ICHM 204 Biophysical Chemistry

Chapter 1.The Anatomy and Physiology of the Human Body

1.0 Introduction: The Contents of the Human Body

- The human body is a very complex, wonderfully and carefully made structure
- Anatomy is the study of the structure of organism (*ana = up, temnein= to cut)*
- Physiology is the study of the functions of organisms (*Physis = nature, logos = discourse*)
- Many aspect of Anatomy and physiology is based on *Chemistry*
- All living and non living thing are regarded to as matter. Matter is anything that has mass and occupy space
- The simplest form of matter is called an **element** and we have 117 stable elements so far discovered; out of which 24 are found in the human body
- Elements are made of atoms and atoms aggregate together to form an element and elements form molecules which comes together to form cells
- Cells also aggregates to form tissues and tissues forms organs
- Organs forms a complex **system** that runs the body
- The study of the chemistry of biological system is called *biochemistry*
- Living things are composed of lifeless molecules called *biomolecules* such as water which constitute 60% of the human body
- Some of the important work of water in the body include; dissolving biomolecules, food nutrients, electrolytes (salt, acid, bases), maintaining body temperature, pH, and also providing an avenue for many complex chemical reactions taking place in the body to happen
- There are *seven classes* of biomolecules that are found in the body: *acids, bases, salt, proteins, carbohydrates, lipids and nucleic acids*

1.1 Amino Acids and Other Body Nutrients: AA is a molecule that contains a α-carbon to which a carboxylic, amino group, hydrogen and a side chain (R) is attached. An amino acid (AA) has 4 elements: C, H, N, O and some may also contain sulfur, phosphorous and iron.

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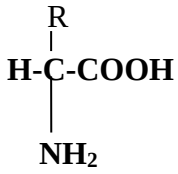
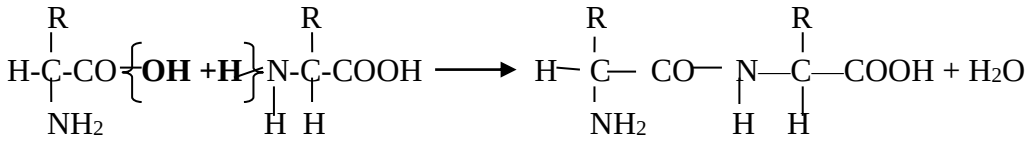
- 

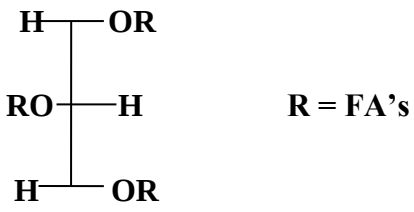
- The side chain, R, are group of atoms that are used to identify different amino acids (AA)
- There are 21different amino acids in the human body which aggregates to form proteins
- Two AA molecules join together by condensing the hydroxyl group of the carboxylic group with the hydrogen of the amino group of another AA to form a bond linking both amino acids together to form a *peptide*, the smallest unit of a protein. *The bond is called a peptide bond*

- 

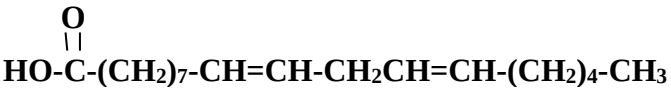
- AA aggregates together to form giant molecules (macro molecules) called *proteins*
- **Protein:** Protein is from the Greek word called *proteios* (*first order*). The function of protein includes; catalyzing reactions (lactase converts lactose to glucose and galactose), transporting substances in blood (albumin, oxygen), communication (insulin), and defense (antibodies). Proteins have a unique structure (shapes, helix) and exist in various sizes (from 5000 to > 1 million).
- **Carbohydrates:** They are compounds that consist of: C, H, O, $(CH_2O)_n$. There are three major types of carbohydrates: **monosaccharide, disaccharide, and polysaccharide.** The body's main monosaccharide is glucose. Others are fructose and galactose which are isomers of glucose. A molecule of glucose and its isomers contains six carbon atoms and are therefore called *hexose sugars* ($C_6H_{12}O_6$). Some monosaccharide's contains only five carbon atoms and are called *pentoses* (ribose and deoxyribose). They are also other sugars but they are not sweet sugars. Disaccharides and polysaccharides are condensed forms of monosaccharides minus some moles of water. Other form of carbohydrates include, starch. The major starch in the human body is *glycogen* with a molecular weight that runs into millions.
- **Lipids:** are water insoluble organic biomolecules that include *triglycerides, steroids, phosphoglyceride, prostaglandins*. The most abundant lipid in the body is the

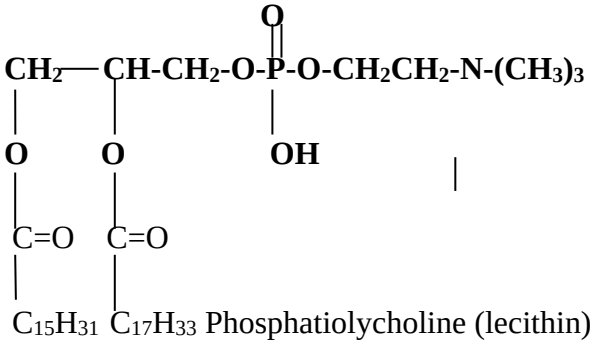
triglycerides (TG, neutral fats) which are used to produce energy for the body. TG consist of one molecule of glycerol (glycerin) condensed with three molecules of fatty acids.

- **Fatty acids (FA):** The fatty acids are long chain hydrocarbons that end with a carboxylic group at one end and a methyl group at the other end. It acts as the tail of the TG. Example includes palmitic, stearic, oleic, linoleic acids. Oleic acid is the most abundant FA in the body ($C_{17}H_{33}COOH$). FA can be saturated (palmitic acid, $C_{15}H_{31}COOH$, stearic acid, $C_{17}H_{35}COOH$) or unsaturated (oleic acid, $C_{17}H_{33}COOH$). FA with many multiple bonds are said to be polyunsaturated. Saturated fats are unhealthy but unsaturated fats are healthy because it helps to reduce production of cholesterol and keeps the heart healthy
- There are FA's that are classified as essential because the human body does not make them but they are necessary for survival: two such acids include linoleic ($C_{17}H_{31}COOH$) and linolenic ($C_{17}H_{29}COOH$)



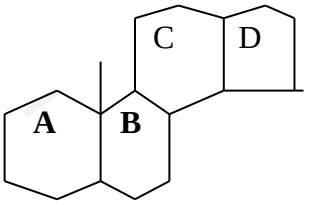
Triglyceride

- **Linoleic acid:**
- 

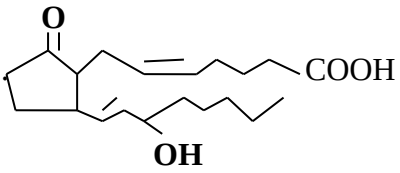
- **Phosphoglyceride:** they are lipids that contain phosphorous element as part of its structures. They are important for the structures of cell membranes
- 

Phosphatiolycholine (lecithin)

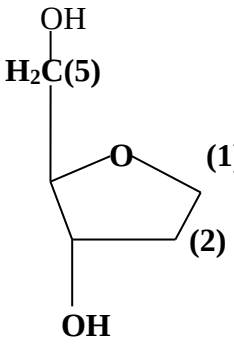
- **Steroids:** compounds with the steroid structure as their nucleus. They are large molecules with no FA's in their structure. Examples include: cholesterol, male and female sex hormones and adrenocorticoids



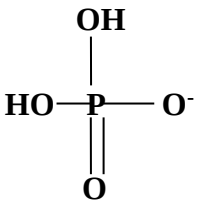
- **Prostaglandins:** are lipids containing a 20-carbon FA that contains 5-carbon ring. There are 14 types of prostaglandins in the semen alone. Others are present in many tissues and it plays a very important role in some hormones

- - 

1.2 Nucleic Acids: survival of living things including man depends on nucleic acids. There are two types of nucleic acids: Deoxyribose nucleic (DNA) and Ribonucleic acids (RNA). The nucleic acids are polymers of small molecules called nucleotides. The deoxyribonucleotide is present in DNA (structural units of DNA) and ribonucleotide in RNA (structural units of RNA). DNA consists of a pentose sugar (deoxyribose), a nitrogenous base (adenine or cytosine or thymine or guanine) and a phosphate group. RNA consists of pentose sugar (ribose) a nitrogenous base (adenine or cytosine or uracil or guanine) and a phosphate group.

- 

(1) A base is attached to carbon-1 and a phosphate to carbon-5

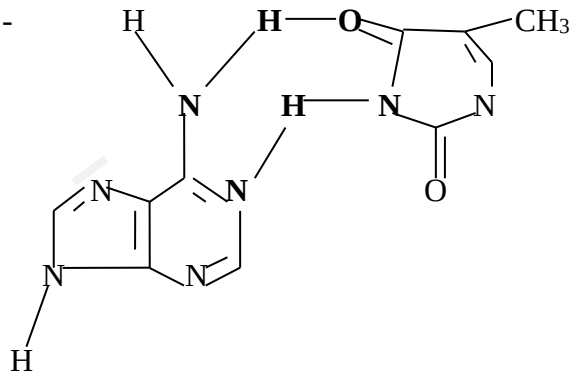
Phosphate group: 

($H_2PO_4^-$)

- Adenine and guanine are called **purine bases** and cytosine and thymine are called **pyrimidine bases**

- Linkages (polynucleotide chain) in the nucleotide is from carbon-3 of one sugar to the phosphate group and attached to carbon-5 on another sugar
- DNA has 2 very long strands of polynucleotide chain s (> 100 milli0n) while RNA has one. The strands of the DNA coil around each other to form a **double helical shape** (a spiral shape of a spring) with its phosphate group pointing outwardly while the bases points inwardly. Hydrogen bonding joins the base in one strand to another base in the other strand to form a **base pair**. Therefore, the base pairs holds (appears like steps of a staircase) together the two strands of DNA
- There are two types of base pairs in a DNA: Adenine-Thymine (A-T) and Guanine-Cytosine (G-C).
- The base pair sequence in a DNA are the same in an individual but different in other individuals

1.3 Bioenergy: The human body makes energy from the food it ingests. It makes, store and use the energy *it ma*kes from food by the process called **Catabolism** which happens in the cells.

