal cord injury in the lower spine, which causes loss of feeling and mobility in the legs and lower trunk; in many cases, paraplegics have problems with the internal organs in their lower bodies, such as their bladders. A quadriplegic has a higher spinal injury, usually in the cervical spine, and in addition to limited mobility in the arms and legs, he or she may have a number of problems related to lack of control over the internal organs.

Diseases like poliomyelitis, syphilis, Lou Gehrig's disease, and multiple sclerosis have all been linked to complete or partial paralysis. Trauma such as a gunshot wound or heavy fall can also damage the spinal cord, while congenital conditions such as spina bifida cause problems from birth. In all instances, the sooner the problem is diagnosed, the better the prognosis for the patient. Paraplegia and quadriplegia cannot be cured, but treatment can slow and reduce the extent of the damage to the spinal cord, allowing the patient more mobility.

A totally paralyzed paraplegic cannot move the legs at all, and has no sensation. Partial paralysis may allow a paraplegic to move the toes or legs, but usually only with great difficulty. In the case of quadriplegics, also known as tetraplegics, partial paralysis is much more common, because total paralysis would mean that the patient's internal organs could not function, requiring extensive supportive care from medical devices.

Being a quadriplegic or paraplegic can be challenging. The paralysis puts the patient at risk for a range of health problems, including fractures, pneumonia, infections, bed sores, and cardiovascular problems. Supportive care may be required, especially for quadriplegics. However, many people with paralysis live very fulfilling and sometimes active lives; both quadriplegics and paraplegics can compete in the Paralympics, for example, and some paraplegics enjoy activities such as extreme wheelchair sports and para-equestrian sport.

### **2.1.4 What are the first signs of paraplegia?**

Most people find they can no longer feel their legs immediately after the accident. The first signs of paraplegia are numbness and immobility in the legs, accompanied by extreme back pain. Once the accident victim has been rescued (which should only be done by qualified experts), they are operated on to fix the break in the dorsal vertebra. Depending on their injury, patients will have to spend several weeks in a special clinic or hospital, until the break in their back is mended. After this, patients have to be remobilized. In a rehabilitation program that usually lasts several months, patients with paraplegia

gradually learn how to cope with the consequences of their disability. After rehabilitation, persons with paraplegia have a good chance of resuming their normal lives without outside help.

#### **2.1.5 What parts of the body are affected by paraplegia?**

Depending on where the back was injured, the paralysis can affect different parts of the body. Paraplegia is the result of an injury to the spine at the level of the thoracic or lumbar vertebra. For most people with paraplegia, the legs and usually parts of the torso are paralyzed. Paralysis means that the muscles in the legs, stomach, back, and possibly also the chest, no longer function. The person affected can no longer walk or stand. The paralysis in the legs is often spastic, which means that the muscles sometimes cramp together. Many people with paraplegia have difficulty sitting up straight.

#### **2.1.6 Does paraplegia also cause loss of feeling?**

The musculature is not the only thing that's lost at the point of the paralysis – the sensation of feeling goes too. People with paraplegia have no feeling of touch or position in the paralyzed parts of their body. They feel neither pain nor temperature in the affected areas. Because the skin can no longer perceive injury, those affected are at risk of burns or injuries from pressure sores (decubitus ulcer).

#### **2.1.7 Are the excretory organs also affected by paraplegia?**

One of the hardest things for people with paraplegia to bear are disorders of the excretory organs. Both the bladder and bowels no longer function correctly. Fifty years ago, these disorders of the excretory organs used to cost most patients their lives after only a few years. Thanks to medical advances (such as self-catheterization), these problems are no longer life-threatening. However, most patients do find them socially limiting.

#### **2.1.8 How does paraplegia affect sexuality?**

Men with paraplegia have problems in achieving a full erection. Both men and women can find their capacity for orgasm is impaired. Despite this, many people describe their sex life as satisfying. Men with paraplegia can father children. Women may become pregnant spontaneously. In most cases, both pregnancy and birth proceed normally.

### **2.2 Malignant**

In medicine, malignant is a term referring to a condition that is dangerous to health.

A malignant tumor (cancerous tumor) is one that is invasive and can spread to other parts of the body. In contrast, tumors that stay localized and don't spread are called benign. Benign tumors may grow quite large and can do damage, but they do not usually spread through the bloodstream or lymph vessels to other parts of the body.

While the term malignant is often used interchangeably with cancer, not all malignant conditions are cancerous. For example, we use the word malignant hypertension to describe blood pressure that is dangerously high, but in this context it has nothing to do with cancer. Likewise, the condition malignant hyperthermia describes a dangerous situation in which a high fever develops during surgery with general anesthesia.

### **2.2.1 Malignant Hypertension**

Malignant hypertension is a rare but very serious form of high blood pressure. Officially, malignant hypertension is defined as severe hypertension that occurs along with internal bleeding of the retinas in both eyes and swelling of optic nerves behind the retinas. Malignant hypertension must be treated quickly to avoid serious organ damage and, possibly, death. All the major organ systems are at risk from the severe blood pressure elevations present in malignant hypertension, but the kidneys, eyes, and brain seem to be most at risk. The kidneys are especially sensitive to increases in blood pressure and permanent kidney damage is a common complication of untreated malignant hypertension. Most of this organ damage is caused by ruptures in small blood vessels in places, which is why retinal bleeding (which has small blood vessels) is included in the diagnostic criteria for malignant hypertension.

### **2.2.2 What Causes Malignant Hypertension?**

Like high blood pressure in general, the exact cause of malignant hypertension is not completely understood. The details of how malignant hypertension starts have been an important research topic for many years, and while the complete picture is still emerging, we do know a few important things:

- Younger patients are at higher risk than older patients, which is the opposite of the risk profile for essential hypertension
- Those of African heritage are at higher risk
- Anyone with a history of kidney failure or a disease called renal artery stenosis (narrowing of arteries in the kidney) has a greatly increased risk
- Pregnant women with gestational hypertension, or women experiencing certain pregnancy related complications (toxemia of pregnancy) appear to have an increased risk

Overall, malignant hypertension is very rare, affecting only about one percent of people with high blood pressure. The serious nature of the disease, however, makes it an important problem.

### **2.2.2 What are the Symptoms of Malignant Hypertension?**

Because malignant hypertension affects organ systems that are directly sensitive to blood pressure (kidneys, eyes, brain, cardiovascular system), the symptoms of the disease tend to be those you would associate with problems in these other organ systems. For example, some symptoms include:

- Blurry vision
- Chest pain
- Seizure
- Decreased urine output
- Weakness or strange tingling/numbness in the arms, legs, or face
- Headache
- Shortness of breath

These symptoms are not exclusive to malignant hypertension, but are generally associated with a number of potentially serious medical conditions like heart attack, stroke, or kidney problems. If you have any of these symptoms, you should seek medical care immediately.

### **2.2.3 How is Malignant Hypertension Treated?**

People with malignant hypertension should always be admitted to the hospital for close observation and treatment. Depending on how serious the problem is in a particular patient, admission to the Intensive Care Unit (ICU) may be required. During the hospital stay, intravenous medications are the main focus of therapy. Some drugs commonly used to reduce blood pressure in this situation are nitroprusside and nitroglycerin. A number of blood tests will also be checked, probably several times, to assess the status of the kidneys and other organs. Sometimes, more complicated tests may be required, and pictures of the heart or other organs may be taken using an echo machine or an ultrasound machine. If treated quickly, malignant hypertension has a good prognosis. After leaving the hospital, it is common for patients prescribed medicines like beta blockers or ACE inhibitors to keep the blood pressure under control in the future.

### **2.2.4 Malignant Hyperthermia (MH)**

Malignant hyperthermia is a rare inherited disorder in which a patient has a severe, life-threatening reaction when anesthesia gases are inhaled or a muscle relaxant called succinylcholine is given. When a patient who has the malignant hyperthermia gene has a reaction, his temperature rises rapidly, his muscles become rigid and the body begins to break down muscle fibers. The condition is serious and can result in the death of healthy patients if doctors cannot halt or control the symptoms with medication.

Testing is available for malignant hyperthermia and is recommended prior to surgery if close relatives have been diagnosed with the disorder. A muscle biopsy, a procedure where a small piece of muscle is removed by inserting a needle into a muscle, must be taken and analyzed to determine if a patient is a carrier.

## **2.3 Benign vs Malignant**

Is it benign or is it malignant (benign vs malignant?) is a question that haunts too many people as they wait for a doctor's visit, or a scan or biopsy result. How are these two terms defined? How are they similar, and what are the differences between benign and malignant tumors?

### **2.3.1 Definitions of Benign vs Malignant**

The term benign is used to describe both medical conditions and tumors, and usually refers to a process that's not especially dangerous. For example, a benign increase in blood pressure would be an increase that's not dangerous, and a benign heart murmur (also called an innocent heart murmur) would be a heart murmur that probably causes very few problems in terms of sickness or the potential for death. A benign tumor or mass is one that may be a nuisance, but does not usually result in death. Uterine fibroids are a common benign tumor, frequently found in women who are perimenopausal. Benign tumors grow locally but do not have the ability to spread to other regions of the body.

The term malignant is often used synonymously with the word "dangerous" in medicine. While it usually refers to a cancerous tumor, it may be used to describe other medical conditions. For example, malignant hypertension (malignant high blood pressure) refers to blood pressure that is dangerously high, and malignant tumors (cancerous tumors) are those that have the ability to spread to other regions of the body either locally, via the bloodstream, or through the lymphatic system.

### 2.3.2 How are Malignant and Benign Tumors Similar?

Some similarities include:

- ***Both can grow quite large.*** Size alone does not make the distinction between these types of tumors. In fact, benign ovarian tumors weighing over a hundred pounds have been removed.
- ***Both can be dangerous at times.*** While benign tumors tend to be more of a nuisance, they can, in some cases, be life threatening. An example is benign brain tumors. When these tumors grow in the enclosed space of the brain, they can put pressure on, and destroy other brain structures, resulting in paralysis, speech problems, seizures, and even death. Some benign tumors, such as pheochromocytomas, secrete hormones that can cause life-threatening symptoms as well.
- ***Both can recur locally.*** If cells are left over after surgery, both benign and malignant tumors may later recur near the region of the original tumor.

