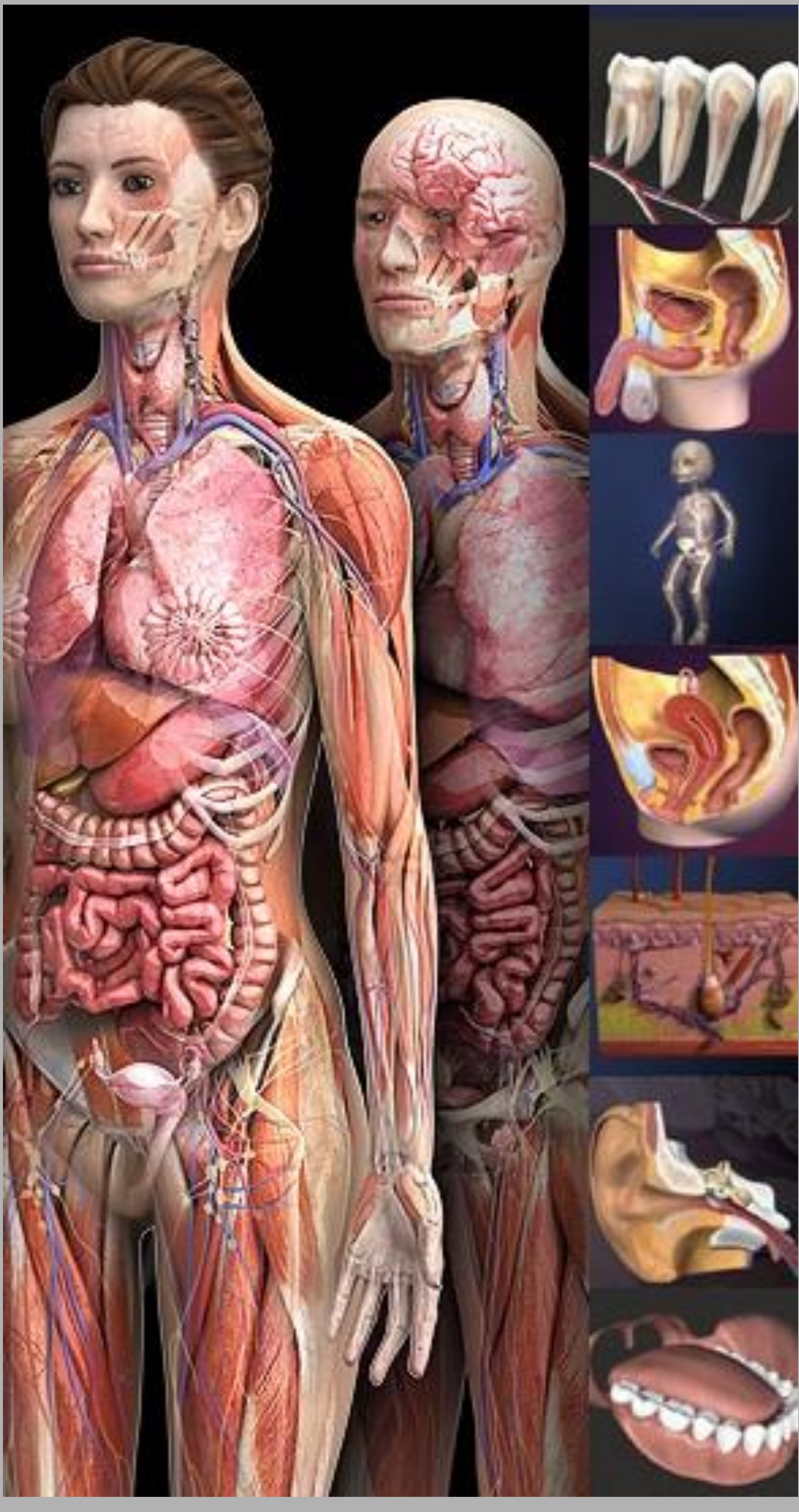
A Text Book Of
Human Biology



Prof. Dr. SAAD M. SHUKR

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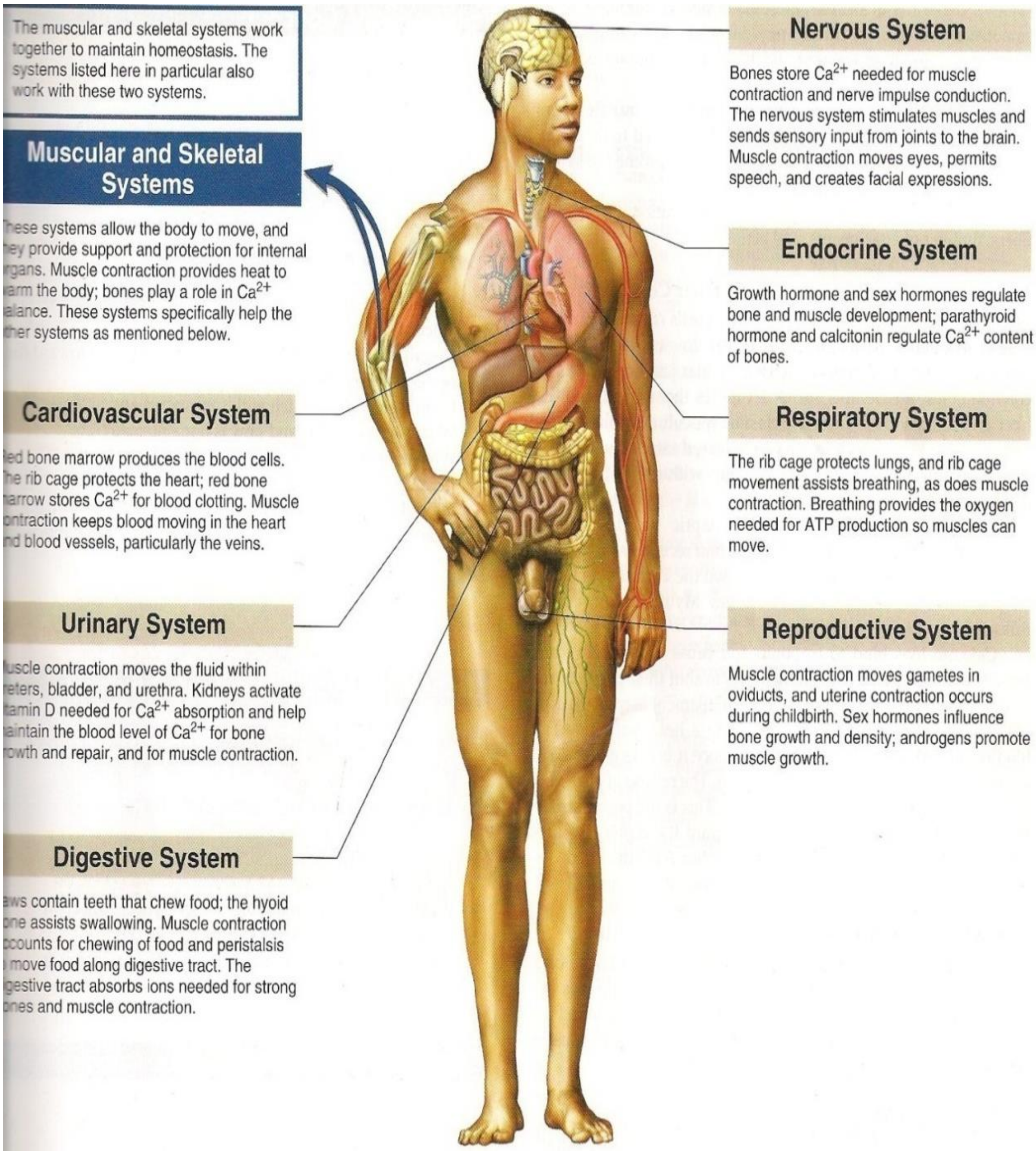
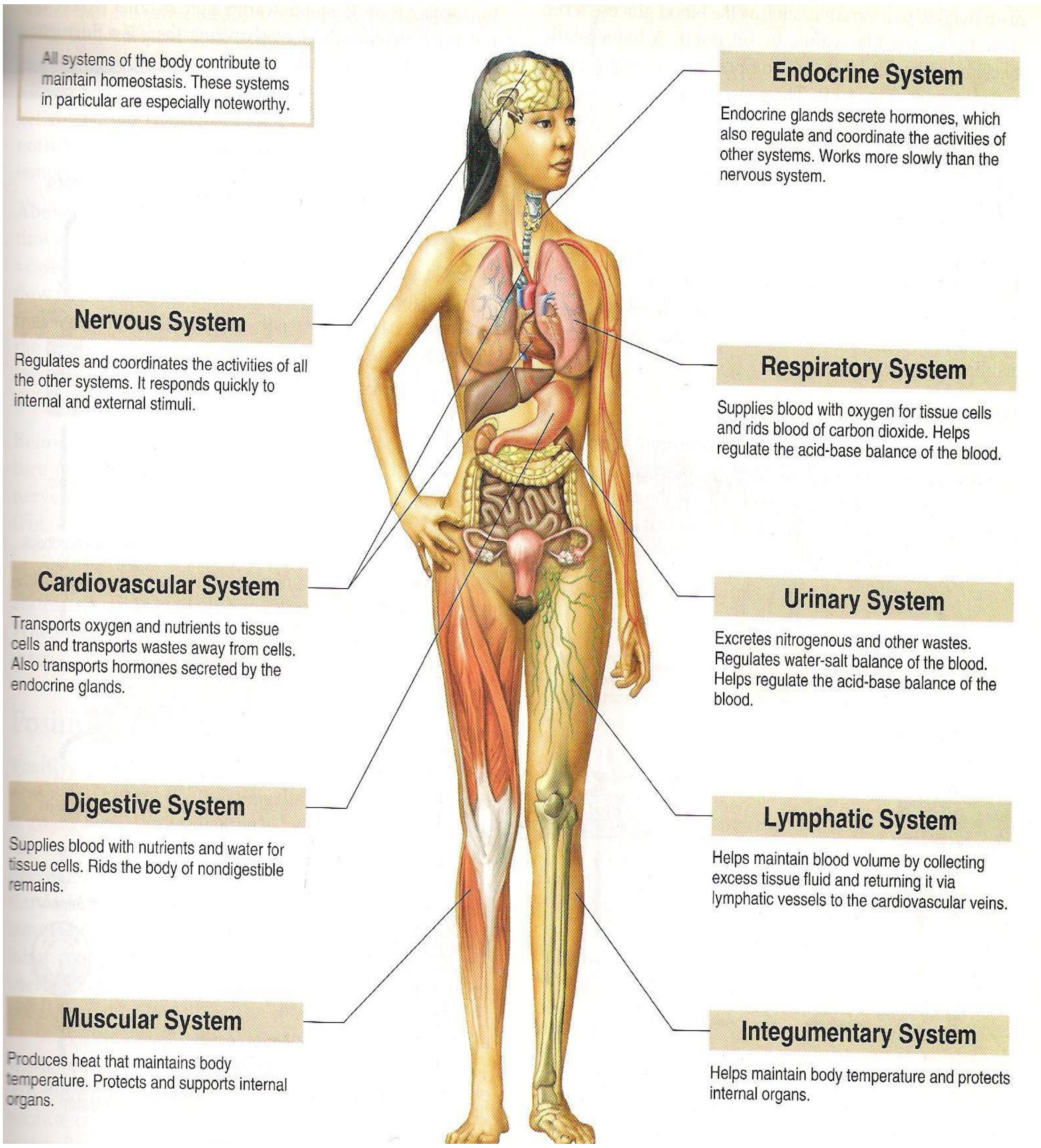
PREFACE

When I was teaching general biology, it became apparent to me that students were very interested in how their bodies worked , how to keep them healthy, and how they can occasionally malfunction. Students also found environmental concepts intriguing. I decided it would be possible to write a text and develop a course for no majors that built on these interests think and carry out research.

The application of biological principles to practical human concerns in now widely accepted as a beneficial approach to the study of biology. Students should leave college with a firm grasp of how their bodies normally more fully integrated into the biosphere. We are frequently called upon to make health and environmental decisions. Wise decisions require adequate knowledge and can help ensure our continued survival as individuals and as a species.


The muscular and skeletal systems work together to maintain homeostasis. The systems listed here in particular also work with these two systems.
Muscular and Skeletal Systems
hese systems allow the body to move, and hey provide support and protection for internal rgans. Muscle contraction provides heat to arm the body; bones play a role in Ca^{2+} alance. These systems specifically help the ther systems as mentioned below.
Nervous System