- **Catabolism:** breaking down of complex food particles (monosaccharides, glycerol, fats etc) to smaller ones (water, carbon dioxide, nitrogenous compounds) and heat. Some of the heat is then stored again as ATP (adenosine triphosphate, used for work of muscle contraction, transportation, biosynthesis, movement) and the rest is used to warm the body.
- **Anabolism:** the opposite of catabolism
- **Biosynthesis:** Anabolism and catabolism are biosynthetic pathways that takes place in the body
- 

Adenine Thymine

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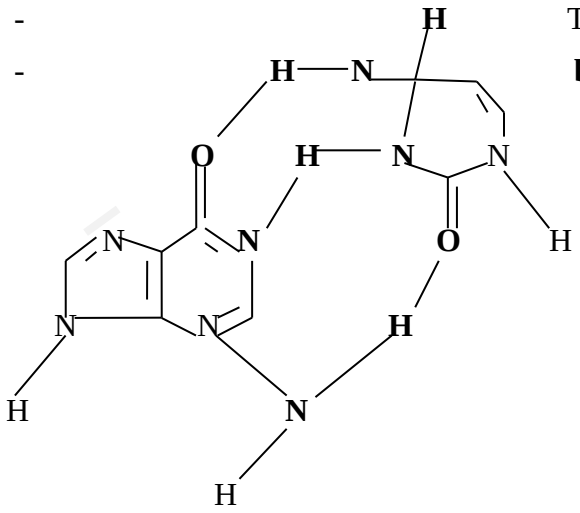

The highlighted alphabets and bond that forms the **base pair** pairing

Guanine Cytosine

ICHM 204 Biophysical Chemistry

Chapter 2 The Human Body Structure

2.1 Introduction

- The human body is made up of; cells, tissue, organ and systems. An average sized adult has >1.0 x 10^{16} cells in its body. The **cells** are the smallest unit of a living matter that is required to maintain life. Cells aggregates to form **tissues** with other nonliving intercellular matter interspersed between them. Tissues aggregates together to form **organs** to perform a specific function (heart, lungs, eyes etc). Organs organize themselves together to form a **system**. The system performs complex functions for the body.

- There are two main cavities in the body; the **ventral** and dorsal **cavity.** Both has subdivisions that houses all the internal organs of the human body

- The **ventral cavity** consists of the **thoracic** (chest) and **abdominopelvic** cavities.

- The thoracic **cavity** consists of the right and left **pleural** cavity (houses the lungs enclosed in pleural sac) and a mid-portion called **mediastinum**. Layers of fiber rap around the midiastinum separating the two pleural cavities. The heart (in pericardial sac) , trachea and bronchi (right and left), esophagus, thymus, blood vessels (thoracic aorta, superior vena cava), thoracic duct and other lymphatic vessels and nodes, nerves (phrenic and vagus) are located in mediastinum cavity.

- The **abdominopelvic cavity** consists of an upper portion called the abdominal **cavity** and a lower part called the **pelvic cavity**.

- The **abdominal cavity** contains the liver, gall bladder, stomach, pancreas, intestines, spleen, kidney, and ureters (viscerals)

- The **pelvic cavity** contains the bladder, ovaries, uterine tubes, uterus (female), prostate gland , part of vas deference, seminal vesicles (men), part of the large colon (sigmoid colon, rectum)

- **The dorsal cavity** consists of the **cranial** (houses the brain) and the **spinal cavity** (houses the spinal cord)

2.2 Organization

Everything, starting from the cell to the system is well organized in orderly and precise manner. They all work in unison and it is the most important characteristics of living things. The body structures grow with years until maturity (young adulthood) and then start to age and atrophies' and then dies.

2.3 Planes of the Body

There are different planes that are used to describe the body. These planes are shown in Table 2.1

Table 2.1 Planes of the Body

Plane	**Description**
Sagittal	A lengthwise plane running from the front to the back (divides body to right and left)
Median	Sagittal plane through the midline (divides the body to right and left halves)
Coronal or frontal	Lengthwise plane that divides running from side to side (divides the body into anterior and posterior parts)
Transverse or horizontal	Crosswise plane (divides body to upper and lower parts)

2.4 Directional Terms: Terms used in describing Body Structure

Parts of the body are located using some directional terms when the body is standing in an **anatomical position**. The anatomical position is when a body is standing erect with arms at the side and the palms turned forward (supinated position). Table 2.2

Table 2.2 Directional Terms

Directional Term	**Description**
Superior or Cranial (Upper)	Toward the head (e.g. arm)
Inferior or Caudal (lower)	Away from the head (e.g. foot)
Anterior or ventral	Front (e.g. knee cap is anterior to the leg)
Posterior or dorsal	Back (shoulder blade is posterior to the body)
Medial or mesial	Towards the midline of the body (the great toe is located at the medial side to the foot)
Lateral	Away from the midline of the body (the little toe is located at the lateral side of the foot)
Proximal	Towards or nearest the trunk or the point of origin of a part (the elbow is located at the proximal end of the forearm
Distal	Away from or farthest from the trunk or the point of origin of a part (the hand is located at the distal end of the forearm

2.5 Abdominal Regions

The abdomen is divided into nine imaginary regions in locating the abdominal organs as shown below

Right hypochondriac	epigastgric	Left hypochondriac
Right Lumbar	Umbilical	left Lumbar
Right iliac	hypogastric	left iliac

The upper horizontal line crosses the abdomen at the level of the ninth rib cartilages and the lower horizontal line crosses the abdomen at the level of the iliac crest. The vertical lines pass through the midpoints of the right and left inguinal (Poupart's) ligaments

The abdomen can also be divided into four quadrants: left upper quadrant (LUQ), Right upper quadrant (RUQ), left lower quadrant (LLQ) and right lower quadrant (RLQ)

LUQ	**RUQ**
LLQ	**RLQ**

2.6 Generalization about body function

- the body most important function is survival which include the survival of individual and the species

- Survival depends on the body maintaining homeostasis

- Homeostasis is relative constancy of extracellular fluid (blood plasma and interstitial fluid) with respect to its chemical composition, osmotic pressure, hydrogen ion concentration, and temperature.

- Homeostasis depends on the body continuously carrying out activities and responding to changes in its environment, exchanging materials between its environment and the cells,

metabolizing foods and integrating all its activities in other to maintain its internal environment constant

-Homeostasis is activated by changes in the extracellular fluid away from homeostasis. Such changes activates the sensor cells that acts by the actions of nerves or hormones to start responses that forms the homeostatic mechanism

- Homeostatic mechanism consists of responses that reverses the initial change and restore or maintain homeostasis by a negative feedback mechanism. Negative feedback mechanism causes changes in the reverse direction to the initial change that triggers homeostasis.

- Responses that make up the homeostatic mechanism are called adaptive responses because it makes the body to adapt to changes in its environment in ways that allow maintenance of homeostasis and promote healthy survival

- Body functions are the same as cell function s and it changes over time. The functions are least efficient at infancy and grow to maximum efficiency at young adulthood (developmental stages) and then start to decline after young adulthood (aging process)

Chapter 3The Anatomy of the Nervous system, Smooth and Voluntary muscles

Divisions of the Vertebrate Nervous System

- Central Nervous System-the brain and the spinal cord
- Peripheral Nervous System-the nerves outside the brain and spinal cord
- Two Division of the PNS
  - Somatic Nervous System-the nerves that convey messages from the sense organs to the CNS and from the CNS to the muscles and glands
  - Autonomic Nervous System-a set of neurons that control the heart, the intestines, and other organs

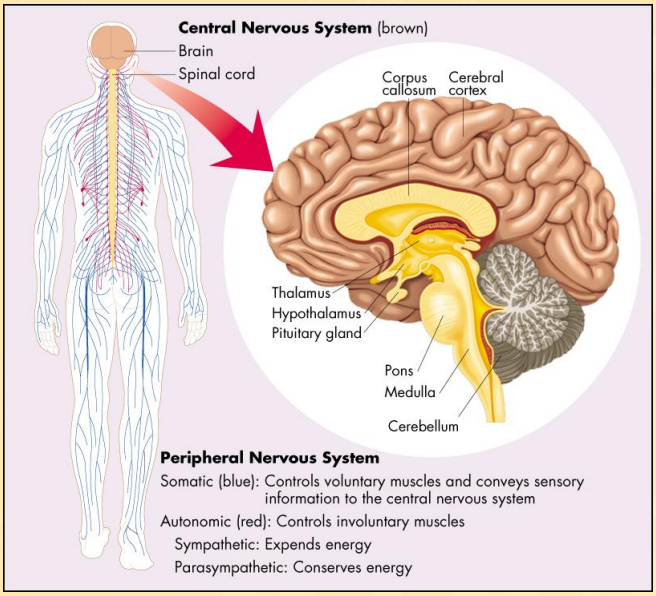

Figure 4.1 The human nervous system
Both the central nervous system and the peripheral nervous system have major subdivisions. The closeup of the brain shows the right hemisphere as seen from the midline.