### 2.3.3 Differences Between Benign and Malignant Tumors

- ***Rate of growth*** - In general, malignant tumors grow much more rapidly than benign tumors, but there are exceptions. Some malignant (cancerous) tumors grow very slowly, while some benign tumors grow rapidly.
- ***Ability to metastasize*** - Benign tumors expand locally, whereas malignant tumors can spread (metastasize) to other parts of the body by way of the bloodstream and lymphatic channels.
- ***Site of recurrence*** - While benign tumors may recur locally — that is, near the site of the original tumor — malignant tumors may recur at distant sites, such as the the brain, lungs, bones and liver, depending on the type of cancer.
- ***"Stickiness"*** - The cells in benign tumors manufacture chemicals (adhesion molecules) that cause them to stick together. Malignant tumor cells do not produce these molecules and can break off and “float away” to other regions of the body.
- ***Tissue invasion*** - In general, malignant tumors tend to invade nearby tissues, whereas benign tumors do not (though they may grow large and cause damage to nearby organs by creating pressure on them). A very simplistic way of thinking about this is to envision a benign tumor as having a wall or boundary (literally, a fibrous sheath surrounding the tumor). This boundary allows the tumor to expand and push (displace) nearby tissues aside, but does not allow the tumor to *penetrate* nearby tissues. In contrast, envision cancer as having “fingers” or “tentacles” that can reach into nearby tissues. In fact, the Latin word cancer derives from the word crab, used to describe the crablike, or fingerlike, projections of cancerous tumors.
- ***Cellular appearance*** - Under a microscope, cells that are benign often look much different from those that are malignant. One of these differences is that the cell nucleus of cancer cells is often larger and appears darker due to an abundance of DNA.
- ***Effective treatments*** - Benign tumors can usually be removed with surgery alone, while cancerous (malignant) tumors will often require chemotherapy and radiation therapy. These additional treatments are needed to attempt to reach cancer cells that have spread beyond the region of the tumor or are left behind after surgery for a tumor.

- ***Likelihood of recurrence*** - Benign tumors seldom occur after surgery, whereas malignant tumors recur much more commonly. Surgery to remove a malignant tumor is more difficult than surgery for a benign tumor. Using the fingerlike analogy above, it is much easier to remove a tumor that has a clear fibrous boundary than a tumor that has penetrated nearby tissues with these fingerlike projections. If cells are left over from these fingers, the tumor is more likely to come back.
- ***Systemic effects*** - Malignant tumors are more likely to have systemic, or total body, effects than benign tumors. Due to the nature of these tumors, symptoms such as fatigue and weight loss are common. Several types of malignant tumors also secrete substances that cause effects on the body beyond those caused by the original tumor. An example of this is the paraneoplastic syndrome caused by some cancers, resulting in a wide array of physical symptoms from hypercalcemia (an elevation of calcium in the blood) to Cushing's syndrome (which in turn causes symptoms such as rounding of the face, stretch marks and weakened bones).
- ***Death toll*** - Benign tumors cause around 13,000 deaths per year in the United States. The number of deaths that can be blamed on malignant (cancerous) tumors is over 575,000.

#### 2.3.4 Areas of Confusion

There are times when it's difficult to know whether a tumor is benign or malignant, and this can be very confusing and frightening if it is you that is living with one of these tumors. Physicians often make the distinction between cancerous and non-cancerous tumors under the microscope, and sometimes the differences are very subtle. Sometimes doctors have to use other clues, such as where the tumor is located, its rate of growth, and other findings, to try and make the distinction.

In addition, ***some benign tumors can become malignant tumors over time***. Some benign tumors very rarely become malignant tumors, whereas other benign tumors frequently transform into malignant tumors. An example of this is adenomatous polyps (adenomas) in the colon. By themselves, these are benign and not dangerous. But over time, they may transform into a colon cancer. Removal of adenomas in order to reduce the risk of developing colon cancer (adenocarcinoma) is behind the recommendation that people over the age of 50 have a screening colonoscopy.

Another area of confusion is that, frequently, normal cells, precancerous cells, and cancerous cells all coexist within the same tumor. Depending on where a biopsy is done, it may not pick up a sample representing the whole tumor; for example, it may only pick up an area of precancerous cells in a tumor that is otherwise cancerous.

Other terms that can make this concept confusing include:

- ***Tumor***: A tumor refers to a growth that can be either benign or malignant. It is essentially a tissue growth that does not serve any useful purpose for the body, and may instead be harmful.
- ***Mass***: A mass can also be benign or malignant. In general the term mass is used to describe a growth that is greater than or equal to 3 cm (1 ½ inches) in diameter.
- ***Nodule***: A nodule may also be either benign or malignant. In general, the term nodule is used to describe growths that are less than or equal to 3 cm (1 ½ inches) in diameter.
- ***Neoplasm***: Literally translated as "new tissue," the term "neoplasm" is usually used synonymously with tumor, and these growths can be either benign or malignant.

### 2.3.5 Malignant Tumor

Malignant tumors are ambitious. Unlike benign tumors that generally stay put, malignant tumors have two goals in life: to survive and to conquer new territory.

So, if you have a malignant tumor in your colon, it's going to try to work its way through your colon. If successful, it will see where else it can go. This is called metastasizing.

In general, malignant tumors grow faster than benign tumors and are more likely to cause health problems.

## 2.4 Neuroleptic malignant syndrome

**Neuroleptic malignant syndrome (NMS)** is a life-threatening neurological disorder most often caused by an adverse reaction to neuroleptic or antipsychotic drugs. NMS typically consists of muscle rigidity, fever, autonomic instability, and cognitive changes such as delirium, and is associated with elevated plasma creatine phosphokinase. The incidence of neuroleptic malignant syndrome has decreased since it was first described, due to changes in prescribing habits, but NMS is still a potential danger to patients being treated with antipsychotic medication. Because of the unpredictability of NMS, treatment may vary substantially but is generally based on supportive care and removal of the offending antipsychotic drug.

### 2.4.1 Signs and symptoms

The first symptoms of neuroleptic malignant syndrome are usually muscle cramps and tremors, fever, symptoms of autonomic nervous system instability such as unstable blood pressure, and alterations in mental status (agitation, delirium, or coma). Once symptoms appear, they may progress rapidly and reach peak intensity in as little as three days. These symptoms can last anywhere from eight hours to forty days. The muscular symptoms are most likely caused by blockade of the dopamine receptor D<sub>2</sub>, leading to abnormal function of the basal ganglia similar to that seen in Parkinson's disease.<sup>[3]</sup>

A raised white blood cell count and creatine phosphokinase (CPK) plasma concentration will be reported due to increased muscular activity and rhabdomyolysis (destruction of muscle tissue). The patient may suffer hypertensive crisis and metabolic acidosis. A non-generalized slowing on an EEG is reported in around 50% of cases.

The fever is believed to be caused by hypothalamic dopamine receptor blockade. The peripheral problems (the white blood cell and CPK count) are caused by the antipsychotic drugs. They cause an increased calcium release from the sarcoplasmic reticulum of muscle cells which can result in rigidity and eventual cell breakdown. No major studies have reported an explanation for the abnormal EEG, but it is likely also attributable to dopamine blockage leading to changes in neuronal pathways.

Unfortunately, symptoms are sometimes misinterpreted by doctors as symptoms of mental illness, delaying treatment. NMS is less likely if a person has previously been stable for a period of time on antipsychotics, especially in situations where the dose has not been changed and there are no issues of noncompliance or consumption of psychoactive substances known to worsen psychosis.

### 2.4.2 Symptoms overview

- Increased body temperature >38°C (>100.4°F), or

- Confused or altered consciousness
- Diaphoresis "sweat shock"
- Rigid muscles
- Autonomic imbalance

#### 2.4.2 *Mnemonic*

A mnemonic used to remember the features of NMS is FEVER.

- **F** – Fever
- **E** – Encephalopathy
- **V** – Vitals unstable
- **E** – Elevated enzymes (elevated CPK)
- **R** – Rigidity of muscles

Revised mnemonic for NMS: FALTER

- **F** – Fever
- **A** – Autonomic instability
- **L** – Leukocytosis
- **T** – Tremor
- **E** – Elevated enzymes (elevated CPK)
- **R** – Rigidity of muscles

#### 2.4.3 **Differential diagnosis**

Differentiating NMS from other neurological disorders can be very difficult. It requires expert judgement to separate symptoms of NMS from other diseases. Some of the most commonly mistaken diseases are: encephalitis, toxic encephalopathy, status epilepticus, heat stroke, and malignant hyperthermia. Due to the comparative rarity of NMS, it is often overlooked and immediate treatment for the syndrome is delayed. Drugs such as cocaine and amphetamine may also produce similar symptoms.

The differential diagnosis is similar to that of hyperthermia, and includes serotonin syndrome. Features which distinguish NMS from serotonin syndrome include bradykinesia, muscle rigidity, and elevated white blood cell count and plasma creatine kinase level.

#### 2.4.4 **Causes**

NMS is usually caused by neuroleptic drug use, and a wide range of drugs can result in NMS. Individuals using haloperidol or chlorpromazine are reported to be at greatest risk. NMS may also occur in people taking dopaminergic drugs (such as levodopa) for Parkinson's disease, most often when the drug dosage is abruptly reduced. In addition, other drugs with anti-dopaminergic activity, such as the antiemetic metoclopramide, can induce NMS. Even drugs without known anti-dopaminergic activity have been associated with NMS; examples include amoxapines and lithium. Also, desipramine, dothiepin, phenelzine, tetrabenazine, and reserpine have been known to trigger NMS. At the molecular level, NMS is caused by a sudden, marked reduction in dopamine activity, either from withdrawal of dopaminergic agents or from blockade of dopamine receptors.



#### 2.4.5 Risk factors

One of the clearest risk factors in the development of NMS is the course of drug therapy chosen to treat a condition. Use of high-potency neuroleptics, rapid increase in dosage of neuroleptics, and use of long-acting forms of neuroleptics are all known to increase the risk of developing NMS.

It has been purported that there is a genetic risk factor for NMS, since identical twins have both presented with NMS in one case, and a mother and two of her daughters have presented with NMS in another case.

Demographically, it appears that males, especially those under forty, are at greatest risk for developing NMS, although it is unclear if the increased incidence is a result of greater neuroleptic use in men under forty. It has also been suggested that postpartum women may be at a greater risk for NMS.

An important risk factor for this condition is Lewy body dementia. These patients are extremely sensitive to neuroleptics. As a result, neuroleptics should be used cautiously in all cases of dementia.

#### 2.4.6 Pathophysiology

The mechanism is thought to depend on decreased levels of dopamine activity due to:

- Dopamine receptor blockade
- Genetically reduced function of dopamine receptor D<sub>2</sub>

However, the failure of D<sub>2</sub> dopamine receptor antagonism or dopamine receptor dysfunction does not fully explain the presenting symptoms and signs of NMS, as well as the occurrence of NMS with atypical antipsychotic drugs with lower D<sub>2</sub> dopamine activity. This has led to the hypothesis of sympathoadrenal hyperactivity (results from removing tonic inhibition from the sympathetic nervous system) as an etiological mechanism for NMS. Release of calcium is increased from the sarcoplasmic reticulum with antipsychotic usage. This can result in increased muscle contractility, which can play a role in breakdown of muscle, muscle rigidity, and hyperthermia. Some antipsychotic drugs, such as typical neuroleptics, are known to block dopamine receptors; other studies have shown that when drugs supplying dopamine are withdrawn, symptoms similar to NMS present themselves.

There is also thought to be considerable overlap between malignant catatonia and NMS in their pathophysiology, the former being idiopathic and the latter being the drug-induced form of the same syndrome.