Bones store Ca^{2+} needed for muscle contraction and nerve impulse conduction. The nervous system stimulates muscles and sends sensory input from joints to the brain. Muscle contraction moves eyes, permits speech, and creates facial expressions.
Endocrine System
Growth hormone and sex hormones regulate bone and muscle development; parathyroid hormone and calcitonin regulate Ca^{2+} content of bones.
Cardiovascular System
ed bone marrow produces the blood cells. he rib cage protects the heart; red bone arrow stores Ca^{2+} for blood clotting. Muscle ontraction keeps blood moving in the heart nd blood vessels, particularly the veins.
Respiratory System
The rib cage protects lungs, and rib cage movement assists breathing, as does muscle contraction. Breathing provides the oxygen needed for ATP production so muscles can move.
Urinary System
uscle contraction moves the fluid within reters, bladder, and urethra. Kidneys activate tamin D needed for Ca^{2+} absorption and help aintain the blood level of Ca^{2+} for bone rowth and repair, and for muscle contraction.
Reproductive System
Muscle contraction moves gametes in oviducts, and uterine contraction occurs during childbirth. Sex hormones influence bone growth and density; androgens promote muscle growth.
Digestive System
aws contain teeth that chew food; the hyoid one assists swallowing. Muscle contraction ccounts for chewing of food and peristalsis move food along digestive tract. The gestive tract absorbs ions needed for strong ones and muscle contraction.