Table 4.1 Anatomical Terms Referring to Directions

Term	Definition
Dorsal	Toward the back, away from the ventral (stomach) side. The top of the brain is considered dorsal because it has that position in four-legged animals.
Ventral	Toward the stomach, away from the dorsal (back) side. (*Venter* is the Latin word for "belly." It also shows up in the word *ventriloquist*, literally meaning "stomach talker.")
Anterior	Toward the front end
Posterior	Toward the rear end
Superior	Above another part
Inferior	Below another part
Lateral	Toward the side, away from the midline
Medial	Toward the midline, away from the side
Proximal	Located close (approximate) to the point of origin or attachment
Distal	Located more distant from the point of origin or attachment
Ipsilateral	On the same side of the body (such as two parts on the left or two on the right)
Contralateral	On the opposite side of the body (one on the left and one on the right)
Coronal plane (or frontal plane)	A plane that shows brain structures as seen from the front
Sagittal plane	A plane that shows brain structures as seen from the side
Horizontal plane (or transverse plane)	A plane that shows brain structures as seen from above

The Nervous System

- The Spinal Cord-part of the CNS found within the spinal column
  - The spinal cord communicates with the sense organs and muscles below the level of the head
    - Bell-Magendie Law-the entering dorsal roots carry sensory information and the exiting ventral roots carry motor information to the muscles and glands
    - Dorsal Root Ganglia-clusters of neurons outside the spinal cord

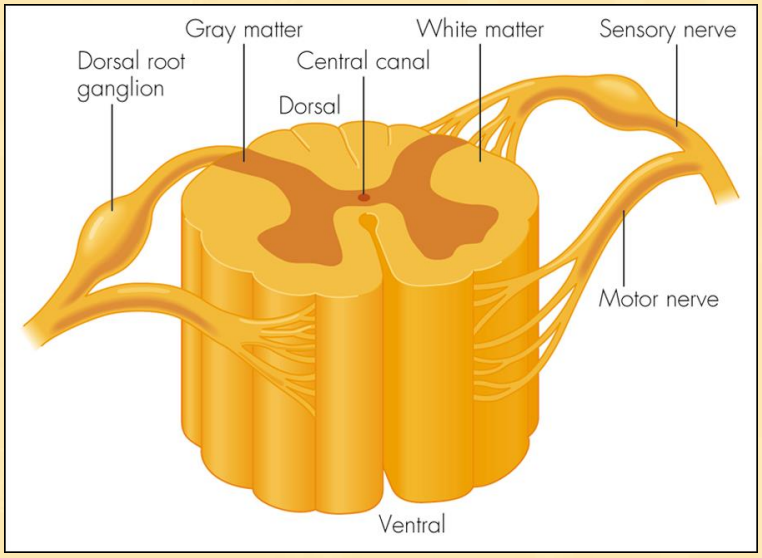

Figure 4.3 Diagram of a cross section through the spinal cord
The dorsal root on each side conveys sensory information to the spinal cord; the ventral root conveys motor commands to the muscles.

Autonomic Nervous System

- Sympathetic-prepares the body for arousal
  - Ex: increased breathing, increased heart rate, decreased digestive activity
  - Form chain of ganglia just outside spinal cord
  - Short preganglionic axons release norepinephrine
  - Long postganglionic axons release norepinephrine
- Parasympathetic-facilitates vegetative, nonemergency responses by the body's organs
  - Ex: increase digestive activity, activities opposing sympathetic system
  - Consists of cranial nerves and nerves from sacral spinal cord
  - Long preganglionic axons extend from the spinal cord to parasympathetic ganglia close to each internal organ; release norepinephrine
  - Shorter postganglionic fibers then extend from the parasympathetic ganglia in the organs; release acetylcholine

The Brain

- The Hindbrain/rhombencephalon
  - Posterior part of brain
  - Medulla-controls vital reflexes like breathing, heart beat, etc
  - Pons-Area where many axons cross from one side of the brain to the other
  - Reticular formation-control motor areas of the spinal cord and sends output to cerebral cortex increasing arousal and attention
  - Raphe system-sends axons to much of the forebrain, increasing or decreasing the brain's readiness to respond to stimuli
  - Cerebellum-control movement, shifts of attention, balance and coordination

The Brain

- The Midbrain-middle of the brain
  - Tegmentum-"roof or covering"
    - Nuclei for third and fourth cranial nerves
    - Parts of Reticular formation
    - Extensions of the pathways between the forebrain and the spinal cord or hindbrain
  - Tectum-"roof"
    - Superior Colliculus & Inferior Colliculus-important in routes of sensory information

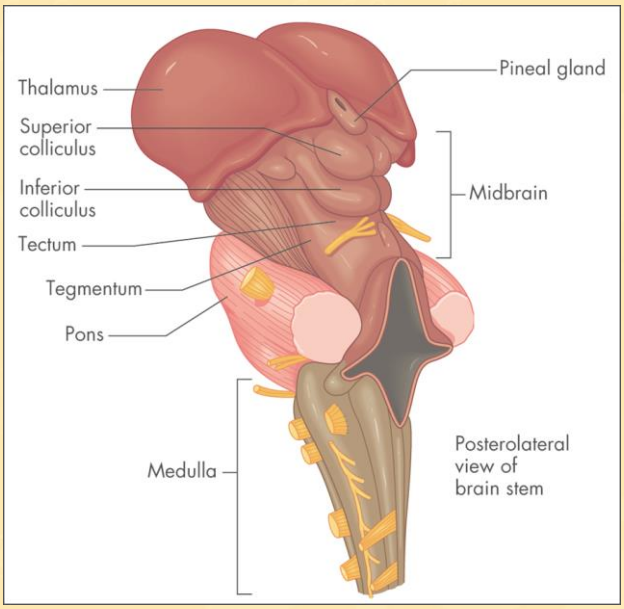

Figure 4.8 The human brain stem
This composite structure extends from the top of the spinal cord into the center of the forebrain. The pons, pineal gland, and colliculi are ordinarily surrounded by the cerebral cortex.

The Brain

- The Forebrain-most anterior and most prominent part of the mammalian brain
  - Thalamus
    - Part of the Diencephalon
    - Center of forebrain
    - Relay Station for Sensory Information
  - Hypothalamus
    - Part of Diencephalon
    - Regulates homeostasis, sexual behavior, fighting, feeding
  - Pituitary Gland
    - Endocrine gland attached to the base of the hypothalamus

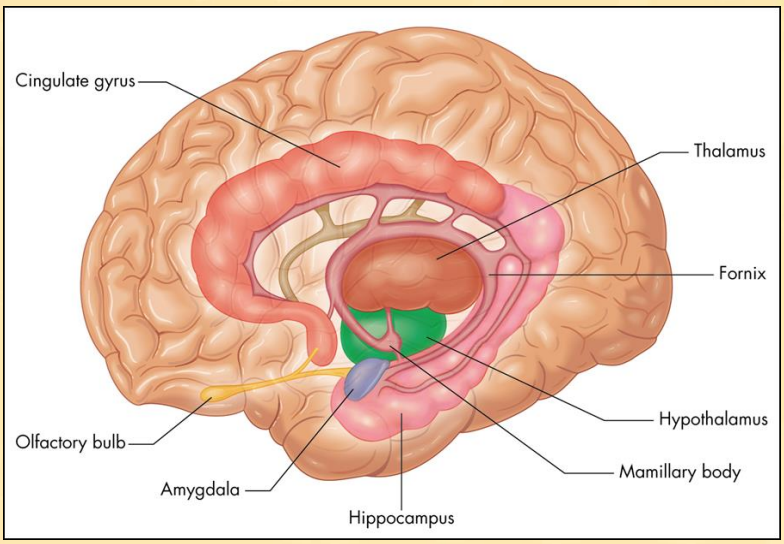

Figure 4.10 The limbic system is a set of subcortical structures that form a border (or limbus) around the brain stem

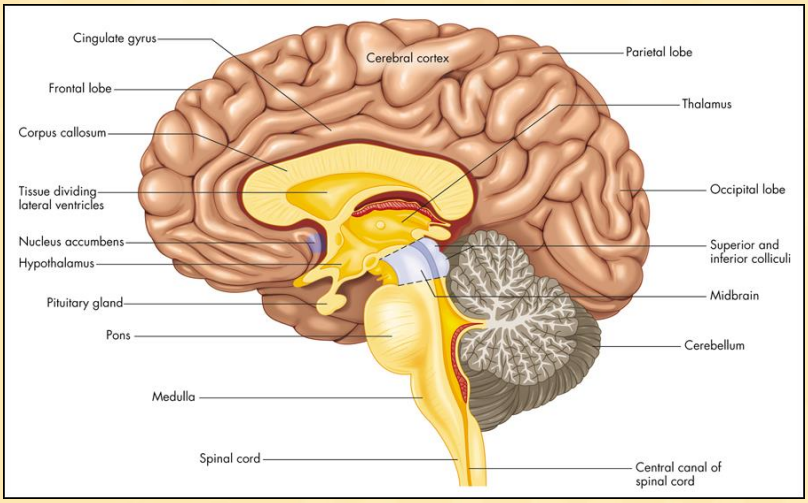

Figure 4.12 A sagittal section through the human brain

The Brain

- Forebrain Cont'd
  - Basal Ganglia
    - Responsible for motor behavior, some memory and emotional expression
  - Basal Forebrain
    - Located on the dorsal surface of the forebrain
    - Received input from the hypothalamus and basal ganglia
    - Send axons to cerebral cortex
    - Important in arousal, wakefulness, and attention
  - Hippocampus
    - Located between thalamus and cerebral cortex
    - Critical for the formation of new memory

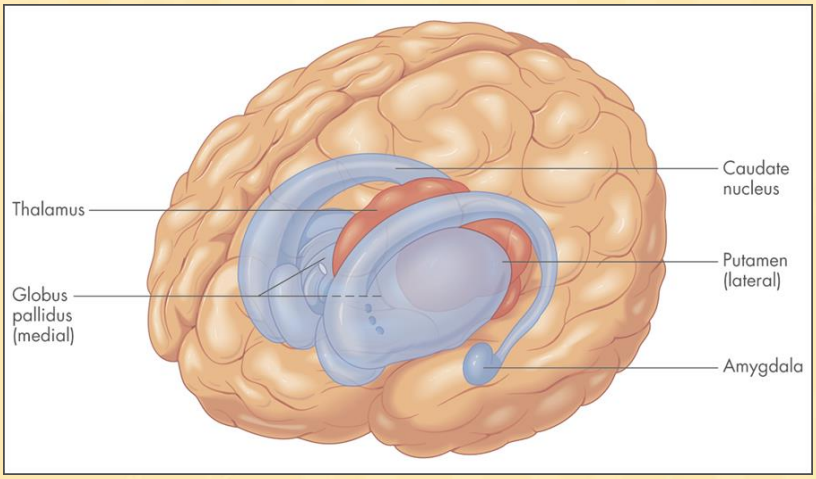

Figure 4.14 The basal ganglia
The thalamus is in the center, the basal ganglia are lateral to it, and the cerebral cortex is on the outside.