#### 2.4.7 Treatment

NMS is a medical emergency, and can lead to death if untreated. The first step is to stop neuroleptic drugs and treat the hyperthermia aggressively, such as with cooling blankets or ice packs to the axillae and groin. Supportive care in an intensive care unit capable of circulatory and ventilatory support is crucial. The correct pharmacological treatment is still unclear. Dantrolene has been used when needed to reduce muscle rigidity, and more recently dopamine pathway medications such as bromocriptine have shown benefit.<sup>[21]</sup> Apomorphine may be used however its use is supported by little evidence.<sup>[3]</sup> Benzodiazepines may be used to control agitation. Highly elevated blood myoglobin levels can result in kidney damage, therefore aggressive intravenous hydration with diuresis may be required. When recognized early NMS can be successfully managed, however up to 10% of cases can be fatal.

### 2.4.8 Prognosis

The prognosis is best when identified early and treated aggressively. In these cases NMS is not usually fatal. In previous studies the mortality rates from NMS have ranged from 20%–38%, however in the last two decades mortality rates have fallen below 10% due to early recognition and improved management. Re-introduction to the drug that originally caused NMS to develop may also trigger a recurrence, although in most cases it does not.

Memory impairment is a consistent feature of recovery from NMS, and usually temporary, though in some cases, may become persistent.

### 2.4.9 Epidemiology

Pooled data suggests the incidence of NMS is between 0.2%–3.23%. However, more physician awareness coupled with increased use of atypical anti-psychotics have likely reduced the prevalence of NMS. Additionally, young males are particularly susceptible and the male:female ratio has been reported to be as high as 2:1.

### 2.4.9 History

NMS was known about as early as 1956, shortly after the introduction of the first phenothiazines. NMS was first described in 1960 by French clinicians who had been working on a study involving haloperidol. They characterized the condition that was associated with the side effects of haloperidol "*syndrome malin des neuroleptiques*", which was translated to neuroleptic malignant syndrome.

### 2.4.10 Research

While the pathophysiology of NMS remains unclear, the two most prevalent theories are:

- Reduced dopamine activity due to receptor blockade
- Sympathoadrenal hyperactivity and autonomic dysfunction

In the past, research and clinical studies seemed to corroborate the D<sub>2</sub> receptor blockade theory in which antipsychotic drugs were thought to significantly reduce dopamine activity by blocking the D<sub>2</sub> receptors associated with this neurotransmitter. However, recent studies indicate a genetic component to the condition. In support of the Sympathoadrenal Hyperactivity model proposed, it has been hypothesized that a defect in calcium regulatory proteins within the sympathetic neurons may bring about the onset of NMS. This model of NMS strengthens its suspected association with malignant hyperthermia in which NMS may be regarded as a neurogenic form of this condition which itself is linked to defective calcium-related proteins.

The introduction of atypical antipsychotic drugs, which do not act on the D<sub>2</sub> dopamine receptors were thought to have reduced the incidence of NMS. However, recent studies suggest that the decrease in mortality may be the result of increased physician awareness and earlier initiation of treatment rather than the action of the drugs themselves. NMS induced by atypical drugs also resembles "classical" NMS (induced by "typical" antipsychotic drugs), further casting doubt on the overall superiority of these drugs.

### *Review Questions*

1. Define the Paraplegia?
2. Explain the Difference Between Paraplegia and Quadraplegia?
3. Explain the Malignant?
4. Explain the Benign vs Malignant?

### Discussion Questions

Discuss the Neuroleptic malignant syndrome?

## Lesson 3 – Hospital welfare services

### Learning Objectives

- To define the Hospital.
- To explain the types of Hospital.
- To explain the Hospital welfare services.
- To describe the types of welfare services in hospitals.

### 3.1 Hospital

A **hospital** is a health care institution providing patient treatment by specialized staff and equipment.

Hospitals are usually funded by the public sector, by health organizations (for profit or nonprofit), health insurance companies, or charities, including direct charitable donations. Historically, hospitals were often founded and funded by religious orders or charitable individuals and leaders. Today, hospitals are largely staffed by professional physicians, surgeons, and nurses, whereas in the past, this work was usually performed by the founding religious orders or by volunteers. However, there are various Catholic religious orders, such as the Alexians and the Bon Secours Sisters, which still focus on hospital ministry today.

In accord with the original meaning of the word, hospitals were originally "places of hospitality", and this meaning is still preserved in the names of some institutions such as the Royal Hospital Chelsea, established in 1681 as a retirement and nursing home for veteran soldiers.

### 3.2 Types

Some patients go to a hospital just for diagnosis, treatment, or therapy and then leave ('outpatients') without staying overnight; while others are 'admitted' and stay overnight or for several days or weeks or months ('inpatients'). Hospitals usually are distinguished from other types of medical facilities by their ability to admit and care for inpatients whilst the others often are described as clinics.

#### 3.2.1 General

The best-known type of hospital is the general hospital, which is set up to deal with many kinds of disease and injury, and normally has an emergency department to deal with immediate and urgent threats to health. Larger cities may have several hospitals of varying sizes and facilities. Some hospitals, especially in the United States, have their own ambulance service.

### **3.2.2 District**

A district hospital typically is the major health care facility in its region, with large numbers of beds for intensive care and long-term care;

### **3.2.3 Specialized**

Types of specialized hospitals include trauma centers, rehabilitation hospitals, children's hospitals, seniors' (geriatric) hospitals, and hospitals for dealing with specific medical needs such as psychiatric problems, certain disease categories such as cardiac, oncology, or orthopedic problems, and so forth. In Germany specialized hospitals are called *fachkrankenhaus*; an example is Fachkrankenhaus Coswig (thoracic surgery).

A hospital may be a single building or a number of buildings on a campus. Many hospitals with pre-twentieth-century origins began as one building and evolved into campuses. Some hospitals are affiliated with universities for medical research and the training of medical personnel such as physicians and nurses, often called teaching hospitals. Worldwide, most hospitals are run on a nonprofit basis by governments or charities. There are however a few exceptions, e.g. China, where government funding only constitutes 10% of income of hospitals.

### **3.2.4 Teaching**

A teaching hospital combines assistance to patients with teaching to medical students and nurses and often is linked to a medical school, nursing school or university.

### **3.2.5 Clinics**

The medical facility smaller than a hospital is generally called a clinic, and often is run by a government agency for health services or a private partnership of physicians (in nations where private practice is allowed). Clinics generally provide only outpatient services.

## **3.3 Hospital welfare services**

### **3.3.1 Definition**

Hospital services is a term that refers to medical and surgical services and the supporting laboratories, equipment and personnel that make up the medical and surgical mission of a hospital or hospital system.

### **3.3.2 Purpose**

Hospital services make up the core of a hospital's offerings. They are often shaped by the needs or wishes of its major users to make the hospital a one-stop or core institution of its local community or medical network. Hospitals are institutions comprising basic services and personnel—usually departments of medicine and surgery—that administer clinical and other services for specific diseases and conditions, as well as emergency services. Hospital services cover a range of medical offerings from basic health care necessities or training and research for major medical school centers to services designed by an industry-owned network of such institutions as health maintenance organizations (HMOs). The mix of services that a hospital may offer depends almost entirely upon its basic mission(s) or objective(s).

There are three basic types of hospitals in the United States: proprietary (for-profit) hospitals; nonprofit hospitals; and charity- or government-supported hospitals. The services within these institutions vary considerably, but are usually organized around the basic mission(s) or objective (s) of the institution:

- Proprietary hospitals. For-profit hospitals include both general and specialized hospitals, usually as part of a healthcare network like Humana or HCA, which may be corporately owned. The main objective of proprietary hospitals is to make a profit from the services provided.
- Teaching or community hospitals. These are hospitals that serve several purposes: they provide patients for the training or research of interns and residents; they also offer services to patients who are unable to pay for services, while attempting to maintain profitability. Nonprofit centers like the University of California at San Francisco (UCSF) or the Mayo Clinics combine service, teaching, and profitability without being owned by a corporation or private owner.
- Government-supported hospitals. This group includes tax-supported hospitals for counties, communities and cities with voluntary hospitals (community or charity hospitals) run by a board of citizen administrators who serve without pay. The main objective of this type of hospital is to provide health care for a community or geographic region.

### 3.3.3 Demographics

The total number of hospitals in the United States, including military and prison hospitals, is over 6,500. Of this total, approximately 3,000 are non-government-related nonprofit hospitals; almost 800 are investor-owned; and 1,156 are government (state, county, or local) hospitals.

### 3.3.4 Description

Over the past two decades, hospital services in the United States have declined markedly as a percentage of health care costs, from 43.5% in 1980 to 32.8% in 2000. This decline was due to shortened lengths of hospital stay, the move from inpatient to outpatient facilities for surgery, and a wave of hospital mergers in the 1990s that consolidated services and staff. Since 2001, however, spending on hospital care in the United States has been growing faster than other sectors of the economy as a result of increasing demand for hospital services. Forty percent of the rise in spending on hospital care is due to escalating costs for hospital services attributed to population growth, the aging of the general population, and growing discontent with the limitations imposed by managed care. In addition, new medical technologies have allowed hospitals to provide life-saving diagnostic and therapeutic alternatives that were unavailable in the 1990s.

At the same time that the use of hospital services is increasing nationwide, government support of hospital services with **Medicaid** and **Medicare** has been decreasing, putting pressure upon hospitals to treat the uninsured and make up for \$21.6 billion in uncompensated care (year 2002). This trend has put pressure on for-profit, not-for-profit and teaching hospitals to provide a broader range of community services or such "low-end" services as mental health care, preventive health services, and general pediatric care. In addition, very recent changes in Federal laws governing the entry of hospitals into new markets—Certificate of Need laws—allow health care providers to offer new hospital services, resulting in the growth of ambulatory surgical centers, special tertiary surgery centers and specialty hospitals that treat a single major disease category. These legislative changes encourage the offering of "high-end" services that are increasingly demanded by consumers.

Hospital services define the core features of a hospital's organization. The range of services may be limited in such specialty hospitals as cardiovascular centers or cancer treatment centers, or very broad to meet the needs of the community or patient base, as in full service health maintenance organizations

(HMOs), rural charity centers, urban health centers, or medical research centers. Hospital services are usually the most general in large urban areas or underserved rural areas, broadly encompassing many services ordinarily offered by other medical providers. The basic services that hospitals offer include:

- short-term hospitalization
- emergency room services
- general and specialty surgical services
- x ray/radiology services
- laboratory services
- blood services

HMO hospitals add a number of special and auxiliary services to the basic list, including:

- pediatric specialty care
- greater access to surgical specialists
- physical therapy and rehabilitation services
- prescription services
- home nursing services
- nutritional counseling
- mental health care
- family support services
- genetic counseling and testing
- social work or case management services
- financial services

Hospitals funded by state, regional, or local government, as well as charity hospitals and hospitals within research and teaching centers, are pressed by community needs to provide for the uninsured or underinsured with more basic services:

- primary care services
- mental health and drug treatment
- infectious disease clinics
- hospice care
- dental services
- translation and interpreter services

### 3.3.5 Diagnosis/Preparation

Most hospitals have extensive surgical services that include preoperative testing, which may include x-rays, **CT scans**, ultrasonography, blood tests, **urinalysis**, and/or an EKG. Medication counseling is offered for current patient prescriptions and how they should be taken during and after surgery. **Informed consent** forms are made available to patients, as well as patient advocate services for questions and assistance in understanding the consent form and similar documents. An anesthesiologist or an assistant discuss with the patient the patient's history of allergies, previous reactions to anesthesia and special precautions that will be taken. Intravenous medications are usually begun in the patient's room before surgery to relax the patient, with general anesthesia administered in the **operating room**.