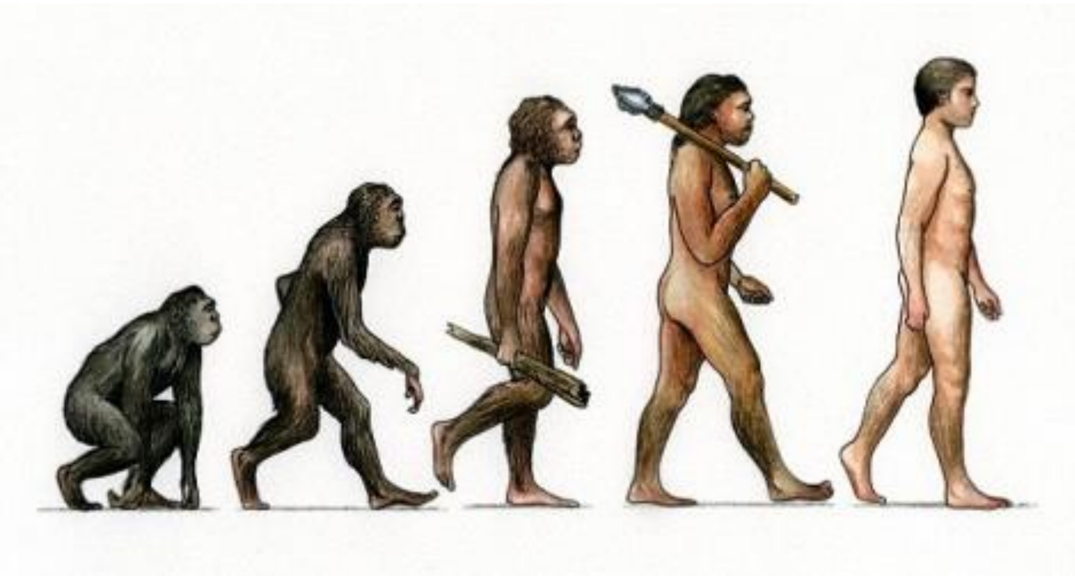

All systems of the body contribute to maintain homeostasis. These systems in particular are especially noteworthy.
Nervous System
Regulates and coordinates the activities of all the other systems. It responds quickly to internal and external stimuli.
Cardiovascular System
Transports oxygen and nutrients to tissue cells and transports wastes away from cells. Also transports hormones secreted by the endocrine glands.
Digestive System
Supplies blood with nutrients and water for tissue cells. Rids the body of nondigestible remains.
Muscular System
Produces heat that maintains body temperature. Protects and supports internal organs.
Endocrine System
Endocrine glands secrete hormones, which also regulate and coordinate the activities of other systems. Works more slowly than the nervous system.
Respiratory System
Supplies blood with oxygen for tissue cells and rids blood of carbon dioxide. Helps regulate the acid-base balance of the blood.
Urinary System
Excretes nitrogenous and other wastes. Regulates water-salt balance of the blood. Helps regulate the acid-base balance of the blood.
Lymphatic System
Helps maintain blood volume by collecting excess tissue fluid and returning it via lymphatic vessels to the cardiovascular veins.
Integumentary System
Helps maintain body temperature and protects internal organs.

An experienced teacher may see this widespread cover as inflated ambition. But it is saying that the book is aimed at the later school years and early college years .

One major objective in this new book is to provide source material for (open-learning) courses which are becoming more popular. Each chapter becomes a unit of study which must be read and then tested. If teachers or students want to use this book for flexi study courses the author will be pleased to answer any enquiries. A system of objective tests with self-marking devices can be used for continuous assessment and student grading, and further study materials are referred to in a final reading.

CHAPTER ONE

INTRODUCING THE HUMAN SPECIES



CHAPTER ONE INTRODUCING THE HUMAN SPECIES

1.1 MAN AND THE APES –THEIR SIMILARITIES

Man shares many similarities with his nearest relatives. The apes. These shared features can be listed as blow (some of them cannot be seen merely by observation).

1. Hairy skin.
2. Eyes face forwards giving stereoscopic vision.
3. Five – fingered hand with opposable thumb.
4. Breeding pairs with complicated mothering behavior
5. Mammary glands present in thoracic region
6. A single uterus (womb) with one or two babies only born at a time.
7. Menstrual cycle (monthly period).

Apes also have blood which is similar to that of man and get the same types of illnesses as us. The chimpanzee and the gorilla show so many similarities to man that it is suggested they are similar to the group from which early man arose. This does not mean that man evolved from the chimpanzee. But that our ancestral ape-like relatives may have been of that sort.

Another most obvious similarity between man and ape is that they are both mammals. Mammals are characterized by the presence of a hairy skin and the possession of mammary glands.

1.2 MAN AND THE APES-THEIR DIFFRENCES

Man also has many obvious differences from the apes. A few of which are shown below:

	Man	Apes
Growth rate	Quite show	Faster
Sexual maturity	14 years	8 years
Full growth (male)	20 years	12 years
Dependency of young	6-8 years (approx)	2 years
Lower limb bones	Longer than upper limbs	Shorter than upper limbs
Toe bones	Rather short	Rather long
Leg	Straight	Curved
Skull-backbone joint	Centre base of skull	At back of skull
Canine teeth	Smallish	Large fangs
Jaws	Short	Large and long
Face	Short steep	Long protruding
Brain	Large	One third size of man's

Man is also unlike ape in that he walks erect on two feet (is bipedal). He therefore has longer and stronger legs. And hands that are free to develop tool-handling skills. This learning how to use tools necessitated a more complex and larger brain. The shape of the skull is another difference.As man's cranium has an upright forehead and the skull a distinct chin. Also man's skin is not totally hair-covered like that of the ape-man is a naked ape. He is a social, feeding on an omivorous diet.