The Brain

- The Ventricles-Assists in cushioning the brain
  - Central Canal-fluid-filled channel in the center of the spinal cord
  - Ventricles-four fluid-filled cavities within the brain
  - CSF-clear fluid similar to blood plasma
    - Formed in choroid plexus
    - Flows from lateral to third to fourth ventricle to central canal or between meninges
  - Meninges-membranes that surround the brain and spinal cord

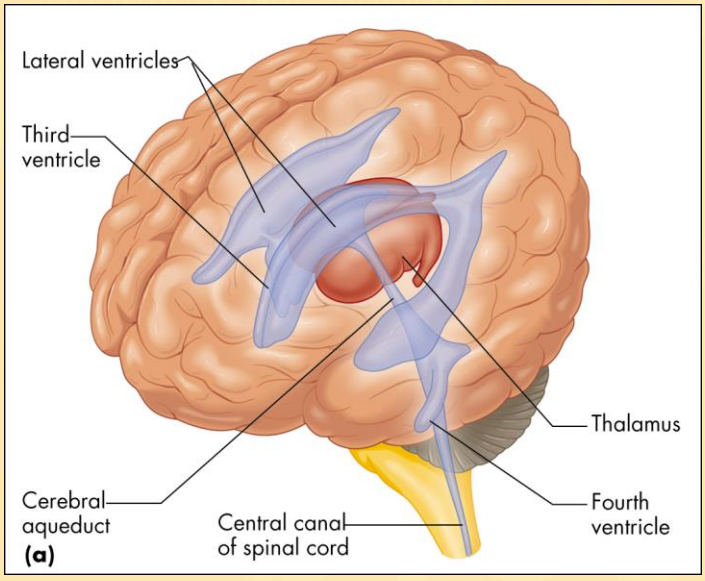

Figure 4.16 The cerebral ventricles
Diagram showing positions of the four ventricles.

The Cerebral Cortex

- Organization of the Cerebral Cortex
  - Contains six distinct layers of cells
  - Organized into columns-cells with similar properties; arranged perpendicular to the laminae
    - Cells within a given column have similar or related properties

The Lobes

- The Occipital Lobe-posterior end of cortex
  - Contains primary visual cortex
- The Parietal Lobe-between occipital love the central sulcus
  - Contains the primary somatosensory cortex-receiving touch sensation, muscle-stretch information and joint position information
- The Temporal Lobe-lateral portion of each hemisphere, near the temples
  - Contains targets for audition, essential for understanding spoken language, complex visual processes, emotional and motivational behaviors
- The Frontal Lobe-extends from the central sulcus to the anterior limit of the brain
  - Contains Primary Motor Cortex-fine movements
  - Contributes to shifting attention, planning of action, delayed response tasks as examples

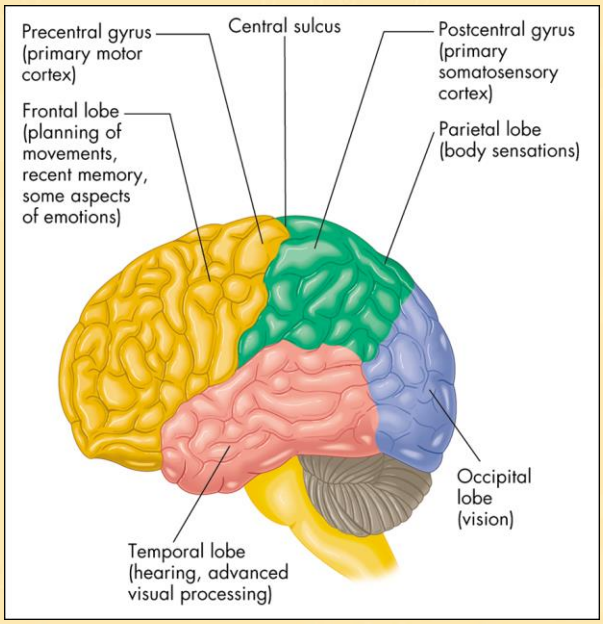

Figure 4.20 Some major subdivisions of the human cerebral cortex
The four lobes: occipital, parietal, temporal, and frontal.

Brain Function

- How Do the Pieces Work Together?
  - Does the Brain Operate as a Whole or a Collection of Parts?
    - Each brain area has a function but it can't do much by itself
  - The Binding Problem
    - The question of how the visual, auditory, and other areas of your brain influence on another to produce a combined perception of the single object
      - Synchronized neural activity?

3.2 Voluntary and Involuntary Muscles

Objectives

After completing this section, you should know:

- the structure of smooth, cardiac and skeletal muscle and where they are found
- what the insertion and origin of a muscle is
- what flexion and extension of a muscle means
- that muscles usually operate as antagonistic pairs
- what tendons attach muscles to bones

Muscles

Muscles make up the bulk of an animal's body and account for about half its weight. The meat on the chop or roast is muscle and is composed mainly of protein. The cells that make up muscle tissue are elongated and able to contract to a half or even a third of their length when at rest. There are three different kinds of muscle; smooth, cardiac and skeletal muscle.

Smooth muscle

Smooth or Involuntary muscle carries out the unconscious routine tasks of the body such as moving food down the digestive system, keeping the eyes in focus and adjusting the diameter of blood vessels. The individual cells are spindle-shaped, being fatter in the middle and tapering off towards the ends with a nucleus in the centre of the cell. They are usually found in sheets and are stimulated by the non-conscious or autonomic nervous system as well as by hormones

Cardiac muscle

Cardiac muscle is only found in the wall of the heart. It is composed of branching fibres that form a three-dimensional network. When examined under the microscope, a central nucleus and faint stripes or striations can be seen in the cells. Cardiac muscle cells contract spontaneously and rhythmically without outside stimulation, but the pacemaker coordinates the heart beat. Nerves and hormones modify this rhythm.

Skeletal muscle

Skeletal muscle is the muscle that is attached to and moves the skeleton, and is under voluntary control. It is composed of elongated cells or fibers lying parallel to each other. Each cell is unusual in that it has several nuclei and when examined under the microscope appears striped or striated. This appearance gives the muscle its names of striped or striated muscle. Each cell of striated muscle contains hundreds, or even thousands, of microscopic fibers each one with its own striped appearance. The stripes are formed by two different sorts of protein that slide over each other making the cell contract (see Figure 3.1).

Figure 3.1 - A striped muscle cell

3.3 Muscle contraction

Muscle contraction requires energy and muscle cells have numerous mitochondria. However, only about 15% of the energy released by the mitochondria is used to fuel muscle contraction. The rest is released as heat. This is why exercise increases body temperature and makes animals sweat or pant to rid them of this heat.

What we refer to as a muscle is made up of groups of muscle fibers surrounded by connective tissue. The connective tissue sheaths join together at the ends of the muscle to form tough white bands of fiber called **tendons**. These attach the muscles to the bones. Tendons are similar in structure to the **ligaments** that attach bones together across a joint (see Figures 3.2a and b).

Remember:

Tendons Tie muscles to bones and **Ligaments Link** bones at joints

3.4 Structure of a muscle

A single muscle is fat in the middle and tapers towards the ends. The middle part, which gets fatter when the muscle contracts, is called the **belly** of the muscle. If you contract your biceps muscle in your upper arm you may feel it getting fatter in the middle. You may also notice that the biceps is attached at its top end to bones in your shoulder while at the bottom it is attached to bones in your lower arm. Notice that the bones at only one end move when you contract the biceps. This end of the muscle is called the **insertion**. The other end of the muscle, the **origin**, is attached to the bone that moves the least

Antagonistic muscles

Skeletal muscles usually work in pairs. When one contracts the other relaxes and vice versa. Pairs of muscles that work like this are called **antagonistic muscles**. For example the muscles in the upper forearm are the biceps and triceps (see Figure3.3). Together they bend the elbow. When the biceps contracts (and the triceps relaxes) the lower forearm is raised and the angle of the joint is reduced. This kind of movement is called **flexion**. When the triceps contracts (and the biceps relaxes), the angle of the elbow increases. The term for this movement is **extension**.

When you or animals contract skeletal muscle it is a voluntary action. For example, you make a conscious decision to walk across the room, raise the spoon to your mouth or smile. There is