### 3.3.6 Aftercare

According to the National Center for Health Statistics of the Centers for Disease Control and Prevention (CDC), 40 million inpatient surgical procedures were performed in the United States in 2000, followed closely by 31.5 million outpatient surgeries. The procedures that were performed most frequently included:

- digestive system: 12 million procedures
- musculoskeletal system: 7.4 million procedures
- cardiovascular system: 6.8 million procedures
- eye: 5.4 million procedures

### 3.3.7 Inpatient aftercare

After inpatient surgery, most patients are taken to a **recovery room** and monitored by nursing staff until they regain full consciousness. If there are complications or if the patient develops respiratory or cardiac problems, he or she is transferred to a surgical **intensive care unit** equipped to deal with acute needs. Intensive care units (ICU) are highly advanced facilities in which patients are monitored by special equipment that measures their heart rate, breathing, blood pressure, and blood oxygen level. Some patients require a respirator to breathe for them and additional intravenous lines to deliver medication and fluids. Once stabilized, patients are transferred to their hospital room.

After returning to the room, the patient is encouraged to sit up, start walking, and do as much as possible to return to a normal level of activity. Special diets may be provided, as well as pain-killing medications and **antibiotics** if needed. A respiratory therapist will usually visit the patient with breathing equipment intended to help the patient's lung function return to normal. A physical therapist may introduce the patient to an **exercise** program or to skills needed to manage with temporary or permanent physical limitations.

Discharge personnel help the patient plan to go home. Some hospitals follow up with an outpatient nurse or social worker service. Pharmaceutical services may be offered to fill take-home prescriptions without the requirement of visiting an outside pharmacy. Medical equipment, like wheelchairs or crutches and other durable equipment, may be provided by the hospital and then purchased by the patient for use at home.

### 3.3.8 Outpatient aftercare

Outpatient or ambulatory surgery services make up almost half of all surgeries in the United States as a result of advances in surgical equipment and technique that allow for laser treatments and other minimally invasive procedures. Outpatient procedures require comparatively little aftercare for the patient due to both the nature of the surgical procedure and the advantages of being able to use regional or local anesthesia. Aftercare in hospital outpatient clinics, **ambulatory surgery centers**, or office-based practices requires that patients recover from anesthetics in the facility. After the anesthetic has worn off, the patient is briefly monitored for complications and released to go home. Many surgical procedures now allow patients to go home after a short recovery period on the same day as the surgery, and benefit from minimal pain and a speedier recovery.



### 3.3.9 Morbidity and mortality rates

According to a health consumer organization, 98,000 people die each year in America's hospitals as a result of **medical errors**. In recent years, many hospitals have introduced special safeguards to cut down on the number of mistakes in medication and surgical services. Two new practices have been adopted by quality hospitals. Computerized order entries for medications cut down drastically on the number of misread prescriptions. The other innovation reduces the number of medical errors in intensive care units by using specially trained physicians—intensivists—in the unit. Hospitals that have introduced these patient safety features can be found on the Internet at consumer health sites.

Proprietary hospitals generally offer more services and "high end" care than government or community hospitals, with teaching hospitals offering the most highly developed new procedures and techniques along with services for the poor and special populations. For-profit hospitals, however, do not have lower rates of morbidity or mortality in their delivery of hospital services. One study in 2000 published by General Internal Medicine found that patients at for-profit hospitals suffered two to four times more complications from surgery as well as delays in diagnosing and treating illness than did patients in nonprofit hospitals. Previous research has shown that death rates are 25% higher in proprietary hospitals than in teaching hospitals, and 6–7% higher in proprietary hospitals than in nonprofit institutions.

#### *Review Questions*

1. Define the Hospital?
2. Explain the types of Hospital?
3. Explain the Hospital welfare services?
4. Explain the types of welfare services in hospitals?

#### *Discussion Questions*

Discuss the Hospital welfare services in details?

## Lesson 4 – Hospitals standing services

### Learning Objectives

- To define the Hospitals standing services.
- To explain the types of Hospitals services.
- To explain the Equipment and systems In hospitals.
- To describe the Changing priorities in hospitals services.

### 4.1 Hospitals standing services

Hospitals vary widely in the services they offer and therefore, in the departments (or "wards") they have. Each is usually headed by a Chief Physician. They may have acute services such as an emergency department or specialist trauma centre, burn unit, surgery, or urgent care

#### 4.1.1 Emergency department

An **emergency department (ED)**, also known as **accident & emergency (A&E)**, **emergency room (ER)**, or **casualty department**, is a medical treatment facility specializing in acute care of patients who present without prior appointment, either by their own means or by ambulance. The emergency department is usually found in a hospital or other primary care center.

Due to the unplanned nature of patient attendance, the department must provide initial treatment for a broad spectrum of illnesses and injuries, some of which may be life-threatening and require immediate attention. In some countries, emergency departments have become important entry points for those without other means of access to medical care.

The emergency departments of most hospitals operate 24 hours a day, although staffing levels may be varied in an attempt to mirror patient volume

##### 4.1.1.1 Department operation

Today, a typical hospital has its emergency department in its own section of the first floor of the campus, with its own dedicated entrance. As patients can present at any time and with any complaint, a key part of the operation of an emergency department is the prioritization of cases based on clinical need. This is usually achieved through the application of triage.

Triage is normally the first stage the patient passes through, and consists of a brief assessment, a set of vital signs, and the assignment of a "chief complaint" (i.e. chest pain, abdominal pain, difficulty breathing, etc.). Most emergency departments have a dedicated area for this process to take place, and may have staff dedicated to performing nothing but a triage role. In most departments, this role is fulfilled by a nurse, although dependent on training levels in the country and area, other health care professionals

may perform the triage sorting, including paramedics or physicians (DOs or MDs). Triage is typically conducted face-to-face when the patient presents, or a form of triage may be conducted via radio with an ambulance crew; in this method, the paramedics will call the hospital's triage center with a short update about an incoming patient, who will then be triaged to the appropriate level of care.

Most patients will be initially assessed at triage and then passed to another area of the department, or another area of the hospital, with their waiting time determined by their clinical need. However, some patients may complete their treatment at the triage stage, for instance if the condition is very minor and can be treated quickly, if only advice is required, or if the emergency department is not a suitable point of care for the patient. Conversely, patients with evidently serious conditions, such as cardiac arrest, will bypass triage altogether and move straight to the appropriate part of the department.

The resuscitation area, commonly referred to as "Trauma" or "Resus", is a key area in most departments. The most seriously ill or injured patients will be dealt with in this area, as it contains the equipment and staff required for dealing with immediately life threatening illnesses and injuries. Typical resuscitation staffing involves at least one attending physician (DO or MD), and at least one and usually two nurses with trauma and Advanced Cardiac Life Support training. These personnel may be assigned to the resuscitation area for the entirety of the shift, or may be "on call" for resuscitation coverage (i.e. if a critical case presents via walk-in triage or ambulance, the team will be paged to the resuscitation area to deal with the case immediately). Resuscitation cases may also be attended by residents, medical students, nursing students, emergency medical technicians, and/or hospital pharmacists, depending upon the skill mix needed for any given case and whether or not the hospital provides teaching services.

Patients who are seriously ill but not in immediate danger of life or limb will be triaged to "acute care" or "majors," where they will be seen by a physician and receive a more thorough assessment and treatment. Examples of "majors" include chest pain, difficulty breathing, abdominal pain and neurological complaints. Advanced diagnostic testing may be conducted at this stage, including laboratory testing of blood and/or urine, ultrasonography, CT or MRI scanning. Medications appropriate to manage the patient's condition will also be given. Depending on the resolution of the patient's chief complaint, he or she may be discharged home from this area or admitted to the hospital for further treatment.

Patients whose condition is not immediately life threatening will be sent to an area suitable to deal with them, and these areas might typically be termed as a *prompt care* or *minors* area. Such patients may still have been found to have significant problems, including fractures, dislocations, and lacerations requiring suturing.

Children can present particular challenges in treatment. Some departments have dedicated pediatrics areas, and some departments employ a play therapist whose job is to put children at ease to reduce the anxiety caused by visiting the emergency department, as well as provide distraction therapy for simple procedures.

Many hospitals have a separate area for evaluation of psychiatric problems. These are often staffed by psychiatrists and mental health nurses and social workers. There is typically at least one room for people who are actively a risk to themselves or others (e.g. suicidal).

Fast decisions on life-and-death cases are critical in hospital emergency rooms. As a result, doctors face great pressures to overtest and overtreat. The fear of missing something often leads to extra blood tests and imaging scans for what may be harmless chest pains, run-of-the-mill head bumps, and non-threatening stomach aches, with a high cost on the Health Care system.<sup>[4]</sup>

#### **4.1.2 Intensive-care unit**

An **Intensive Care Unit (ICU)**, also known as a **Critical Care Unit (CCU)**, **Intensive Therapy Unit** or **Intensive Treatment Unit (ITU)** is a special department of a hospital or health care facility that provides intensive-care medicine.

Intensive Care Units cater to patients with the most severe and life-threatening illnesses and injuries; that require constant, close monitoring and support from specialist equipment and medication in order to maintain normal bodily functions. They are staffed by highly trained doctors and critical care nurses who specialise in caring for seriously ill patients. Common conditions that are treated within ICU's include those such as trauma, multiple organ failure and sepsis.

Patients may be transferred directly to an Intensive Care Unit from an Emergency Department if required, or from a ward if they rapidly deteriorate; or immediately after surgery if the surgery is majorly invasive and the patient is at high risk of complications.

##### **4.1.2.1 Equipment and systems**

Common equipment in an ICU includes mechanical ventilators to assist breathing through an endotracheal tube or a tracheotomy; cardiac monitors including those with telemetry; external pacemakers; defibrillators; dialysis equipment for renal problems; equipment for the constant monitoring of bodily functions; a web of intravenous lines, feeding tubes, nasogastric tubes, suction pumps, drains, and catheters; and a wide array of drugs to treat the primary condition(s) of hospitalization. Medically induced comas, analgesics, and induced sedation are common ICU tools needed and used to reduce pain and prevent secondary infections.