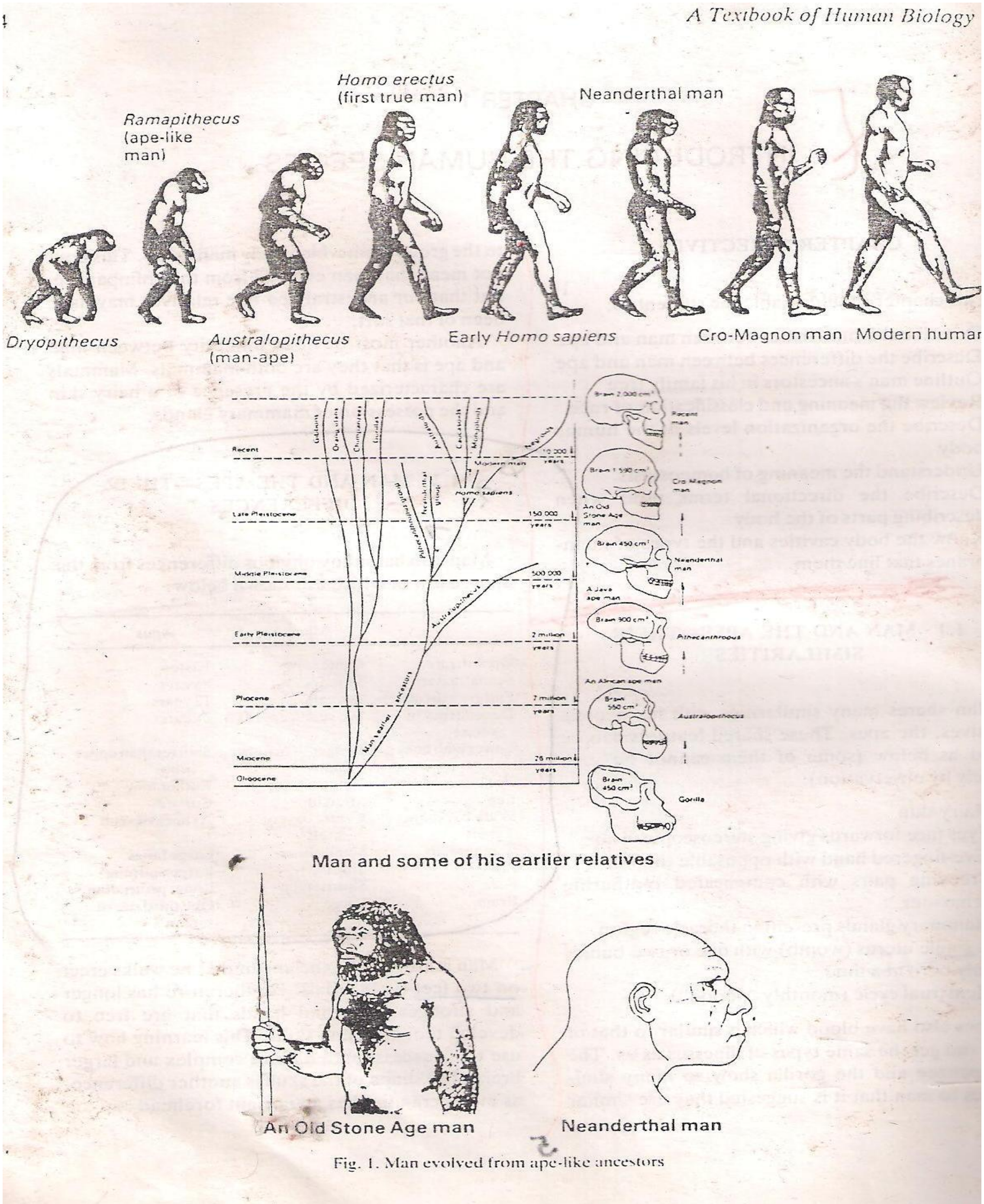


Fig. 1. Man evolved from ape-like ancestors

Man considers himself (clever) and more advanced than other animals for a number of reasons.The so called advanced from apes and superior to most other animals can be listed as follows.

1. He has a large complex brain
2. He has an unspecialized hand with opposable fingers and thumb useful for accurate use of tools.
3. He makes and uses tools
4. He has stereoscopic vision.
5. He uses language and speech for communication.
6. He modifies his environment for his own purposes.
7. He creates and survives in social institutions.
8. He forms “mental” and abstracts concepts.
9. He often cooks his food.

If these “advanced” features of man do not make very much sense at this stage of your reading then return to study this section later.

CHAPTER SUMMARY

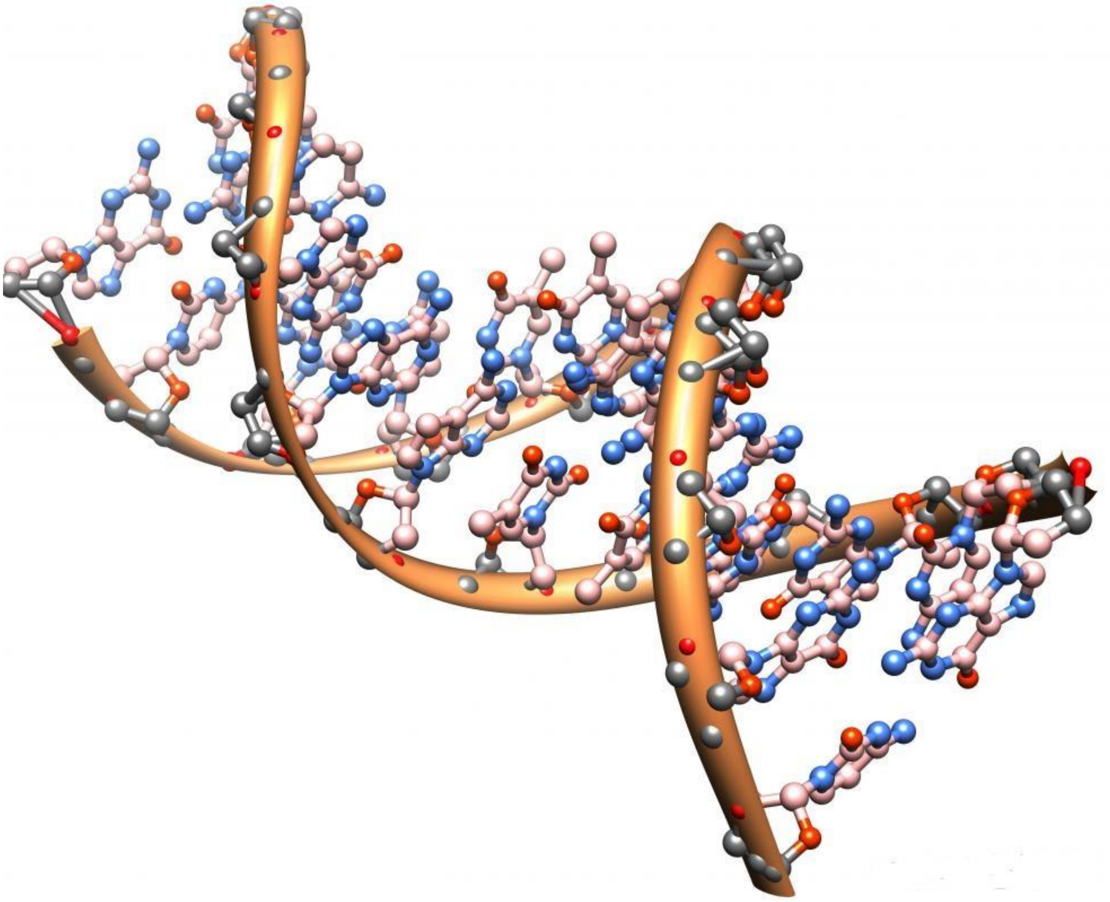
1. Man is a mammal and such as has many similarities to his close relatives, the apes. As man and apes are both mammals they are hairy and have mammary glands.
2. Man differs from apes in a wide range of characters, including his brain size, limb structure and facial characteristics. He is also a tool-user and has a language communication method.
3. The ancestors of man stretch back millions of years to ape-men creatures that roamed the countryside in Africa. The first true

men appeared about a million years ago and modern man came along about five hundred thousand years ago.