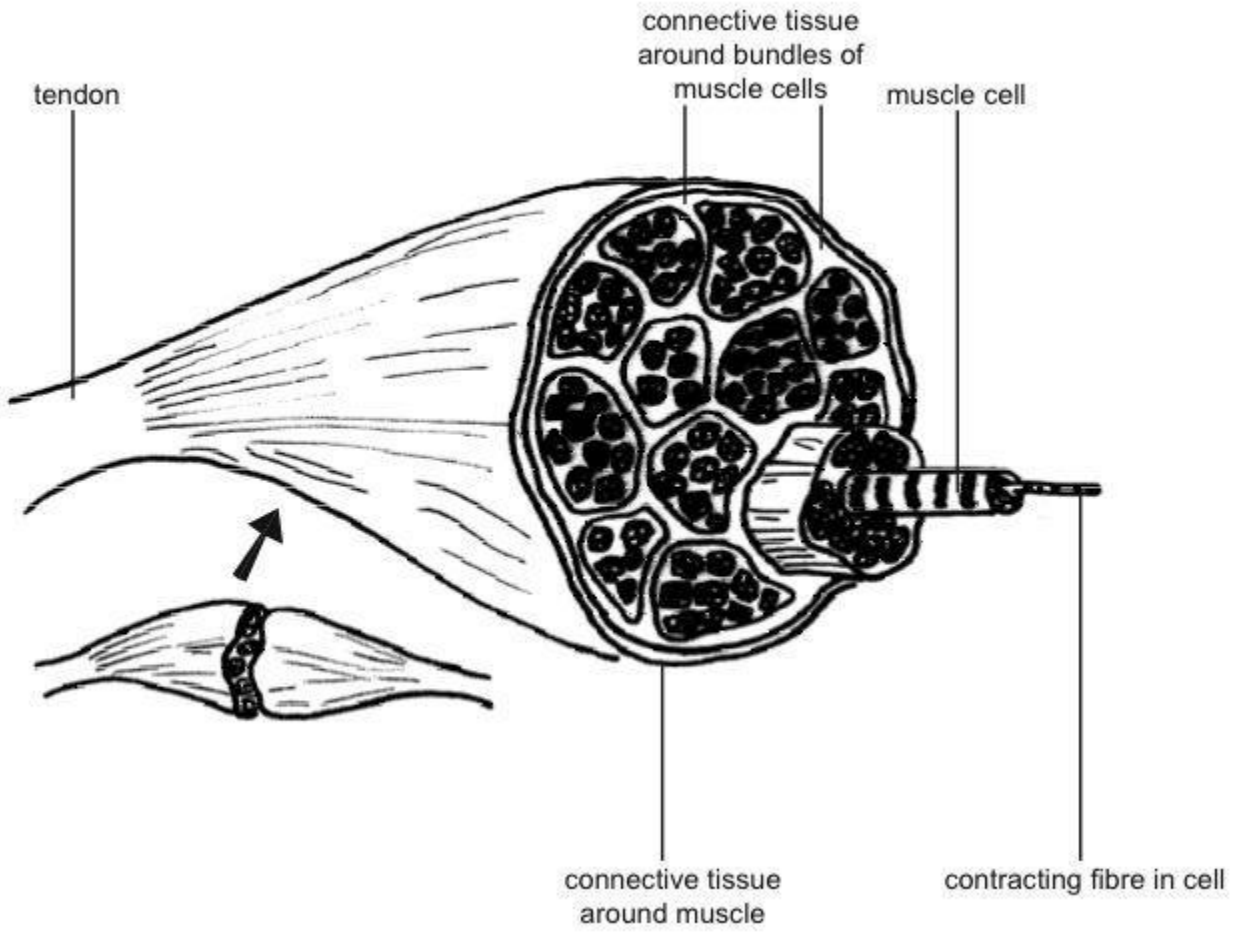

Figure 3.2 a and b - The structure of a muscle

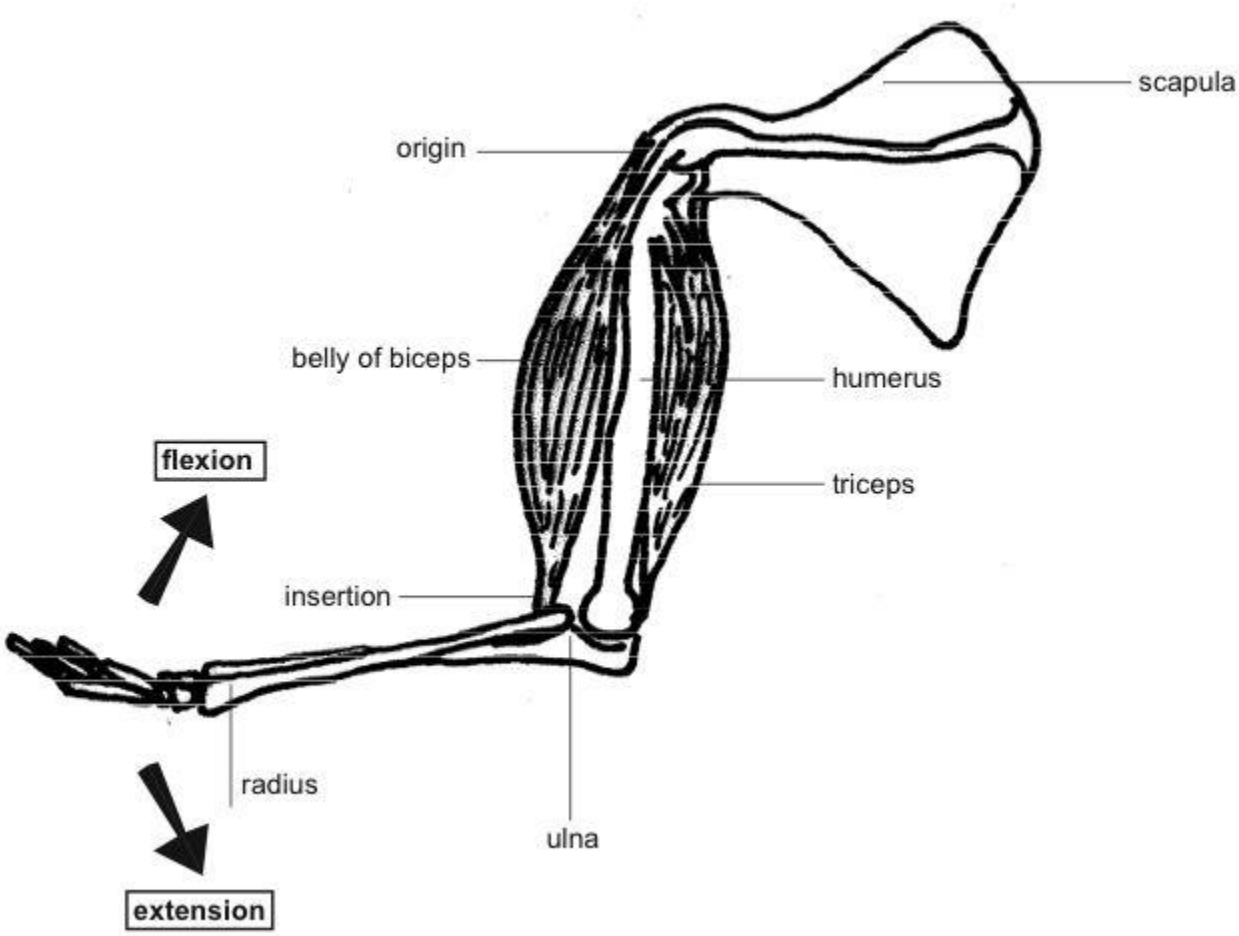

Diagram 3.3 - Antagonistic muscles, flexion and extension

Summary

- There are three different kinds of muscle tissue: **smooth muscle** in the walls of the gut and blood vessels; **cardiac muscle** in the heart and **skeletal muscle** attached to the skeleton.

- **Tendons** attach skeletal muscles to the skeleton.
- **Ligaments** link bones together at a joint.
- Skeletal muscles work in pairs known as **antagonistic pairs.** As one contracts the other in the pair relaxes.

- **Flexion** is the movement that reduces the angle of a joint. **Extension** increases the angle
- however, another way in which contraction of muscles attached to the skeleton happens that is not under voluntary control. This is during a **reflex action**, such as jerking your hand away from the hot stove you have touched by accident. This is called a **reflex arc**

Test Yourself

1. What kind of muscle tissue :
a) moves bones:
b) makes the heart pump blood:
c) pushes food along the intestine:
d) makes your mouth form a smile:
e) makes the hair stand up when cold:
f) makes the diaphragm contract for breathing in:

2. What structure connects a muscle to a bone?

3. What is the insertion of a muscle?

4. Which muscle is antagonistic to the biceps?

5. When you flex your knee what movement are you making?

6. When you extend your ankle joint what happens?

1. What kind of muscle tissue:

a) *Skeletal muscle* moves bones.
b) *Cardiac muscle* makes the heart pump blood.
c) *Smooth muscle* pushes food along the intestine.
d) Smiling is a voluntary action (usually!) so *skeletal muscle* is involved.
e) You cannot control "Goosebumps" so the muscles involved are *smooth muscles*.
f) Although breathing seems to be involuntary most of the time it is possible to control it voluntarily so the diaphragm (the main breathing muscle) is a *skeletal muscle*.

2. What structure connects a muscle to a bone?

A *tendon* connects a muscle to a bone.

3. What is the insertion of a muscle? *The insertion of a muscle is the end attached to the bone that moves most when the muscle contracts*.

4. Which muscle is antagonistic to the biceps?

The triceps is the muscle that forms the other half of the antagonistic pair with the biceps.

5. When you flex your knee what movement are you making?

When you flex your knee you bend your knee.

6. When you extend your ankle joint what happens?

When you extend your ankle joint you point your toes.

Chapter 4 Introduction on pharmacology, Classification of drugs

4. 1 CAUSES OF DISEASE

There are nine major causes of disease. Frequently a disease may be produced by a combination of these causes, or the same disease may be caused by different factors in different patients, or the cause may be unknown (Idiopathic).

a. **Prenatal Influences**: By this is meant those factors which may operate before birth to produce disease in the offspring; factors may be manifested at birth (congenital disease) or may not become obvious until later in life

   (1) Heredity: Among prenatal factors, one influence is heredity. A disease may be genetically transmitted from a parent to offspring. The parents who transmit the disease to their offspring may or may not have the disease themselves. Examples of some hereditary diseases are hemophilia and congenital dislocation of the hip.
   (2) Congenital influence. Diseases affecting the mother while she is pregnant with the baby may adversely affect the offspring. For example, some diseases may be transmitted directly to the baby via the bloodstream, as is often seen in the case of syphilis in the mother. Alternatively, the pregnant woman may have a disease such as German measles, which interferes with the normal development of the child in the uterus (in utero), although, the child does not acquire the disease. Malnutrition in the mother could result in a poorly nourished baby, which could also interfere with the normal development of the child.
   (3) Mechanical. Purely mechanical factors are also felt to be responsible for some abnormalities present at birth. Abnormal positioning of the baby in utero is felt to be occasionally responsible for wryneck; torsion or twisting of the umbilical cord would limit the blood and food supply to the baby, and dire results could occur. Any defect or disease present at the time of birth is called a congenital disease or condition. Injuries or effects sustained during the process of being born may be included here

b. **Parasites**. Parasites are organisms that live on or within the body of the man or any other living organism, and at the expense of the one parasitized. Parasites may live on the surface of the skin (ectoparasites), or they may enter the body through the skin, the respiratory tract, the gastrointestinal tract, or the genitourinary tract where they may enter the bloodstream and be carried to distant parts of the body. If they live inside the body, but outside the cells, they are called extracellular endoparasites; if they enter the body's cells, they are called intracellular endoparasites. They all cause disease by interfering with the tissue and organ functions; they accomplish this by elaborating toxins, or poisons; by

causing inflammation, or irritation; by producing enzymes which destroy tissue; and by causing mechanical blockage of function.