#### **4.1.3 Pediatric intensive care unit**

A **pediatric intensive care unit** (also **paediatric**), usually abbreviated to **PICU**, is an area within a hospital specializing in the care of critically ill infants, children, and teenagers. A PICU is typically directed by one or more pediatric intensivists or PICU consultants and staffed by doctors, nurses, and respiratory therapists who are specially trained and experienced in pediatric intensive care. The unit may also have nurse practitioners, physician assistants, physiotherapists, social workers, child life specialists, and clerks on staff although this varies widely depending on geographic location. The ratio of professionals to patients is generally higher than in other areas of the hospital, reflecting the acuity of PICU patients and the risk of life-threatening complications. Complex technology and equipment is often in use, particularly mechanical ventilators and patient monitoring systems. Consequently, PICUs have a larger operating budget than many other departments within the hospital.

##### **4.1.3.1 Levels of care**

###### **4.1.3.1.1 United States**

###### ***4.1.3.1.1.1 Level 1***

Level I PICUs are variable in size, personnel, physical characteristics, and equipment, and that they differ in the types of specialized care (ie, care following transplantation or cardiac surgery) that they provide.

Nurse-to-patient ratios range from 2 nurses to 1 patient to 1 nurse to 3 patients. Registered respiratory therapists are required to be assigned primarily to the Level I PICU in-house 24 hours per day.

#### **4.1.3.1.1.2 Level 2**

Level II PICUs are smaller than level I PICUs and are able to care for less critical patients.

#### **4.1.4 Neonatal intensive care unit**

A **neonatal intensive care unit (NICU)** is an intensive care unit specializing in the care of ill or premature newborn infants. The first official ICU for neonates was established in 1961 at Vanderbilt University by Professor Mildred Stahlman, officially termed a NICU when Stahlman was the first to use a ventilator off-label to assist a baby with breathing difficulties.

A NICU is typically directed by one or more neonatologists and staffed by nurses, nurse practitioners, pharmacists, physician assistants, resident physicians, and respiratory therapists. Many other ancillary disciplines and specialists are available at larger units. The term *neonatal* comes from *neo*, "new", and *natal*, "pertaining to birth or origin".

##### **4.1.4.1 Changing priorities**

NICUs now concentrate on treating very small, premature, or congenitally ill babies. Some of these babies are from higher-order multiple births, but most are still single babies born too early. Premature labour, and how to prevent it, remains a perplexing problem for doctors. Even though medical advancements allow doctors to save low-birth-weight babies, it is almost invariably better to delay such births.

Over the last 10 years or so, SCBUs have become much more 'parent friendly', encouraging maximum involvement with the babies. Routine gowns and masks have gone and parents are encouraged to help with care as much as possible. Cuddling and skin-to-skin contact, also known as Kangaroo care, are seen as beneficial for all but the frailest (very tiny babies are exhausted by the stimulus of being handled; or larger critically ill infants). Less stressful ways of delivering high-technology medicine to tiny patients have been devised: sensors to measure blood oxygen levels through the skin, for example; and ways of reducing the amount of blood taken for tests.

Some major problems of the NICU have almost disappeared. Exchange transfusions, in which all the blood is removed and replaced, are rare now. Rhesus incompatibility (a difference in blood groups) between mother and baby is largely preventable, and was the most common cause for exchange transfusion in the past. Breathing difficulties, intraventricular hemorrhage, necrotizing enterocolitis and infection still claim many infant lives and are the focus of many current research projects.

The long-term outlook for premature babies saved by NICUs has always been a concern. From the early years, it was reported that a higher proportion than normal grew up with disabilities, including cerebral palsy and learning difficulties. Now that treatments are available for many of the problems faced by tiny or immature babies in the first weeks of life, long-term follow-up, and minimising long-term disability, are major research areas.

Besides prematurity and extreme low birth-weight, common diseases cared for in a NICU include perinatal asphyxia, major birth defects, sepsis, neonatal jaundice, and Infant respiratory distress syndrome

due to immaturity of the lungs. The leading cause of death in NICUs is generally necrotizing enterocolitis. Complications of extreme prematurity may include intracranial hemorrhage, chronic bronchopulmonary dysplasia, or retinopathy of prematurity. An infant may spend a day of observation in a NICU or may spend many months there. Overall survival rates, for all gestational ages lumped together, are roughly 70%.

Neonatology and NICUs have greatly increased the survival of very low birth-weight and extremely premature infants. In the era before NICUs, infants of birth weight less than 1400 grams (3 lb, usually about 30 weeks gestation) rarely survived. Today, infants of 500 grams at 26 weeks have a fair chance of survival.

The NICU environment provides challenges as well as benefits. Stressors for the infants can include continual light, a high level of noise, separation from their mothers, reduced physical contact, painful procedures, and interference with the opportunity to breastfeed. A NICU can be stressful for the staff as well. A special aspect of NICU stress for both parents and staff is that infants may survive, but with damage to the brain or eyes.

NICU rotations are essential aspects of pediatric and obstetric residency programs, but NICU experience is encouraged by other specialty residencies, such as family practice, surgery, Pharmacy, and emergency medicine.

## **4.2 Neurology**

**Neurology** is a medical specialty dealing with disorders of the nervous system. To be specific, neurology deals with the diagnosis and treatment of all categories of disease involving the central and peripheral nervous system; or equivalently, the autonomic nervous systems and the somatic nervous systems, including their coverings, blood vessels, and all effector tissue, such as muscle.

A neurologist is a physician specializing in neurology and trained to investigate, or diagnose and treat neurological disorders. Neurologists may also be involved in clinical research, and clinical trials, as well as basic research and translational research. While neurology is a non-surgical specialty, its corresponding surgical specialty is neurosurgery.<sup>[2]</sup> Neurology, being a branch of medicine, differs from neuroscience, which is the scientific study of the nervous system in all of its aspects.

## **4.3 Oncology**

**Oncology** is a branch of medicine that deals with cancer.

### **Diagnosis**

The most important diagnostic tool remains the medical history: the character of the complaints and any specific symptoms (fatigue, weight loss, unexplained anemia, fever of unknown origin, paraneoplastic phenomena and other signs). Often a physical examination will reveal the location of a malignancy.

Diagnostic methods include:

- Biopsy, either incisional or excisional;
- Endoscopy, either upper or lower gastrointestinal, bronchoscopy, or nasendoscopy;
- X-rays, CT scanning, MRI scanning, PET scan, ultrasound and other radiological techniques;

- Scintigraphy, Single Photon Emission Computed Tomography, Positron emission tomography and other methods of nuclear medicine;
- Blood tests, including tumor markers, which can increase the suspicion of certain types of tumors or even be pathognomonic of a particular disease.

Apart from in diagnosis, these modalities (especially imaging by CT scanning) are often used to determine operability, i.e. whether it is surgically possible to remove a tumor in its entirety.

Generally, a "tissue diagnosis" (from a biopsy) is considered essential for the proper identification of cancer. When this is not possible, "empirical therapy" (without an exact diagnosis) may be given, based on the available evidence (e.g. history, x-rays and scans.)

Occasionally, a metastatic lump or pathological lymph node is found (typically in the neck) for which a primary tumor cannot be found. This situation is referred to as "carcinoma of unknown primary", and again, treatment is empirical based on past experience of the most likely origin.

#### **4.4 Therapy**

It completely depends on the nature of the tumor identified what kind of therapeutical intervention will be necessary. Certain disorders (such as ALL or AML) will require immediate admission and chemotherapy, while others will be followed up with regular physical examination and blood tests.

Often, surgery is attempted to remove a tumor entirely. This is only feasible when there is some degree of certainty that the tumor can in fact be removed. When it is certain that parts will remain, curative surgery is often impossible, e.g. when there are metastases elsewhere, or when the tumor has invaded a structure that cannot be operated upon without risking the patient's life. Occasionally surgery can improve survival even if not all tumour tissue has been removed; the procedure is referred to as "debulking" (i.e. reducing the overall amount of tumour tissue). Surgery is also used for the palliative treatment of some of cancers, e.g. to relieve biliary obstruction, or to relieve the problems associated with some cerebral tumors. The risks of surgery must be weighed against the benefits.

Chemotherapy and radiotherapy are used as a first-line radical therapy in a number of malignancies. They are also used for adjuvant therapy, i.e. when the macroscopic tumor has already been completely removed surgically but there is a reasonable statistical risk that it will recur. Chemotherapy and radiotherapy are commonly used for palliation, where disease is clearly incurable: in this situation the aim is to improve the quality of and prolong life.

Hormone manipulation is well established, particularly in the treatment of breast and prostate cancer.

There is currently a rapid expansion in the use of monoclonal antibody treatments, notably for lymphoma (Rituximab), and breast cancer (Trastuzumab).

Vaccine and other immunotherapies are the subject of intensive research.

#### **4.5 Obstetrics and gynaecology**

**Obstetrics and gynaecology** (or **obstetrics and gynecology**; often abbreviated to **OB/GYN**, **OBG**, **O&G** or **Obs & Gynae**) are the two surgical–medical specialties dealing with the female reproductive organs in their pregnant and non-pregnant state, respectively, and as such are often combined to form a

single medical specialty and postgraduate training programme. This combined training prepares the practicing OB/GYN to be adept at the surgical management of the entire scope of clinical pathology involving female reproductive organs, and to provide care for both pregnant and non-pregnant patients. In veterinary medicine, theriogenology is the more commonly used term that also includes andrology.

#### *Review Questions*

1. Define the Hospitals standing services?
2. Explain the types of Hospitals services?
3. Explain the Equipment and systems In hospitals?
4. Explain the Neurology and Oncology?

#### *Discussion Questions*

Discuss the Hospitals standing services in details?



## Lesson 5 – Medical stores

### Learning Objectives

- To define the Medical stores.
- To explain the custody of drugs.
- To explain the poor monitoring of drug sale.
- To describe the Storing medicine safely.

### 5.1 Medical stores

The medical store is a place where patients visit to fill their prescriptions. The medicines being technical products are potentially hazardous to cause disability or loss of life if it were used unscientifically. The anomalies in regulating the sales of medicines across the counter are a major controversy due to the trade organizations requesting the government to amend the Drug and Cosmetic Act Rule 65(15)(c) to redefine the definition of qualified person as anybody having minimum experience of 5 years as partner/proprietor retail pharmacy outlet. They have called for all India Bandh and agitation on 10th May 2013. The letter appeals to public of India to take their side and show sympathy to the agitating owners or business partners by supporting them in their endeavour to do away with pharmacy profession from public service. Here, we will discuss the significance of pharmacist presence while drugs are dispensed to the patients.