4. All men belong to species Homo sapiens, but there are many subspecies or races of men. The characteristics that go to make up a race of man are not easy to recognize.
5. The human body shows organization at various levels, ranging from chemical to organ and system levels.
6. Correct body function is maintained by homeostatic processes, such as temperature regulation or blood sugar regulation.
7. The anatomical position together with directional terms enables us to describe parts of the body accurately and without confusion.
8. Body cavities are lined by membranes of either serous, mucous or synovial type. It is in many of the major cavities that the organs are located.

CHAPTER TWO

The CHEMICAL BASIS OF LIFE



Introduction

For many centuries, biology was the study of the natural world. Biologists searched for and studied their anatomy and how they are acted in nature. Then in the 1700s, scientists discovered the chemical and physical basis of the living things. They soon realized that the chemical organization of all living things is remarkably similar.

CHEMICAL PRINCIPLES

ELEMENTS: All living things on earth are composed of fundamental blocks of matter called elements. More than one hundred elements are known to exist, including some made by scientists. An element is a substance that cannot be decomposed by chemical means. Oxygen, iron, calcium, sodium, hydrogen, carbon and nitrogen are examples of elements.

ATOMS: Each of the elements is composed of one particular kind of atom. An atom is the smallest part of an element that can enter into combinations with atoms of other elements.

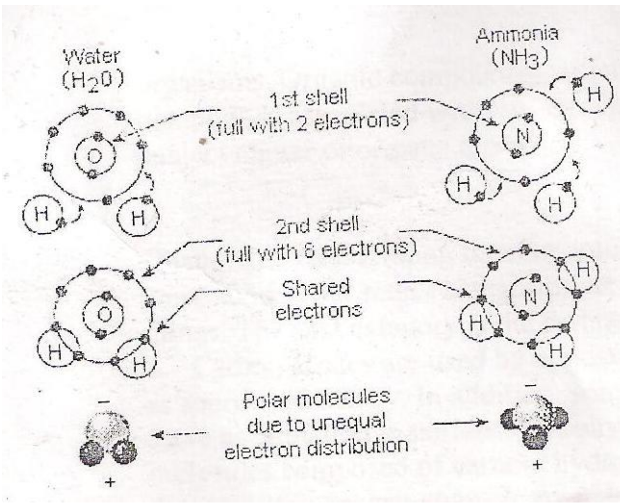
Atoms consist of positively charged particles called protons surrounded by negatively charged particles called electrons. A third particle called neutron has no electrical charge; it has the same weight as proton. Protons and neutrons adhere tightly to form the dense, positively charged nucleus of the atom. Electrons spin around the nucleus.

The arrangement of electrons in an atom plays an essential role in the chemistry of the atom. Atoms are most stable when their outer shell has a full quota. The first electron shell has a maximum of two electrons. The second and all other outer shells have a maximum of eight electrons. Atoms tend to gain or lose electrons until their outer shells have a stable arrangement. The gaining or losing of electrons, or the sharing of electrons, contributes to the chemical reactions in which an atom participates.

Molecules: Most of the compounds of interest to biologists are composed of units called molecules. A molecule is a precise arrangement of atoms of different elements, and a compound may be a collection of molecules. The arrangements of the atoms in a molecule account for the properties of a compound. The molecular weight is equal to the atomic weights of the atoms in the molecule. For example, the molecule may also composed of two or more atoms of the same elements, as in oxygen gas, O2. But oxygen is not a compound.

The atoms in molecules may be joined to one another by various linkages called bonds. One example of a bond is an **ionic bond**. An ionic bond is formed when the electrons of one atom transfer to a second atom. This creates electrically charged atoms called ions. The electrical charges cause the ions to be attracted to one another, and the attraction forms the ionic bond.

A second type of linkages is called a covalent bond. A covalent bond forms when two atoms share one or more electrons with one another. For example, oxygen shares its electrons with two hydrogen atoms, and the resulting molecule is water (H_2O). Nitrogen shares its electrons with three hydrogen atoms, and the resulting molecule is ammonia (NH_3). If one pair of electrons is shared, the bond is single bond; if two pairs are shared, then it is a double bond.



Formation of a covalent bond in water and ammonia molecules. Two hydrogen atoms share their electrons with an oxygen atom in the water molecule. These hydrogen atoms share their electrons with a nitrogen atom on the ammonia molecule. In each molecule, the second shell fills with eight electrons.

Acids and bases. Certain chemical compounds release hydrogen ions (H+) when the compounds are placed in water. These compounds are called acids. For example, when hydrogen chloride is placed in water it releases its hydrogen ions and the solution becomes hydrochloric acid.

Certain chemical compounds attract hydrogen atoms when they are placed in water. These substances are called bases. An example in water, it attracts hydrogen ions, and a basic (or alkaline) solution results as hydroxyl (-OH) ions accumulate.

Organic Compounds:

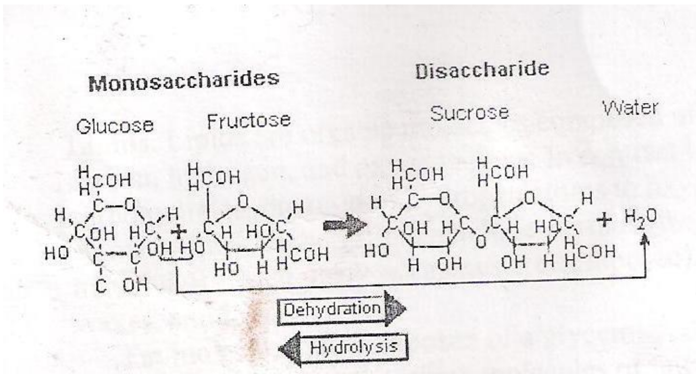
The chemical compounds of living thins are known as organic compounds because of their association with organisms. Organic compounds, which are the compounds associated with life processes, are the subject matter of organic chemistry.

Carbohydrates. Among the numerous types of organic compounds, four major categories are found in all living things. The first category is the carbohydrates.

Carbohydrates are used by almost all organisms as sources of energy. In addition, some carbohydrates are molecules composed of carbon, hydrogen, and oxygen the ratio of hydrogen atoms to oxygen atoms is 2:1.

The simple carbohydrates are commonly referred to as sugars. Sugars can be **monosaccharides** if they are composed of single molecules or **disaccharides** if they are composed of two molecules. The most important monosaccharide is **glucose**, a carbohydrate with the molecular formula $C_6 H_{12} O_6$.Glucose is the starting material for cellular respiration, and it is the main product of photosynthesis (see the chapters "Photosynthesis" and "Cellular Respiration").

There important disaccharides are also found in living things. One disaccharide is maltose, a combination of two glucose units covalently linked. Another disaccharide is sucrose, the table sugar formed by linking glucose to another monosaccharide called fructose. A third disaccharide is lactose, composed of glucose and galactose units.