(1). Viruses: These are the smallest agents known to produce disease; whether they are living organisms or complex chemical compounds is not known. They are known to be intracellular endoparasites that cause such common diseases in man as poliomyelitis, common cold, influenza, measles, mumps, chickenpox, smallpox, hepatitis, encephalitis, warts, rabies, yellow fever, and lymphogranuloma venereum.

(2) Rickettsiae: These organisms are larger than viruses, but are still very small intracellular endoparasites. These organisms are transmitted to man by mites, ticks, fleas or lice, and they produce Rocky Mountain spotted fever, typhus (epidemic and endemic), scrub typhus (tsutsugamushi fever), Q fever, and Rickettsialpox

(3) Bacteria: Bacteria are minute, one-celled, organisms that may occur alone or in large groups called colonies. Significant bacteria can be divided by their shape into three main groups.
(a) Cocci: Cocci are round, one-celled bacteria. The primary members of this group are staphylococci, which group themselves in clusters; streptococci, which arrange themselves in chains; and diplococci, which arrange themselves in pairs. All are pyogenic (produce pus).
(b) Bacilli: Bacilli are rod-shaped; however, they vary from straight to irregular-curved and branched shapes. They cause such common diseases as typhoid fever, diphtheria, tuberculosis, and leprosy.
(c) Spirochetes: Spirochetes are spiral-shaped and can move or twist. Spirilla and Treponema pallidum are examples. The latter cause's syphilis
(4) Fungi: These extracellular endoparasites or ectoparasites are larger and higher in the scale of plant life than are the bacteria. They include the yeast and molds, and produce infections of the skin such as ringworm, and infections of the mucous membranes such as thrush. Some attack internal organs, especially the lungs and central nervous system, very often with disastrous results.
(5) Protozoa: These are one-celled animal parasites (either extracellular or intracellular) that cause such common diseases as malaria and amoebic dysentery.
(6) Metazoa: These many-celled, larger animals include the helminthes (worms) such as the ascaris, the hookworm, the pinworm, the tapeworms, and the flukes, as well as the arthropods (mites, lice, and so forth.).

(c) **Intoxicants:** Intoxication is the process of taking any chemical substance that causes disease or injury into the body. Many substances are very useful in small amounts, and do not cause intoxication; but the same substances may be very toxic in larger amounts, and result in severe illness or death.

(d) **Trauma:** Trauma may be defined as injury sustained by the body as the result of a physical agent or force. The physical agents that may produce trauma or injury of the body are: (1) *Light*: In excessive amounts, light can cause temporary blindness (2) *Heat*: Excessive heat can cause burns of the body, heat cramps, heat exhaustion, or heatstroke (3) *Cold:* Cold is absence or deficiency of heat. Exposure to low temperatures can result in frostbite and other cold injury.
(4) *Electricity*: One can sustain burns, electric shock, or both when exposed to this agent.

(5) *Ionizing radiation*: Excessive exposure to x-rays or to radioactive elements can produce burns, radiation sickness, malignancies, cataracts of the eye, and genetic changes.
(6) *Mechanical forces*: These agents produce contusions, abrasions, lacerations, fractures, sprains, and strains.
(7) *Sound*: Exposure to excessive noise can cause temporary or permanent deafness to certain wavelengths.

(e) Circulatory Disturbances: Any interference with the blood flow to a portion of the body results in a circulatory disturbance: (1) Ischemia: A decrease in the normal diameter of an artery supplying a portion of the body results in a decrease in the amount of blood that flows to the part. The area becomes more pale and colder than normal, and is said to be ischemic (2) *Thrombosi:*. Whenever a vessel wall becomes diseased, the blood tends to collect at the diseased or injured site and form a thrombus (clot). The presence of an intravascular blood clot is called thrombosis. (3) *Embolism*: Portions of a thrombus may break loose, and then travel freely in the bloodstream until stopped by a vessel too small for the particle to pass through; or foreign particles, such as air bubbles or fat globules, may be introduced into the bloodstream and travel freely until stopped by a smaller vessel. These foreign particles are known as emboli. The process of obstruction or occlusion of a blood vessel by a transported foreign material is known as embolism (4) *Gangrene*: When an extremity or portion thereof loses its arterial blood supply as the result of thrombosis, embolism, trauma, or from any other cause, a massive area of the tissue dies, and is said to have undergone gangrene, or to have become gangrenous (5) *Infarction:* Death of the tissue of an organ or portion thereof as the result of the loss of its blood supply is known as infarction. The necrotic (dead) area itself is called an infarct (6) *Hemorrhage*: This is the loss of blood

(f) Neuropsychiatric Disturbances: (1) *Organic disorders:* Injury or disease of the nervous system tissue may result in the loss of the nerve supply to a particular part of the body. Therefore, because of loss of enervation, secondary changes in the tissue occur, such as atrophy. In addition, the normal functions may become paralyzed, and there may be loss of sensation and other changes (2) *Functional disorders:* Disturbances of the mind or psyche may produce neuroses, psychoses, or character and behavior disorders. Such disturbances may or may not be inherited; the environment, childhood experiences, and many other factors have a bearing on the production of psychiatric disturbances.

(g) Mechanical Disturbances: Certain static mechanical abnormalities may result in disease within the body. For example, volvulus or twisting of the intestine on itself, torsion of the spermatic cord, strangulation of a hernia, and intussusceptions, are all often on a purely mechanical basis.

(h) Disorders of Metabolism, Growth, or Nutrition: Metabolism has to do with the total chemical cycle of converting substances into forms that are usable to the body. Metabolism occurs in two phases (1) *Anabolism*: In anabolism, foodstuffs are broke down (digested) and reconverted into compounds which can be utilized as energy, or as building blocks for new tissue cells and substances. In anabolism, living tissue is manufactured from non-living substances. This results in growth or replenishment. (2) *Catabolism*: Catabolism is the breaking down of the body's complex substances by wear, tear, and age into waste products of simpler composition for

elimination. Metabolism and growth then are dependent on the body's receiving enough of the proper foodstuffs in order to supply its needs, in other words, on proper nutrition. Metabolism and growth are further regulated by the vitamins and hormones. The hormones are supplied by the ductless glands of the body (the pituitary, thyroid, parathyroid, pancreas, adrenals, and gonads), and any disorder of these glands will profoundly disturb growth and metabolism. The vitamins are supplied by the diet; if the diet or nutrition is unsatisfactory, disturbances in growth and metabolism can result also. Therefore, metabolism, growth, and nutrition are closely related to one another.

(i) Neoplasms: Normally, the body grows by multiplication of its cells. At first, in the embryo, these cells are all alike or undifferentiated. However, as they multiply, they come under the influence of certain factors and take on different forms and different functions to make up the different tissues, organs, and systems of the body (that is, they become differentiated). This growth and differentiation is a slow, methodical, controlled process. However, some cells may not differentiate entirely, but for some unknown reasons, retain varying degrees of undifferentiating, break free of their growth control, and form a new growth (neoplasm) or tumor. Tumors cause disease by interfering with the function of normal cells, tissues, and organs. They may cause pressure on an organ so that its normal cells are destroyed or its blood supply is shut off. A tumor may fill the cavity of an organ so that the organ wall cannot contract properly. The tumor may also use up the nutritive materials taken into the body so that there is not enough for the normal tissues. Tumors are of two types: benign and malignant: (1) *Benign:* These are more slowly growing, the cells are more differentiated, the tumor is well separated from the surrounding tissues by its capsule, and can usually be completely removed surgically
(2) *Malignant:* These are more rapidly growing with very little growth control, and the cells are more primitive or undifferentiated. The cells of the tumor infiltrate or grow between the normal tissue cells, and are much more difficult to remove surgically. Because of this, the malignant tumor tends to recur and tends to metastasize or spread via the blood and the lymph vessels. The common term for malignant tumors is cancer. The medical profession speaks of carcinoma when the malignant tumor arises from tissue that covers the surface of the body, lines a hollow structure, or forms glands, and sarcoma when the malignant tumor arises from any other tissue in the body such as fatty, muscular, bony, or fibrous tissue.

(j) Idiopathic (Unknown) Causes: There are many diseases of known etiology. The affected organ and effective treatment are often known, however, the cause and the mechanism through which the disease disrupts the body's functions remain unknown.

4.2 TREATMENT OF DISEASE AND INJURY

4.2.1. Patients who have disease or injury must be properly diagnosed and treated. The physician is responsible for these functions; however, the physician may delegate the accomplishment of some of the treatments to other members of the medical team (that is, physicians' assistants and physical therapists). In general, all types of treatment may be classified as either preventive or corrective.

4.2.2 PREVENTIVE TREATMENT

Preventive treatment includes all measures used to prevent disease. (a) Preventive procedures include sanitary measures such as cleanliness, proper waste disposal, inspection of food and food handlers, isolation diseased individuals, aseptic surgical technique, and the use insecticides of and rodenticides to control vectors of disease. (b) Another preventive measure is immunization. Active immunity is the result of a direct introduction into the individual's body of an antigenic preparation (frequently bacteria or viruses) so that an individual produces his own antibodies that defend him against the particular antigen introduced. Passive immunity is produced by injecting serum-containing antibodies into an individual. This blood serum may be from animals or humans in which the antibodies were produced by an active immunity process. c. A third preventive measure consists of preventive psychiatry and mental health work, in which the individual or his environment is manipulated in a manner to prevent excessive mental stress.