#### 5.1.1 The custody of drugs, what matters?

The drugs are really dangerous if it goes to the hands of public without control. They are as dangerous as guns. They can kill a person. In earlier times all the drugs need to be labelled as poison in red letters to alert the general public to get cautioned regarding the potential danger if used in indiscriminate manner. On one hand the government is thinking of making regulations about pharmacovigilance of drugs, where in the impact of drug use on health of the patients, need to be documented and reported to the government, so that the government decides whether such drug to be used or put a ban on sale of such drug. It is not an easy issue while using the drugs. There are numerous cases of drug accidents happenings across the country, which go unnoticed due to public negligent attitude and government in action. Pharmacists who are inadequate in technical education or have misconceptions regarding how to use medicine effectively and how to manage patients on medication, the patients will have to pay price by way of suffering and drug accidents. They fail to counsel the patients and educate them how to use medicine safely and effectively. The job of pharmacist is not selling the medicine but to dispense the medicine. The differences between selling and dispensing need to be discussed in order to appreciate the spirit of the law mandating the supervision of a registered pharmacist in dispensing. The pharmacist is supposed explain the doubts of the patients in the matters of drug, disease and life style changes that help the patient in his disease management. In USA, a report says the prescription drug misuse is a major cause of deaths, out beating the deaths due to car accidents. In India, we have grossly over looked the issue and do not believe that drugs can cause damage to health. This attitude is grossly due to ignorance among public who dare to self medicate themselves and injure with loss kidney or some other major internal organ damage. The law enacted ensures the public access to the drugs with safety. The currently the retail shops are engaged in just selling the medicine ignoring the patient safety altogether. The custody of

medicine is an important issue; any attempt to dilute or differ can lead to chaos in health care provision. The government should make stringent practice of Drugs and Cosmetic Act 1945 and Pharmacy Act 1940. They should upgrade the minimum qualification for registered pharmacist to B. Pharm or Pharm D like any other developed country. The public is paying for medicine expects good quality service and a value for the money they spend on health care. The trade organizations have previously attempted to do away with registered pharmacist by filing a case in Allahabad High Court Bench in 2000, in which the judgement favoured the stand of trade organizations. This order was challenged by Pharmacy Council of India in Supreme Court. After studying the merits and demerits of the case, the Supreme Court gave landmark judgement, in which it stated it would be contempt of law, if a drug store does function in the absence of a registered pharmacist. After decade of silence the trade organizations have approached again to government of India that the law needs to be amended by removing the education requirements of a pharmacist.

### **5.1.2 Poor monitoring and enforcing of the law**

The currently due to poor monitoring and enforcing of the law, the retail drug sale is violated by selling the prescription schedule drugs openly to the public with least concern for safety of the patients. Recently there was protest in Mumbai, when a drug regulator asked the retail pharmacist to abide by the law and make sure the presence of the pharmacist available during working of the retail business and does not fallow the regulations. They threatened with protests and Bundh. They presumed that public support and sympathy will silence the regulator. On the other hand, public remained silent, indicating that the law is good for them. At least this should be a warning sign for trade organizations, but instead they have called for an India Bundh and protest to amend the law in their favour. This is purely selfish act which needs to be condemned. The people visit medical shops in agony and pain to get solace for their suffering. They spend money to buy medicine and support the retail business. They trust the shop owner as a friend and a technical expert in the matter of drug. The mere argument that existing law does not suit the interest of a retail shop owner and is one side of the story. The retail shop exists for providing service to the needy patients, and it should never be negotiated with patient safety. Looking at the outcry of the trade organization is not illegal and also not acceptable, which puts its member interests above patient safety.

## **5.2 Storing medicine safely**

Many people store their medications in the bathroom. But this popular spot is actually one of the worst places to keep medicine. Bathroom cabinets tend to be warm and humid, an environment that speeds up a drug's breakdown process.

This is especially true for tablets and capsules. Being exposed to heat and moisture can make medicines less potent before their expiration date. For example, a warm, muggy environment can cause aspirin tablets to break down into acetic acid (vinegar) and salicylic acid, both of which can irritate the stomach.

Instead, keep medicines in a cool, dry, secure place out of a child's reach. You may need to use a locked cabinet or box. If you must keep your medicines in the bathroom, keep the containers tightly closed. If you store medicines in a kitchen, keep them away from the stove, sink, and any hot appliances.

Consider refilling your prescriptions each month, instead of every 3 months to make sure they are still potent.

In rare cases, medicine that is improperly stored can become toxic. To prevent danger, follow these tips:

- Always store drugs out of children's reach.
- Always keep medicines in their original container.

- Don't leave the cotton plug in a medicine bottle. This can draw moisture into the container.
- Check the expiration date each time you take a drug. Replace any medications that are out of date.
- Never use a medication that has changed color, texture, or odor, even if it has not expired. Throw away capsules or tablets that stick together, are harder or softer than normal, or are cracked or chipped.
- Ask your pharmacist about any specific storage instructions.

Be aware that children or adolescents can get hold of their parents' unused sedative or painkiller prescriptions and abuse them or accidentally poison themselves.

Throw out unused medicine safely and promptly by using the procedures recommended by the Food and Drug Administration. This includes placing medicines in a sealed bag in your trash, mixed with coffee grounds, kitty litter, or other inedible substances. You can also ask the pharmacist for advice on how to throw out old medicines. Use community "drug give back" programs if they are available.

Travelers need to follow these tips for safely storing their medications:

- Before leaving home, list all your medications, as well as the name and number of your pharmacist and doctor.
- Pack your medicine in a carry-on bag instead of a checked suitcase.
- Bring an extra supply with you in case your return is delayed.
- Never leave medicines in a car. Heat can quickly destroy the drug.
- Watch time changes. Set a separate watch to your usual time so you can remember when to take your medicine.

### *Review Questions*

1. Define the Medical stores?
2. Explain the custody of drugs?
3. Explain the poor monitoring of drug sale?
4. Explain the Storing medicine safely?

### *Discussion Questions*

Discuss the Medical stores in details?

## Lesson 6 – Medical record

### Learning Objectives

- To define the Medical record.
- To explain the purpose of Medical record.
- To explain the Different types of medical records.
- To describe the Electronic medical record.

### 6.1 Medical record

The terms **medical record**, **health record**, and **medical chart** are used somewhat interchangeably to describe the systematic documentation of a single patient's medical history and care across time within one particular health care provider's jurisdiction. The medical record includes a variety of types of "notes" entered over time by health care professionals, recording observations and administration of drugs and therapies, orders for the administration of drugs and therapies, test results, x-rays, reports, etc. The maintenance of complete and accurate medical records is a requirement of health care providers and is generally enforced as a licensing or certification prerequisite.

The terms are used for both the physical folder that exists for each individual patient and for the body of information found therein.

Medical records have traditionally been compiled and maintained by health care providers, but advances in online data storage have led to the development of personal health records (PHR) that are maintained by patients themselves, often on third-party websites.<sup>[2]</sup> This concept is supported by US national health administration entities and by AHIMA, the American Health Information Management Association.

Because many consider the information in medical records to be sensitive personal information covered by expectations of privacy, many ethical and legal issues are implicated in their maintenance, such as third-party access and appropriate storage and disposal. Although the storage equipment for medical records generally is the property of the health care provider, the actual record is considered in most jurisdictions to be the property of the patient, who may obtain copies upon request.

#### 6.1.1 Purpose

The information contained in the medical record allows health care providers to determine the patient's medical history and provide informed care. The medical record serves as the central repository for planning patient care and documenting communication among patient and health care provider and professionals contributing to the patient's care.

The traditional medical record for inpatient care can include admission notes, on-service notes, progress notes (SOAP notes), preoperative notes, operative notes, postoperative notes, procedure notes, delivery notes, postpartum notes, and discharge notes.

Personal health records combine many of the above features with portability, thus allowing a patient to share medical records across providers and health care systems.

### **6.1.2 Auxiliary purpose**

In addition, the individual medical record anonymised may serve as a document to educate medical students/resident physicians, to provide data for internal hospital auditing and quality assurance, and to provide data for medical research and development.

### **6.1.3 Contents**

A patient's individual medical record identifies the patient and contains information regarding the patient's case history at a particular provider. The health record as well as any electronically stored variant of the traditional paper files contain proper identification of the patient. Further information varies with the individual medical history of the patient.

### **6.1.4 Media applied**

Traditionally, medical records were written on paper and maintained in folders often divided into sections for each type of note (progress note, order, test results), with new information added to each section chronologically. Active records are usually housed at the clinical site, but older records are often archived offsite.

The advent of electronic medical records has not only changed the format of medical records but has increased accessibility of files. The use of an individual dossier style medical record, where records are kept on each patient by name and illness type originated at the Mayo Clinic out of a desire to simplify patient tracking and to allow for medical research.

Maintenance of medical records requires security measures to prevent from unauthorized access or tampering with the records.

### **6.1.5 Medical history**

The medical history is a longitudinal record of what has happened to the patient since birth. It chronicles diseases, major and minor illnesses, as well as growth landmarks. It gives the clinician a feel for what has happened before to the patient. As a result, it may often give clues to current disease states. It includes several subsets detailed below.

#### **6.1.5.1 Surgical history**

The surgical history is a chronicle of surgery performed for the patient. It may have dates of operations, operative reports, and/or the detailed narrative of what the surgeon did.

#### **6.1.5.2 Obstetric history**

The obstetric history lists prior pregnancies and their outcomes. It also includes any complications of these pregnancies.

#### **6.1.5.3 Medications and medical allergies**

The medical record may contain a summary of the patient's current and previous medications as well as any medical allergies.

#### **6.1.5.4 Family history**

The family history lists the health status of immediate family members as well as their causes of death (if known). It may also list diseases common in the family or found only in one sex or the other. It may also include a pedigree chart. It is a valuable asset in predicting some outcomes for the patient.

#### **6.1.5.5 Social history**

The social history is a chronicle of human interactions. It tells of the relationships of the patient, his/her careers and trainings, schooling and religious training. It is helpful for the physician to know what sorts of community support the patient might expect during a major illness. It may explain the behavior of the patient in relation to illness or loss. It may also give clues as to the cause of an illness (e.g. occupational exposure to asbestos).

#### **6.1.5.6 Habits**

Various habits which impact health, such as tobacco use, alcohol intake, exercise, and diet are chronicled, often as part of the social history. This section may also include more intimate details such as sexual habits and sexual orientation.

#### **6.1.5.7 Immunization history**

The history of vaccination is included. Any blood tests proving immunity will also be included in this section.

#### **6.1.5.8 Growth chart and developmental history**

For children and teenagers, charts documenting growth as it compares to other children of the same age is included, so that health-care providers can follow the child's growth over time. Many diseases and social stresses can affect growth and longitudinal charting and can thus provide a clue to underlying illness. Additionally, a child's behavior (such as timing of talking, walking, etc.) as it compares to other children of the same age is documented within the medical record for much the same reasons as growth.

### **6.1.6 Medical encounters**

Within the medical record, individual medical encounters are marked by discrete summations of a patient's medical history by a physician, nurse practitioner, or physician assistant and can take several forms. Hospital admission documentation (i.e., when a patient requires hospitalization) or consultation by a specialist often take an exhaustive form, detailing the entirety of prior health and health care. Routine

visits by a provider familiar to the patient, however, may take a shorter form such as the *problem-oriented medical record* (POMR), which includes a problem list of diagnoses or a "SOAP" method of documentation for each visit. Each encounter will generally contain the aspects below:

#### **6.1.6.1 Chief complaint**

This is the main problem (traditionally called a complaint) that has brought the patient to see the doctor or other clinician. Information on the nature and duration of the problem will be explored.