Glucose and fructose molecules combine to form the disaccharide sucrose. In the synthesis, a water molecule is produced. The process is therefore called dehydration. The reversal of the process is hydrolysis; a process in which the molecule is split and the elements of water is added.

Complex carbohydrates are known as **polysaccharides.** Polysaccharides are formed by linking innumerable monosaccharides are the starches, which are composed of hundreds or thousands of glucose units linked to one another. **Starches** serve as a storage form carbohydrates. Much of the world's human population satisfies its energy needs with the starches of rice, wheat, corn, and potatoes.

Another important polysaccharides is **glycogen.** Glycogen is also composed of thousands of glucose units, but the units are bonded in a different pattern than in starch. Glycogen is the form in which glucose is stored in the human liver.

Still another important polysaccharides is **cellulose**. Cellulose is used primarily as a structural carbohydrate. It is also composed of glucose units, but the units cannot be released from one another except by a few species of organisms. Wood is composed chiefly of cellulose, as are the walls of all plants. Cotton fabric and paper are commercial cellulose products.

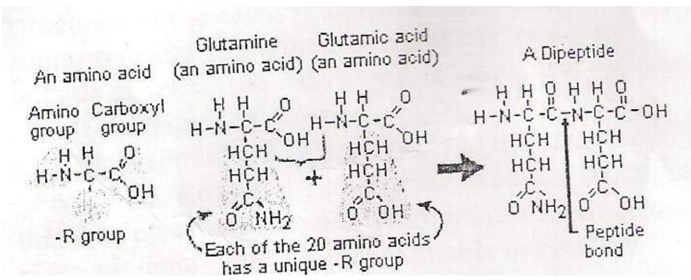
Lipids: Lipids are organic molecules composed of carbon, hydrogen and oxygen atoms. In contrast to carbohydrates the ratio of hydrogen atoms to oxygen atoms is much higher. Lipids include steroids (the material of which many hormones are composed), waxes and **fats**.

Fat molecules are composed of a glycerol molecule and one, two or three molecules of fatty acids. A glycerol molecule contains three hydroxyl (-OH) groups. **A fatty acid** is a long chain of carbon atoms (from four to twenty-four) with a carboxyl (-COOH) group at one end. The fatty acids in a fat may be all alike or they may all be different. They are bound to the glycerol molecule by a process that involves the removal of water.

Certain fatty acids have one or more double bonds in their molecules. Fats that include these molecules are called **unsaturated fats**. Other fatty acids have no double bonds. Fats that include these fatty acids are called **saturated fats**. In most human health situations, the consumption of unsaturated fats is preferred to the consumption of saturated fats.

Fats stored in cells usually form clear oil droplets called **globules** because fats do not dissolve in water. Plants often store fat s in large, clear globules in the cells of **adipose tissue**. The fats in adipose tissue contain much concentrated energy. Hence, they serve as a reserve energy supply to the organism. The enzyme lipase breaks down fats into fatty acids and glycerol in the human digestive system.

Proteins: proteins are among the most complex of all organic compounds. They are composed of units called **amino acids**, which contain carbon, hydrogen, oxygen, and nitrogen atoms. Certain amino acids also have sulfur atom, phosphorus, or other trace elements such as iron or copper.



The structure and chemistry of amino acids; Each amino acid (left illustration) has an amino group and a carboxyl (organic acid) group. Also, there is a group of atoms called an –R group attached to the molecule. The –R group varies among amino acids (middle illustration). When two amino acids are joined in a dipeptide, the –

OH of one amino acid is removed, and the –H of the second is removed. A dipeptide bond (right illustration) forms to join the amino acids together.

Many proteins are immense in size and extremely complex. However, all proteins are composed of long chains of relatively simple amino acids. There are twenty kinds of amino acids, and each has an amino (-NH_2) group, a carboxyl (-COOH) group, and a group of atoms called –R group (-R for radical). The amino acids differ depending on the nature of the –R group. Examples of amino acids are alanine, valine, glutamic acids, tryptophan, tyrosine and histidine.

Amino acids are linked to form a protein by the removal of water molecules. The process is called dehydration synthesis, and a byproduct of the synthesis is water. The links forged between the amino acids are called **peptide bonds**, and small proteins are often called **peptides**.

All living things depend upon proteins for their existence. Proteins are the major molecules from which living things are constructed. Certain proteins are dissolved or suspended in the watery substance of the cells, while others are incorporated into various structures of the cells. Proteins are also found as supporting and strengthening materials in tissues outside of cells. Bone, cartilage, tendons and ligaments are all composed of proteins.

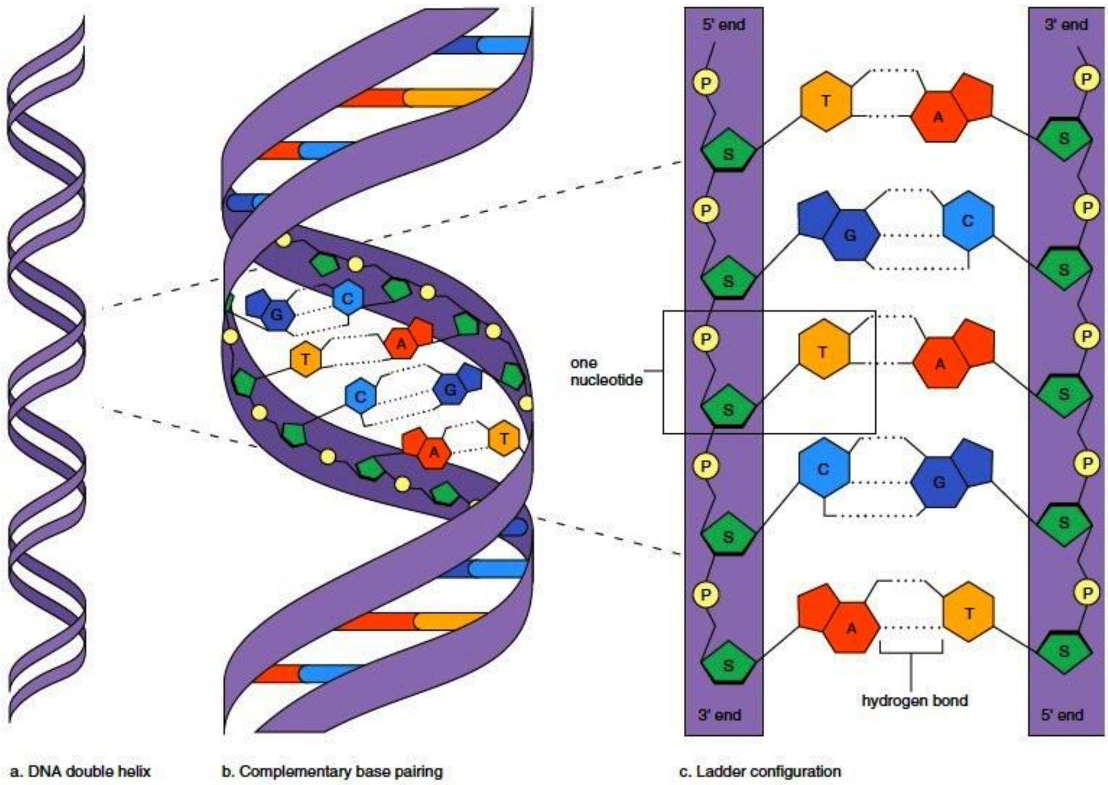
One essential use of proteins is in the construction of enzymes. **Enzymes** catalyze the chemical reactions that take place within cells. They are not used up in a reaction; rather, they remain available to catalyze succeeding reactions.