4.3 CORRECTIVE/SYMPTOMATIC TREATMENT

People who have some disease or condition want to receive prompt medical treatment. Many people believe that the use of prescribed medications is the only way to ensure that a disease or condition will be cured or improved. The use of drugs does have an important role in the treatment of disease; however, other treatment methods are available. For example, rest, radiotherapy, and physical therapy are very useful in the treatment of certain conditions. In many cases, various treatment methods are used to benefit the patient. (a) *Rest* prevents overwork of a diseased organ and includes more than freedom from physical work; a patient must have mental rest also. (b) *Diet* is of extreme importance both in the prevention of disease and in medical care. An adequate intake of proteins, carbohydrates, fats, vitamins, and minerals is necessary in the treatment of all patients. Patients with fever generally require increased amounts of all dietary constituents. Patients with certain diseases require diets in which the various dietary constituents are carefully controlled. One example of a special diet of this type is that for diabetes mellitus, in which the amounts of protein, fat, and carbohydrates must be individually regulated. (c). Nursing care is another essential part of medical care. In addition to doing technical procedures such as administering drugs, nursing service personnel watch for the appearance of changes in the patient's condition. Frequently the personalities of such personnel will be an important factor in promoting the patient's morale, securing his cooperation, and fostering in him a desire to get well.

4.4 Pharmacology

4.4.1 Introduction: Pharmacology is the study of the actions and effects of drugs on living systems and their therapeutic uses.. A drug may be broadly defined as any substance or group of substances, which affects living tissue. However, the term may be specifically defined as any substance used to prevent, diagnose, or treat disease, prevent pregnancy or provide palliative (relief but not cure disease processes) relief. The administration of drugs could be done locally or through the systemic process. Local administration is done at a specific point by administering drugs such as ointments, creams anesthetics. The systemic administration is through blood circulation.

4.4.2 Sources of Drugs

Drugs can be obtained from different sources such as

(a) Plants: Ephedrine has been used to treat nasal congestion by the Chinese for ages. Belladonna (or Deadly Nightshade), is the source of atropine and scopolamine causes the pupils of the eye to dilate and appear black and was a favorite poison in the middle ages. Opium, a product obtained from the poppy plant, is mentioned in early Greek mythology as a sleep producer. Other plant drugs include alkaloids such as morphine is used to treat pain

(b) **Animals:** Animals provide us with large supplies of natural products like hormones. Insulin, used in the treatment of diabetes mellitus, used to be obtained from the pancreas of pork, beef, and even fish. Heparin, a potent anticoagulant, is obtained from the intestinal and lung mucosa of beef and hogs

(c) **Minerals:** Minerals, such as iron and iodine, are essential for normal growth and development. An old remedy for pallor (a very pale complexion) was the water used to cool horseshoes in the blacksmith shop. This water contained small amounts of iron in solution.

(d) d. **Microorganisms:** You are probably aware of the fact that microbes can cause disease and/or death. Fortunately, some microorganisms can be used to produce antibiotics. These antibiotics can be used to kill or stop the growth of other microbes. Furthermore, chemically treated or killed microorganisms can be used to produce vaccines

(e) **Synthetics:** Most drugs today are synthetically made. Examples of synthetically produced drugs are aspirin and the sulfa drugs.

4.4.3 Three Areas of Pharmacology

There are three areas of pharmacology

(a) Pharmacokinetics: Process, by which the body absorbs, distribute, metabolize and excrete drugs from the body. For example,

(b) Pharmacodynamics: process by which the body uses drugs. For example, diabetics use insulin to reduce the level of blood glucose. Pharmacodynamics studies how the insulin reduces blood glucose.

(c) Pharmacotheraputics: process by which the body responds to drugs. For example, using Demerol has a side effect of nausea and vomiting, hence, an antiemetic is prescribed along with Demerol

Side effects are unintended symptoms a drug has on the body while *adverse effect* are unintended symptoms that is so severe that it requires reducing dosage or stopping further administration of the drug.

4.4.4 Understanding and Identifying of Various Drugs

Drugs generally have different names and therefore, drugs are classified as follow:

(a) Chemical name: This is a number or letter that represents the chemical make-up of a drug. For example, *aspirin* chemical name *methyl salicylate*.

(b) *Generic name:* this is the name given to the drug by the company that developed it. It remains the same even after the patent has expired and other companies can market the drug. For example, *aspirin is also called Ecotrin* by another manufacturer

(c) Trade or brand name: This is the name given to the drug by any company marketing the drug. It may change after the patent is released.

4.4.5 Terms and Definition of Terms used in Pharmacology

a. **Drug:** A drug may be broadly defined as any substance or group of substances, which affects living tissue. However, the term may be specifically defined as any substance used to prevent, diagnose, or treat disease or to prevent pregnancy.
b. **Pharmacology:** Pharmacology is the study of the actions and effects of drugs on living systems and their therapeutic uses.
c. **Bioavailability**. Bioavailability refers to the amount of drug that is available to the target tissue after the drug has been administered. In other words, it is the amount of the drug available to produce the desired effect.
d. **Pharmacognosy:** Pharmacognosy is the study of the characteristics of natural drugs.
e. **Toxicology:** Toxicology is the science of poisons. Toxicology includes the origin, chemical properties, toxic actions, detection, and proper antidotal therapy of poisons.
f. **Posology:** Posology is the science of dosage. It deals with the amount of drug necessary to produce a desired physiological, therapeutic, or prophylactic effect.
g. **Usual recommended dose:** The usual recommended dose is the amount of drug that will ordinarily produce the effect for which the drug is intended. In addition to the usual recommended dose, the usual dosage range is indicated for many drugs in the United States pharmacopoeia/National Formulary. The usual dose range provides a guide in deciding whether the prescriber should be consulted about the correctness of the prescribed dose.
h. **Minimum dose**: The minimum dose is considered the smallest dose of drug that produces the therapeutic effect
i. **Maximum dose:** The maximum dose is considered the largest dose of a drug that can be safely administered.
j. **Toxic dose**: The toxic dose of a drug is considered the amount of a drug that will produce noxious (harmful) effects.
k. **Lethal dose**: The lethal dose of a drug is the amount of substance that will cause death. The term "LD50" is always written in association with lethal dose. LD50 means that 5O percent (or 1/2) of the animals given that amount of drug died. The LD50 of a drug should be used as a guide, rather than an absolute number.
l. **Single dose**: The single dose of a drug is the amount of that substance to be taken at one time.
m. **Daily dose**: The daily dose of a drug is the amount of that substance to be taken in a 24-hour period. The daily dose of a drug is into several individual doses.
n. **Maintenance dose**: The maintenance dose of a drug is the amount of that substance taken to maintain or continue a desired therapeutic effect. Some drugs must be taken on a daily basis in order to maintain the desired therapeutic effect. For example, drugs used to treat high blood pressure often must be taken daily to maintain a lowered blood pressure.

o. Loading dose: The first dose given of a drug to achieve maintenance drug levels quickly. Drugs that are given only one or two times a day may take two or three days to reach a maximum effect. To overcome this time, a loading dose is given to achieve the levels associated with the maximum effect more quickly. Loading doses are often used in very sick patients.

p. The following abbreviations indicate to the medical staff that the drug is a time-releasing drug: DUR-duration, SR-sustained release, CR-continuous release, SA-sustained action, Contin-continuous release, LA- long acting

4.4.6 FACTORS WHICH INFLUENCE DRUG DOSAGE EFFECTS

Many factors influence how a dose of a particular drug will affect a patient. Since not all patients are the same size, weight, age, and sex, it would be wise to consider how these factors might influence how much drug a person should receive and the effect(s) that drug might have on the patient. The usual recommended adult dose of medication, as found in standard references, is based on the assumption that the patient is a "normal" adult. Such a "normal" (or average) adult is said to be 5 feet 9 inches (173 centimeters) tall and weigh 154 pounds (70 kilograms). However, many people do not fit into this category. Therefore, the following factors should be considered when patients receive drugs:

a. **Weight.** Obese (overweight) patients may require more medication than thin patients may because the drug has more tissue to which it can go. The dosage of many drugs is calculated on a weight basis. For example, a person might be prescribed a drug that has a dosage of 5 milligrams of drug per pound of patient body weight.

b. **Surface Area.** A person's height and weight are related to the total surface area of his body. The "normal" (average) adult has a body surface area of approximately 1.73 square meters. A nomogram is used to determine the surface area of a patient. The dosage of certain drugs (for example, the anticancer drugs) is determined by the patient's body surface area.

c. **Age**. As a rule, the very young and the elderly require less than the normal adult dose of most medications. Part of this requirement for less medication is due to the altered metabolism of the drug. Since body enzyme systems greatly influence drug metabolism, considering the differences in these enzyme systems based upon age is important. In the infant, some enzyme systems are not yet fully developed. On the other hand, the enzyme systems of the elderly may not function as well as in the past. Although several formulas are available for calculating a child's dose of medication, the two most accepted methods are those based upon the patient's weight (that is, milligrams per kilogram of body weight) or body surface area (that is, milligrams per square meter of surface area).

d. **Sex.** Physiological differences between the sexes may influence the dose or the requirement for drugs. Since females have proportionately more fat tissue than males, drugs, which have a high affinity (likeness) for fat, may require larger doses in females. Moreover, estrogen and testosterone, two sex hormones, can affect the patient’s rate of metabolism which can, in

turn, influence the rate at which a drug is metabolized, absorbed, or excreted from the body. The requirement for iron is much higher in the female than in the male, because of the loss of blood in each menstrual cycle.