#### **6.1.6.2 History of the present illness**

A detailed exploration of the symptoms the patient is experiencing that have caused the patient to seek medical attention.

#### **6.1.6.3 Physical examination**

The physical examination is the recording of observations of the patient. This includes the vital signs, muscle power and examination of the different organ systems, especially ones that might directly be responsible for the symptoms the patient is experiencing.

#### **6.1.6.4 Assessment and plan**

The assessment is a written summation of what are the most likely causes of the patient's current set of symptoms. The plan documents the expected course of action to address the symptoms (diagnosis, treatment, etc.).

### **6.1.5 Orders and prescriptions**

Written orders by medical providers are included in the medical record. These detail the instructions given to other members of the health care team by the primary providers.

#### **6.1.5.1 Progress notes**

When a patient is hospitalized, daily updates are entered into the medical record documenting clinical changes, new information, etc. These often take the form of a SOAP note and are entered by all members of the health-care team (doctors, nurses, physical therapists, dietitians, clinical pharmacists, respiratory therapists, etc.). They are kept in chronological order and document the sequence of events leading to the current state of health.

#### **6.1.5.2 Test results**

The results of testing, such as blood tests (e.g., complete blood count) radiology examinations (e.g., X-rays), pathology (e.g., biopsy results), or specialized testing (e.g., pulmonary function testing) are included. Often, as in the case of X-rays, a written report of the findings is included in lieu of the actual film.

### **6.1.5.3 Other information**

Many other items are variably kept within the medical record. Digital images of the patient, flowsheets from operations/intensive care units, informed consent forms, EKG tracings, outputs from medical devices (such as pacemakers), chemotherapy protocols, and numerous other important pieces of information form part of the record depending on the patient and his or her set of illnesses/treatments.

### **6.1.6 Administrative issues**

Medical records are legal documents that can be used as evidence via a subpoena duces tecum<sup>[9]</sup>, and are thus subject to the laws of the country/state in which they are produced. As such, there is great variability in rules governing production, ownership, accessibility, and destruction. There is some controversy regarding proof verifying the facts, or absence of facts in the record, apart from the medical record itself.

### **6.1.7 Demographics**

Demographics include patient information that is not medical in nature. It is often information to locate the patient, including identifying numbers, addresses, and contact numbers. It may contain information about race and religion as well as workplace and type of occupation. It also contains information regarding the patient's health insurance. It is common to also find emergency contact information located in this section of the medical chart.

### **6.1.8 Production**

In the United States, written records must be marked with the date and time and scribed with indelible pens without use of corrective paper. Errors in the record should be struck out with a single line (so that the initial entry remains legible) and initialed by the author.

Orders and notes must be signed by the author. Electronic versions require an electronic signature.

### **6.1.9 Ownership of patient's record**

Ownership and keeping of patient's records varies from country to country.

#### **6.1.10 US law and customs**

In the United States, the data contained within the medical record belongs to the patient, whereas the physical form the data takes belongs to the entity responsible for maintaining the record per the Health Insurance Portability and Accountability Act. Patients have the right to ensure that the information contained in their record is accurate, and can petition their health care provider to amend factually incorrect information in their records.

#### **6.1.11 UK law and customs**

In the United Kingdom, ownership of the NHS's medical records has in the past generally been described as belonging to the Secretary of State for Health and this is taken by some to mean copyright also belongs to the authorities.



### **6.1.12 German law and customs**

In Germany ownership of patient's records is not explicitly codified. Hence traditional keeping of patient's records is with the hospitals and the practitioners. There is no comprehensive data set containing all information on one patient in one file defined yet. Since 1995, patients are identified via a health insurance card that includes name and address information as well as an ID assigned by the insurance provider. An upgrade to advanced health insurance cards (Elektronische Gesundheitskarte) that can store additional medical information was planned for 2006. Discussion on the benefit, the associated cost, and on data privacy issues is still ongoing as of 2011. There is no comprehensive data set containing all information on one patient in one file defined yet. Since 1997, patients are identified via a health insurance card that includes name and address information as well as ID assigned by the insurance provide.

### **6.1.13 Accessibility**

In the United States, the most basic rules governing access to a medical record dictate that only the patient and the health-care providers directly involved in delivering care have the right to view the record. The patient, however, may grant consent for any person or entity to evaluate the record. The full rules regarding access and security for medical records are set forth under the guidelines of the Health Insurance Portability and Accountability Act (HIPAA). The rules become more complicated in special situations.

#### **6.1.13.1 Capacity**

When a patient does not have capacity (is not legally able) to make decisions regarding his or her own care, a legal guardian is designated (either through next of kin or by action of a court of law if no kin exists). Legal guardians have the ability to access the medical record in order to make medical decisions on the patient's behalf. Those without capacity include the comatose, minors (unless emancipated), and patients with incapacitating psychiatric illness or intoxication.

#### **6.1.13.2 Medical emergency**

In the event of a medical emergency involving a non-communicative patient, consent to access medical records is assumed unless written documentation has been previously drafted (such as an advance directive)

#### **6.1.13.3 Research, auditing, and evaluation**

Individuals involved in medical research, financial or management audits, or program evaluation have access to the medical record. They are not allowed access to any identifying information, however.

#### **6.1.13.4 Risk of death or harm**

Information within the record can be shared with authorities without permission when failure to do so would result in death or harm, either to the patient or to others. Information cannot be used, however, to initiate or substantiate a charge unless the previous criteria are met (i.e., information from illicit drug testing cannot be used to bring charges of possession against a patient). This rule was established in the United States Supreme Court case *Jaffe v. Redmond*[1].

In the United Kingdom, the Data Protection Acts and later the Freedom of Information Act 2000 gave patients or their representatives the right to a copy of their record, except where information breaches confidentiality (e.g., information from another family member or where a patient has asked for information not to be disclosed to third parties) or would be harmful to the patient's wellbeing (e.g., some psychiatric assessments). Also, the legislation gives patients the right to check for any errors in their record and insist that amendments be made if required.

#### **6.1.14 Destruction**

In general, entities in possession of medical records are required to maintain those records for a given period. In the United Kingdom, medical records are required for the lifetime of a patient and legally for as long as that complaint action can be brought. Generally in the UK, any recorded information should be kept legally for 7 years, but for medical records additional time must be allowed for any child to reach the age of responsibility (20 years). Medical records are required many years after a patient's death to investigate illnesses within a community (e.g., industrial or environmental disease or even deaths at the hands of doctors committing murders, as in the Harold Shipman case).

#### **6.1.15 Abuses**

The outsourcing of medical record transcription and storage has the potential to violate patient-physician confidentiality by possibly allowing unaccountable persons access to patient data. Falsification of a medical record by a medical professional is a felony in most United States jurisdictions. Governments have often refused to disclose medical records of military personnel who have been used as experimental subjects.

#### **6.1.16 Data Breach**

Given the series of medical data breaches and the lack of public trust, some countries have enacted laws requiring safeguards to be put in place to protect the security and confidentiality of medical information as it is shared electronically and to give patients some important rights to monitor their medical records and receive notification for loss and unauthorized acquisition of health information. The United States and the EU have imposed mandatory medical data breach notifications.

Patients' medical information can be shared by a number of people both within the health care industry and beyond. The Health Insurance Portability and Accessibility Act (HIPAA) is a federal law pertaining to medical privacy that went into effect in 2003. This law established standards for patient privacy in all 50 states, including the right of patients to access to their own records. HIPAA provides some protection, but does not resolve the issues involving medical records privacy.

Medical and healthcare providers have experienced 767 security breaches resulting in the compromised confidential health information of 23,625,933 patients during the period of 2006-2012.

### **6.2 Electronic medical record**

An electronic health record is a representation of all a patients' data that would originally be found in the paper based record. It contains all information ranging from pathology, radiology and clinical information that has been combined and structured in a digital form.

The system is designed to capture and re-present data that accurately capture the state of the patient at all times. It allows for an entire patient history to be viewed without the need to track down the patient's previous medical record volume and assists in ensuring data is accurate, appropriate and legible. It reduces the chances of data replication as there is only one modifiable file, which means the file is constantly up to date when viewed at a later date and eliminates the issue of lost forms or paperwork. Due to all the information being in a single file, it makes it much more effective when extracting medical data for the examination of possible trends and long term changes in the patient.

### **6.2.1 Comparison with paper-based records**

Paper-based records are still by far the most common method of recording patient information for most hospitals and practices in the U.S. The majority of doctors still find their ease of data entry and low cost hard to part with. However, as easy as they are for the doctor to record medical data at the point of care, they require a significant amount of storage space compared to digital records. In the United States, most states require physical records be held for a minimum of seven years. The costs of storage media, such as paper and film, per unit of information differ dramatically from that of electronic storage media. When paper records are stored in different locations, collating them to a single location for review by a health care provider is time consuming and complicated, whereas the process can be simplified with electronic records. This is particularly true in the case of person-centered records, which are impractical to maintain if not electronic (thus difficult to centralize or federate). When paper-based records are required in multiple locations, copying, faxing, and transporting costs are significant compared to duplication and transfer of digital records. Because of these many "after-entry" benefits, federal and state governments, insurance companies and other large medical institutions are heavily promoting the adoption of electronic medical records. The US Congress included a formula of both incentives (up to \$44,000 per physician under Medicare or up to \$65,000 over six years, under Medicaid) and penalties (i.e. decreased Medicare and Medicaid reimbursements for covered patients to doctors who fail to use EMRs by 2015) for EMR/EHR adoption versus continued use of paper records as part of the Health Information Technology for Economic and Clinical Health (HITECH) Act, enacted as part of the American Recovery and Reinvestment Act of 2009.

One study estimates electronic medical records improve overall efficiency by 6% per year, and the monthly cost of an EMR may (depending on the cost of the EMR) be offset by the cost of only a few "unnecessary" tests or admissions. Jerome Groopman disputed these results, publicly asking "how such dramatic claims of cost-saving and quality improvement could be true".

However, the increased portability and accessibility of electronic medical records may also increase the ease with which they can be accessed and stolen by unauthorized persons or unscrupulous users versus paper medical records, as acknowledged by the increased security requirements for electronic medical records included in the Health Information and Accessibility Act and by large-scale breaches in confidential records reported by EMR users. Concerns about security contribute to the resistance shown to their widespread adoption.

Handwritten paper medical records can be associated with poor legibility, which can contribute to medical errors. Pre-printed forms, the standardization of abbreviations, and standards for penmanship were encouraged to improve reliability of paper medical records. Electronic records help with the standardization of forms, terminology and abbreviations, and data input. Digitization of forms facilitates the collection of data for epidemiology and clinical studies.