Every species manufactures proteins unique to that species. The information for synthesizing the unique proteins is located in the nucleus of the cell. The so-called genetic code specifies the sequence of amino acids in proteins. Hence, the genetic code regulates the chemistry taking place within a cell. Proteins also can serve as a reserve source of energy for the cells. When the amino group is removed from an amino acid, the resulting compound is energy rich.

Nucleic acids: Like proteins, nucleic acids are very large molecules. The nucleic acids are composed of smaller units called **nucleotides**. Each nucleotide contains a carbohydrate molecule, a phosphate group, and a nitrogen-containing molecule that because of its properties is called a nitrogenous base.

Living organisms have two important kinds of nucleic acids. One type is called **deoxyribonucleicacid**, or **DNA**. The other is **ribonucleic acid**, or **RNA**. DNA is found primarily in the nucleus of the cells, while RNA is found in both the nucleus and the cytoplasm of the cell.

DNA and RNA differ from one another in their components. DNA contains the carbohydrate deoxyribose, while RNA has ribose. In addition, DNA contains the base thymine, while RNA has uracil. The structure of DNA and its importance in the life of cells is explored in this book's chapter "Gene Expression (Molecular Genetics)."



Overview of DNA structure

CHAPTER THREE

CELLS

Introduction

All animals and plants are made up of cells. The cell is the smallest unit of living material that can exist on its own. Although very few cells can actually exist independently. Cells are generally members of a community and thus dependent upon others cells for support and survival.

Cells come in different forms because they have different jobs to do. A cell from a piece of skin is very different from a cell taken from a piece of bone. But although there is no such thing as a "typical cell" we can generalize and talk about the parts (organelles) of cells in a general sort of way.

The study of cells is called cytology.

3.1 THE CELL AND ITS ORGANELLES

Some large cells(e.g. an egg. Such as frogspawn) can be seen with the unaided eye. Most cells.Though .aremuch smaller and so we need a microscope to be able to examine them.

Object	Sizes	Viewing limits
House – fly	0-01 m (smaller than)	Naked Eye
Human egg and sperm red blood cell.	0-1 mm (smaller than	
Most cells	0-01 mm(smaller than)	Light Microscope
Granules and small		
Cells	0-001 mm(smaller than)	
virus	0-01 micrometer (pm)	Electron Microscope
Protein molecules	0-001 pm (variable)	
Amino acid molecules	0-1 nm	

The optical (light) microscope allows us to see objects as small as 200 nanometres (nm). That is very small because b nanometer = 1×10^{-6} mm (if these measurements are new to you turn to p.410).

In order to see the parts of a cell that are smaller than this we need to use an electron microscope. This type of microscope is big. Expensive and uses beams of electrons instead of light to show up the cell parts that we are looking for. We really do not see the actual object. But see its image or shadow – rather like the shadow on the wall when a hand is held in front of a candle flame. An electron microscope allows us to observe objects that are only 0.5nm aparts. That is really very very small.

Look at the chart on page 22 and notice the sizes of some parts of a cell.

Organelle	Microscopic measurements
Nucleus	3-25 pm
Mitochondria	1-10 pm × 0-10 pm
Golgi bodies	0 5-10 pm
Plasma membrane	0-001 pm (1-7.5nm)
Lyosomes	0.opm
Cillia	5-10.0 pm long 0.3 pm diameter
Flagella	150-220 pm long 0.5 pm diameter
ribosomes	15-25nm
Chloroplasts	1-10 pm × 2-4 pm
Microvilli	1.0 pm long. 0.08 pm diameter

Micrometer (pm) = 0.001 mm

Nanometer (nm) = 0.001 pm

Angstrom (a) = 0.1 nm

1 mm = 1000 micrometres (pm)

1 pm = 1000 nanometres (nm)

1nm = 10 angstroms (A)

A diagram of a generalized cell will show that. Just like the human body. It is made of many parts that do different jobs.These parts are called organelles (small organs) and are where the chemical reaction that go to make up the living processes of the cell take place.

A cell examined under the light microscope will reveal an outer cell membrane enciosing an inner fluid. Jelly- like area called the cytoplasm. The organelles are immersed in this watery cytoplasm.

Cytoplasm is about 70% water in which salts are dissolved to form a solution. There are also suspended within it large moccules. Such as proteins.Which cannot dissolve in the water. These macromolecules are held suspended in the cytoplasm as a colloid