e. **Genetic Factors**. Various racial and ethnic groups have differences in some metabolic and enzyme systems which can affect the utilization of drugs.
f. **Physical Condition of the Patient**. The physical condition of the patient influences how a particular drug might act. Consequently, the weak or debilitated patient might require smaller doses of some medications. Patients who are in extreme pain may require larger doses of analgesic agents than those patients who are in less pain.
g. **Psychological Condition of the Patient.** The patient's attitude about his disease or treatment can influence the effectiveness of a drug. It has been shown that patients receiving placebo tablets (tablets that contain no active ingredient) sometimes have the same side effects as the patients who were taking tablets of the same appearance that did contain the drug. In some cases, both types of patients (those taking the placebo and those taking the drug) recovered at the same time.
h. **Tolerance**. The therapeutic effects of some drugs are lessened in individuals after the drugs have been used for long periods. Thus, an individual who has used such a drug for a long time needs larger doses of the drug than he did when he first began to take it in order to obtain the same effect. This effect is called tolerance. Persons who use opium, heroin, cocaine, amphetamines, and barbiturates develop a tolerance to these substances. Cross-tolerance occurs when the use of one drug causes a tolerance to another drug. Alcoholics, barbiturate addicts, and narcotic addicts develop a cross-tolerance to sedatives and anesthetics.
i. **Time of Administration.** The time when a drug is administered is important. Some orally administered medications should be taken before meals (that is, on an empty stomach) to increase the amount of drug absorbed into the system. Other oral medications (that is, those that cause irritation to the gastrointestinal tract) should be taken after meals on a full stomach.
j. **Drug Interaction**. The interaction between two or more drugs may influence the overall effectiveness of each of the drugs. (1) Synergism. Synergism is the joint action of drugs. That is, their combined effects are greater than the sum of their independent effects. Concurrent administration (giving both drugs at the same time) of synergists may require that the dose of each drug be lowered. In the case of synergism, 1 + 1 = 2 1/2. Synergism may be beneficial or harmful. Beneficial effects may be obtained when combining two potentially toxic drugs to achieve the desired therapeutic effect without causing harm to the patient. Harmful effects may occur when alcohol and some depressants are combined. (2) Additive. In an additive drug interaction, the combined effects are equal to the sum of the independent effects of the drugs. In the case of the additive

effect, 1 + 1 = 2. (3) Antagonism. Antagonism is the canceling effect of one drug upon another. A sedative administered with a stimulant may antagonize or cancel the effects of the stimulant. Of course, the degree of antagonism varies from complete cancellation of the effect to varying degrees of reduced effectiveness.

k. **Routes of Administration**. Drugs may be given to patients using a variety of methods. Some drugs are only effective if they are given in a particular dosage form. Other drugs are administered in forms that enhance or decrease their effect or localize the drug effects.

l. Oral. Most drugs available today can be administered by mouth (orally). Drugs can be orally administered in the form of tablets, capsules, powders, solutions, or suspensions. Drugs administered by the oral route are usually taken for their systemic effect. These medications must pass through the stomach and be absorbed in the intestinal tract. Orally administered medications are usually easy to take and are usually less expensive than other dosage forms. (2) Sublingual/buccal. The sublingual/buccal route of administration is closely related to the oral route; however, in the sublingual/buccal route the dosage form is not swallowed. The tablet is to be dissolved under the tongue (sublingual) or in the pouch of the cheek (buccal). The drugs administered in this manner are rapidly absorbed and have the advantage of bypassing the gastrointestinal tract. Nitroglycerin, for heart patients, in tablet form is more likely the most frequently administered sublingual drug. (3) Rectal. Drugs administered by the rectal route may have a local effect (as for hemorrhoids) or a systemic effect (as in the prevention of nausea and vomiting). The rectal route is convenient to use in pediatric patients (children) or in patients who are unconscious or vomiting. The amount of drug absorbed in the rectal route is usually less than if the drug were administered orally. The absorption of drugs administered rectally is unpredictable and can vary among patients. (4) vaginal/urethral. Drugs administered using the vaginal/urethral routes are used for their local effect. That is, they are usually given to treat an infection or other pathological condition. Drugs administered in this route should not be irritating since systemic absorption may occur. (5) Inhalation. Drugs administered by inhalation have either may a local or systemic effect. Anesthetics, like nitrous oxide, are inhaled and exert their effect after absorption into the circulatory system. Sprays for nasal congestion have their effect on the tissue in the nose and do not necessarily enter the general circulation. (6) Topical. The topical route is probably the oldest route of administration. Topical medications are applied directly upon the skin. As long as the skin is intact (not broken or cut), drugs applied in this manner exert a local effect. The base (vehicle) used to carry the ingredients in the local preparation can influence the action of the drug. For example, dimethylsulfoxide (DMSO) will readily penetrate the skin and carry the active ingredient along with it. (7) Parenteral. The term parenteral literally means to avoid the gut (gastrointestinal tract). Thus, parenterals are injectable drugs that enter the

body directly and are not required to be absorbed in the gastrointestinal tract before they show their effect. Parenteral routes of administration usually have a more rapid onset of action (show their effects more quickly) than other routes of administration. Parenteral products must be sterile (free from living microbes). The parenteral route of administration does have its disadvantages: it hurts, it is not a convenient route, and once administered the injected drug cannot be retrieved.

m. (a) Intravenous (IV). The injection of a drug directly into the patient's veins is the most rapid route of administration. This type of parenteral route results in the most rapid onset of action. (b) Intra-arterial. In this parenteral route, the drug is injected directly into the patient's arteries. This route is not frequently used. (c) Intrathecal. The intrathecal route involves the administration of a drug directly into the spine (subarachnoid space) as in spinal anesthesia. The intrathecal route is used because the blood-brain barrier often precludes or slows the entrance of drugs into the central nervous system. (d) Intramuscular (IM). The intramuscular route is used when drugs are injected deeply into muscle tissue. If the drug is in aqueous (water) solution, absorption is rapid. However, if the drug is in an oily liquid or in the form of a suspension, it can prolong the release of the drug. (e) Intradermal (ID). In this route, the drug is injected into the (top few layers) of the skin. Ideally, the drug is placed within the dermis. The intradermal route is used almost exclusively for diagnostic agents. (f) subcutaneous (Sub-Q/SC). This route involves the injection of the drug under the skin into the fatty layer, but not into the muscle. Absorption of the drug is rapid. Insulin is normally administered subcutaneously.

4.4.7 Types of Adverse Reactions to Drugs

A patient will sometimes have an adverse reaction to a drug. Adverse reactions can have a direct toxic effect on various systems of the body or the adverse reactions can occur in the form of milder side effects.

a. **Direct Toxicity:** (1) In general terms, toxicity refers to the poison-like effects certain substances can produce in the body. Fortunately, most drugs do not produce toxic effects in most patients. However, when some drugs are administered to a patient over prolonged periods or when some drugs are given in high dosages, direct toxic effects can result. Direct toxicity may involve one or more of the body's systems. Certain parts of the body (that is, bone marrow) produce red and white blood cells. If a toxic accumulation of a substance affects these parts of the body, blood dyscrasias (the formation of malformed or destroyed white or red blood cells) may occur. (2) The liver has as one of its main functions the detoxification of chemical substances when they are absorbed. If these substances damage the liver significantly, its ability to detoxify them if greatly affected. Of course, if these substances are not detoxified, the concentration of the substance in the body (that is, blood stream) constantly increases. Thus, hepatotoxicity (the destruction of the cells of the liver) can result in the accumulation of toxic products to the point that other body systems are affected. (3) The kidneys are responsible for eliminating water-

soluble toxic products (that is, waste products from cellular respiration) from the bloodstream. If nephrotoxicity (damage to the kidneys) results, the accumulation of these toxic products can result in death. (4) Toxic effects may not be limited to the person who is taking the drug. In the past, it has been demonstrated that some drugs will cross the placental barrier and enter the circulatory system of the fetus. Some drugs can exert serious effects on the developing fetus. For example, the fetus may abort or be born with any number of mental or physical defects. Since few mothers are willing to subject themselves and their unborn children to drug testing, the effects of most drugs on the fetus are unknown. Most of what is known about teratogenicity, fetal malformations, has been learned either from experimental studies with animals or from the unfortunate experiences of some mothers. The fetus is particularly susceptible to the adverse effects of medications during the first three months after conception (the first trimester). Unfortunately, many women do not realize they are pregnant until they are well into their first trimester.

b. **Allergic Reactions**. A few individuals may be allergic, or hypersensitive, to a drug. This allergy may arise because of a prior contact with a particular substance called an allergen (it may even be the drug itself). This acquiring of an allergy is called sensitization. You should understand that the symptoms of an allergy are not related to the ordinary effects of the drug. Allergic reactions to a drug may range from a mildly irritated skin rash to anaphylaxis (a fatal shock). It has been shown that penicillin, a widely prescribed antibiotic, produces varying types of allergic reactions in from 1 to 10 percent of the patients who are administered the drug.
c. **Side Effects**. Most drugs do not produce only one single effect. Instead, they may produce several physiological responses at the same time. For example, antihistamines, drugs frequently used for their anti-allergic action tend to produce drowsiness. In this case, drowsiness is a side effect of the antihistamines. With some drugs, the side effects are so worrisome and inconvenient that the patient may stop taking the medication.
d. **Drug Dependence.** All drugs have the potential of producing dependence, the need to have that drug. There are two major types of dependence: psychological and physiological.
e. Psychological dependence may occur after a patient has been taking a medication for a long time. With psychological dependence, the patient becomes so convinced that he needs the drug (in order to continue to lead an improved life) that he will go to great lengths to ensure that he receives the medication. Patients habituated to amphetamines may demonstrate this type of dependence. Psychological dependence is very difficult to treat. (2) With physiological dependence, the patient's body develops a real need for the drug over a long period. Since there is a physiological need for the drug, the body reacts by going through withdrawal symptoms (that is, tremors, nausea, vomiting, and convulsions) if the drug is suddenly withheld. The patient habituated to narcotics and barbiturates have physiological dependence.

ICHM 204 Biophysical Chemistry

3rd Week September 16: The endocrine glands, its function and roles

4th Week September 23: The gastro intestinal system.

5th Week September 30. Components of blood and coagulation, Ventilation

6th Week October 7. Excretory organs and their functions

7th Week October 14. **Mid Term Examination**

8th Week October 21. Homeostasis, urine formation acid –base balance, role in maintenance of blood volume and pressure.

9th Week October 28. Introduction on pharmacology, Classification of drugs

10th Week November 4. Autonomic pharmacology

11th Week November 11 Theories of drug action, Dose-response curves antagonism, principles of drug metabolism and excretion

12th Week November 18. Drug screening, bioassay, drug toxicity

13th Week November 25. Revision 14th Week December 2 Finals