In contrast, EMRs can be continuously updated. The ability to exchange records between different EMR systems ("interoperability") would facilitate the co-ordination of health care delivery in non-affiliated health care facilities. In addition, data from an electronic system can be used anonymously for statistical reporting in matters such as quality improvement, resource management and public health communicable disease surveillance.

### **6.2.3 Contribution under UN administration and accredited organizations**

The United Nations World Health Organization (WHO) administration intentionally does not contribute to an internationally standardized view of medical records nor to personal health records. However, WHO contributes to minimum requirements definition for developing countries.

The United Nations accredited standardisation body International Organization for Standardization (ISO) however has settled thorough work for standards in the scope of the HL7 platform for health care informatics. Respective standards are available with ISO/HL7 10781:2009 Electronic Health Record-System Functional Model, Release 1.1 and subsequent set of detailing standards.

### **6.2.4 In the United States**

#### **6.2.4.1 Usage**

Even though EMR systems with a computerized provider order entry (CPOE) have existed for more than 30 years, fewer than 10 percent of hospitals as of 2006 had a fully integrated system.

In the United States, the CDC reported that the EMR adoption rate had steadily risen to 48.3 percent at the end of 2009. This is an increase over 2008, when only 38.4% of office-based physicians reported using fully or partially electronic medical record systems (EMR) in 2008. However, the same study found that only 20.4% of all physicians reported using a system described as minimally functional and including the following features: orders for prescriptions, orders for tests, viewing laboratory or imaging results, and clinical progress notes. As of 2012, 72 percent of office physicians are using basic electronic medical records.

The usage of electronic medical records can vary depending on who the user is and how they are using it. Electronic medical records can help improve the quality of medical care given to patients. Many doctors and office-based physicians refuse to get rid of the traditional paper records. Harvard University has conducted an experiment in which they tested how doctors and nurses use electronic medical records to keep their patients' information up to date. The studies found that electronic medical records were very useful; a doctor or a nurse was able to find a patient's information fast and easy just by typing their name; even if it was misspelled. The usage of electronic medical records increases in some work places due to the ease of use of the system; whereas the president of the Canadian Family Practice Nurses Association says that using electronic medical records can be time consuming, and it isn't very helpful due to the complexity of the system. Beth Israel Deaconess Medical Center reported that doctors and nurses prefer to use a much more friendly user software due to the difficulty and time it takes for a medical staff to input the information as well as to find a patient's information. A study was done and the amount of information that was recorded in the EMRs was recorded; about 44% of the patient's information was recorded in the EMRs. This shows that EMRs are not very efficient most of the time.

The cost of implementing an EMR system for smaller practices has also been criticized. Despite this, tighter regulations regarding meaningful use criteria have resulted in more physicians adopting EMR systems. Software, hardware and other services for EMR system implementation are provided for cost by

various companies, including Dell. Open source EMR systems exist, but have not seen widespread adoption of open-source EMR system software. Beyond financial concerns there are a number of legal and ethical dilemmas created by increasing EMR use.

#### **6.2.4.2 Goals And Objectives**

- Improve care quality, safety, efficiency, and reduce health disparities

Quality and safety measurement

Clinical decision support (automated advice) for providers

Patient registries (e.g., “a directory of patients with diabetes”)

- Improve care coordination
- Engage patients and families in their care
- Improve population and public health

Electronic laboratory reporting for reportable conditions (hospitals)

Immunization reporting to immunization registries

Syndromic surveillance (health event awareness)

- Ensure adequate privacy and security protections

#### **6.2.4.3 Quality**

Studies call into question whether, in real life, EMRs improve the quality of care. 2009 produced several articles raising doubts about EMR benefits. A major concern is the reduction of physician-patient interaction due to formatting constraints. For example, some doctors have reported that the use of check-boxes has led to fewer open-ended questions.

#### **6.2.4.4 Costs**

The steep price of EMR and provider uncertainty regarding the value they will derive from adoption in the form of return on investment have a significant influence on EMR adoption. In a project initiated by the Office of the National Coordinator for Health Information (ONC), surveyors found that hospital administrators and physicians who had adopted EMR noted that any gains in efficiency were offset by reduced productivity as the technology was implemented, as well as the need to increase information technology staff to maintain the system.

The U.S. Congressional Budget Office concluded that the cost savings may occur only in large integrated institutions like Kaiser Permanente, and not in small physician offices. They challenged the Rand Corp. estimates of savings. "Office-based physicians in particular may see no benefit if they purchase such a product—and may even suffer financial harm. Even though the use of health IT could generate cost

savings for the health system at large that might offset the EMR's cost, many physicians might not be able to reduce their office expenses or increase their revenue sufficiently to pay for it. For example, the use of health IT could reduce the number of duplicated diagnostic tests. However, that improvement in efficiency would be unlikely to increase the income of many physicians." One CEO of an EMR company has argued if a physician performs tests in the office, it might reduce his or her income. "Given the ease at which information can be exchanged between health IT systems, patients whose physicians use them may feel that their privacy is more at risk than if paper records were used."

Doubts have been raised about cost saving from EMRs by researchers at Harvard University, the Wharton School of the University of Pennsylvania, Stanford University, and others.

#### **6.2.4.5 Software quality and usability deficiencies**

The Healthcare Information and Management Systems Society (HIMSS), a very large U.S. health care IT industry trade group, observed that EMR adoption rates "have been slower than expected in the United States, especially in comparison to other industry sectors and other developed countries. A key reason, aside from initial costs and lost productivity during EMR implementation, is lack of efficiency and usability of EMRs currently available." The U.S. National Institute of Standards and Technology of the Department of Commerce studied usability in 2011 and lists a number of specific issues that have been reported by health care workers. The U.S. military's EMR "AHLTA" was reported to have significant usability issues.

#### **Legal status**

Electronic medical records, like other medical records, must be kept in unaltered form and authenticated by the creator. Under data protection legislation, responsibility for patient records (irrespective of the form they are kept in) is always on the creator and custodian of the record, usually a health care practice or facility. The physical medical records are the property of the medical provider (or facility) that prepares them. This includes films and tracings from diagnostic imaging procedures such as X-ray, CT, PET, MRI, ultrasound, etc. The patient, however, according to HIPAA, has a right to view the originals, and to obtain copies under law.

#### **6.2.4.6 Technical features**

- Digital formatting enables information to be used and shared over secure networks
- Track care (e.g. prescriptions) and outcomes (e.g. blood pressure)
- Trigger warnings and reminders
- Send and receive orders, reports, and results

#### **6.2.4.7 Health Information Exchange**

- Technical and social framework that enables information to move electronically between organizations
- Reporting to public health
- ePrescribing
- Sharing laboratory results with providers

Using an EMR to read and write a patient's record is not only possible through a workstation but, depending on the type of system and health care settings, may also be possible through mobile devices that are handwriting capable. Electronic Medical Records may include access to Personal Health Records (PHR) which makes individual notes from an EMR readily visible and accessible for consumers.

Some EMR systems automatically monitor clinical events, by analyzing patient data from an electronic health record to predict, detect and potentially prevent adverse events. This can include discharge/transfer orders, pharmacy orders, radiology results, laboratory results and any other data from ancillary services or provider notes. This type of event monitoring has been implemented using the Louisiana Public health information exchange linking state wide public health with electronic medical records. This system alerted medical providers when a patient with HIV/AIDS had not received care in over twelve months. This system greatly reduced the number of missed critical opportunities.

#### **6.2.4.8 In ambulances**

Ambulance services in Australia have introduced the use of EMR systems. The benefits of EMR in ambulances include the following: better training for paramedics, review of clinical standards, better research options for pre-hospital care and design of future treatment options.

Automated handwriting recognition of ambulance medical forms has also been successful. These systems allow paper-based medical documents to be converted to digital text with substantially less cost overhead. Patient identifying information would not be converted to comply with government privacy regulations. The data can then be efficiently used for epidemiological analysis.

#### **6.2.4.9 GP2GP project**

GP2GP is an NHS Connecting for Health project in the United Kingdom. It enables GPs to transfer a patient's electronic medical record to another practice when the patient moves onto the list.

### **6.2.5 Privacy concerns**

A major concern is adequate confidentiality of the individual records being managed electronically. According to the *Los Angeles Times*, roughly 150 people (from doctors and nurses to technicians and billing clerks) have access to at least part of a patient's records during a hospitalization, and over 600,000 payers, providers and other entities that handle providers' billing data have some access.

In the United States, this class of information is referred to as Protected Health Information (PHI) and its management is addressed under the Health Insurance Portability and Accountability Act (HIPAA) as well as many local laws. The HIPAA protects a patient's information; the information that is protected under this act are: information doctors and nurses input into the electronic medical record, conversations between a doctor and a patient that may have been recorded, as well as billing information. Under this act there is a limit as to how much information can be disclosed, and as well as who can see a patient's information. Patients also get to have a copy of their records if they desire, and get notified if their information is ever to be shared with third parties.

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In the European Union (EU), several directives of the European Parliament and of the Council protect the processing and free movement of personal data, including for purposes of health care.

### **6.2.6 Technical standards**

Though there are few standards for modern day EMR systems as a whole, there are many standards relating to specific aspects of EMRs. These include:

- HL7 – messages format for interchange between different record systems and practice management systems.
- ANSI X12 (EDI) – A set of transaction protocols used in the US for transmitting health care claims related to the billing and payment of patient data.
- CEN – CONTSYS (EN 13940), a system of concepts to support continuity of care.
- CEN – EHRcom (EN 13606), a standard for the communication of information from EHR systems.
- CEN – HISA (EN 12967), a services standard for inter-system communication in a clinical information environment.
- DICOM – a standard for representing and communicating radiology images and reporting

### **6.2.7 Lack of semantic interoperability, a fundamental problem**

In the United States, there are no standards for semantic interoperability of health care data; there are only syntactic standards. This means that while data may be packaged in a standard format (using the pipe notation of HL7, or the bracket notation of XML), it lacks definition, or linkage to a common shared dictionary. The addition of layers of complex information models (such as the HL7 v3 RIM) does not resolve this fundamental issue.

### **6.2.8 The Future of Electronic Health Records – Personally Controlled Electronic Health Records**

A PCEHR is a system that proposes to store admission or event summaries in an electronic format over a large network accessible by doctors, nurses, GPs and chemists without the need for written scripts or requesting medical files from another hospital. The system proposes to record and store any health information provided by a health care professional that has agreed to be a part of the system. This allows the storage and retrieval of a lifetimes worth of clinical and demographic information of a patient that can be viewed as event summaries and reports with the appropriate authorization

#### *Review Questions*

1. Define the Medical records?
2. Explain the purpose of Medical record?
3. Explain the Different types of medical records?
4. Explain the Breathing disorders?

- To explain the purpose of Medical record.



- To explain the Different types of medical records.
- To describe the Electronic medical record.

#### Discussion Questions

Discuss the Medical records in details?

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