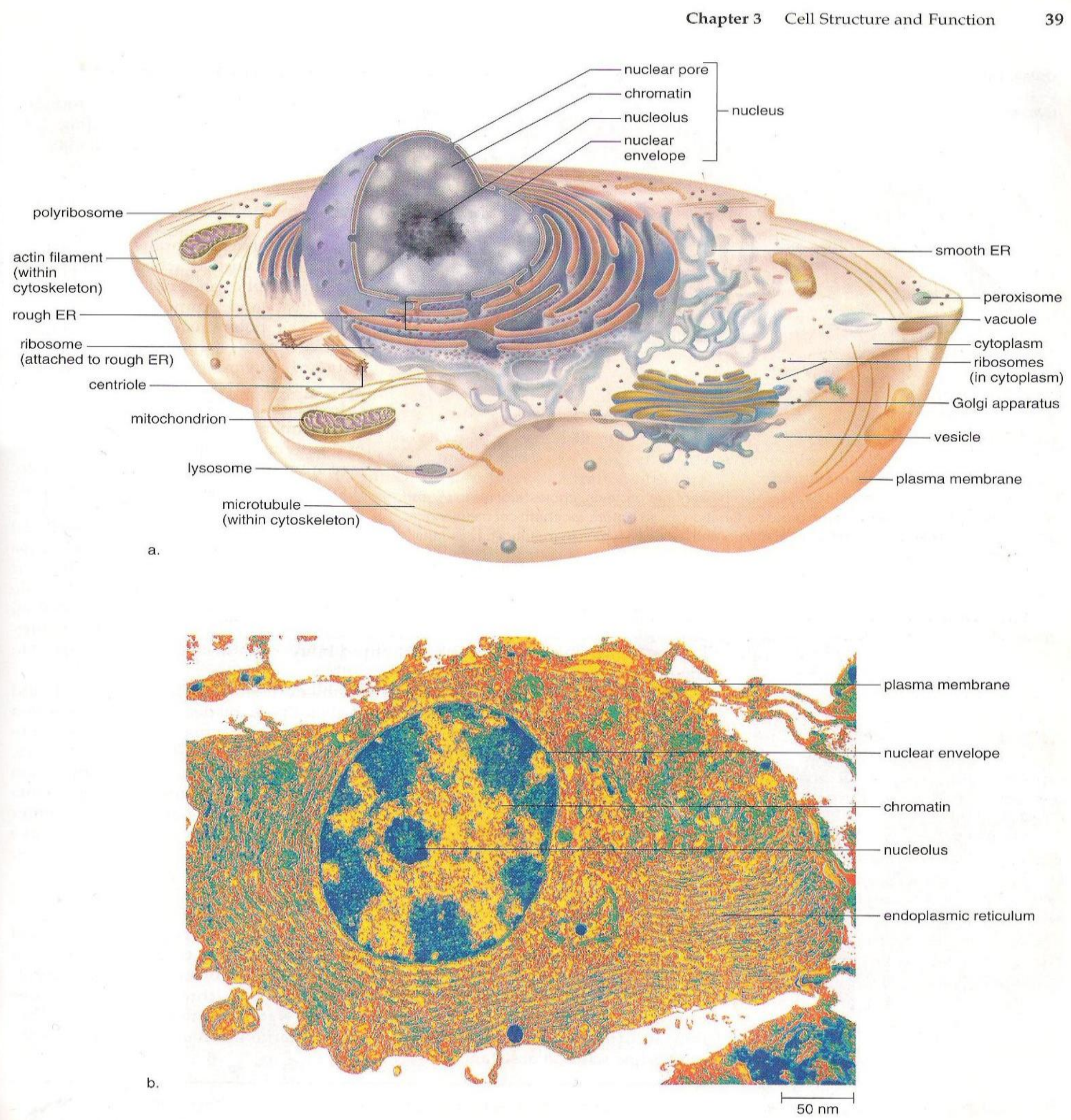


Figure 3.3 **Animal cell.**
a. Generalized drawing. **b.** Transmission electron micrograph. See Table 3.1 for a description of these structures, along with a listing of their functions.

The organelles we are going to look at briefly are:

3.2 the nucleus

3.3 the membranes and vacuoles

3.4 the energy-producing organelles, the mitochondria (singular mitochondrion)

3.5 the movement-related parts such as the centrioles, microfilaments and cilia.

3.2 THE NUCLEUS

The nucleus is a large organelle that may or may not be centrally located within the cytoplasm. It is enveloped in a double membrane that has pores to permit the two-way traffic of large molecules.

When a special type of stain (haematoxylin) is put on to a cell the nucleus soake up the colour. The areas within the nucleus that become coloured are described as chromatin.This coils up into stringy. Rod like chromosomes when the cell divides into two. Chemically chromatin (and therefore chromosomes) is made up of large protein molecules and DNA (deoxyribonucleic acid). That controls the production of proteins by cells. The nucleic acids are the inheritance factors of cells another area within the nucleus that becomes darkened by stains is called the nucleolus. This is made up of RNA and aids in the production of structures called ribosomes

3.3 THE MEMBRANES AND VACUOLES

If we look closely at at a cell using the high magnifications of an electron microscope (it can magnify more than 200,000 times compared with the 2,000 times of the light microscope) we are able to see membranous structure within the cell.

Endoplasmic reticulum is a system or net work of double-membraned tubular canals running throughout the cytoplasm. Some of these membranes are dotted with extremely small granular particles called ribosomes. This membrane with ribosome

Medical Biology

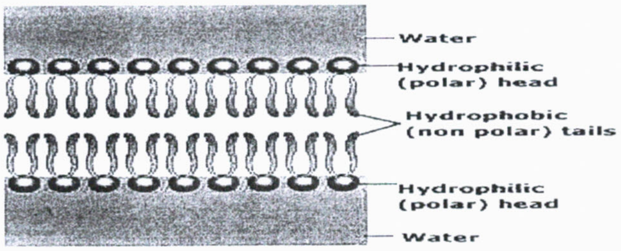
Cell structure

1- cell membrane

According to **cell theory**, cells are the main unit of organization in biology. Whether you are a single cell or with trillions of cells. All cells are contained by a **cell membrane** (also known as the plasma membrane or cytoplasmic membrane) which is a biological membrane that separates the interior of all cells from the outside environment, in another words is a type of biological membranes which encloses the protoplasm (the nucleus and the cytoplasm with its organelles and inclusions) and separates one cell from other cells and from the external environment . The cell membrane is not a solid structure, it is made of millions of smaller molecules that create a flexible and porous container **(Proteins** and **phospholipids**).

Phospholipid molecules

are shaped with a head and a tail region. The head section of the molecule likes water (**hydrophilic**) while the tail does not (**hydrophobic**). Because the tails want to avoid water, they tend to stick to each other and let the heads face the watery areas inside and outside of the cell. The two surfaces of molecules create the **lipid bilayer**.



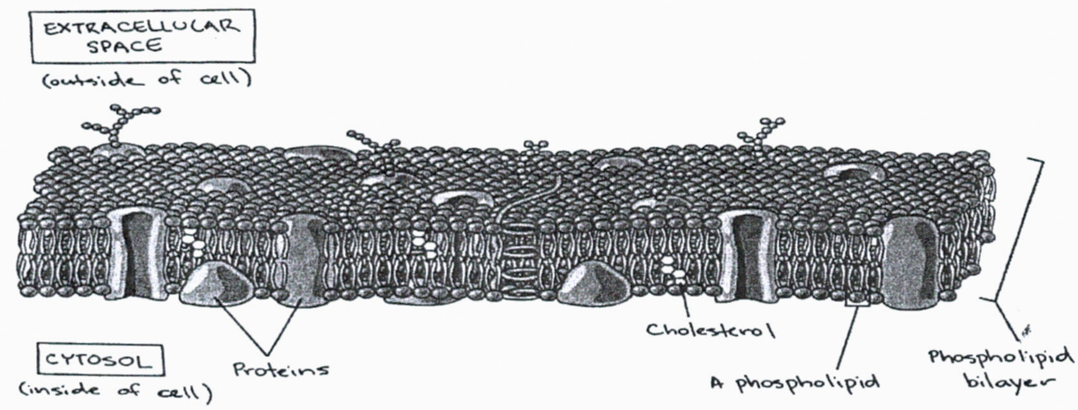
Proteins in Plasma Membrane

In plasma membrane, proteins perform various functions, and this diversity is reflected in the significantly different types of proteins associated with the lipid bilayer. There are three types of proteins in plasma membrane, which includes:

Integral proteins: are embedded within the lipid bilayer. They cannot easily be removed from the cell membrane, extending through the lipid bilayer so that one end contacts the interior of the cell and the other touches the exterior, are the only class of proteins that can perform functions both inside and outside of the cell.

Peripheral Proteins: Peripheral proteins are attached to the exterior of the lipid bilayer. They are easily separable from the lipid bilayer, able to be removed without harming the bilayer in any way

Lipid-anchored proteins (also known as **lipid-linked proteins**) located on either side of the cell membrane, that are attached to lipids embedded within the cell membrane



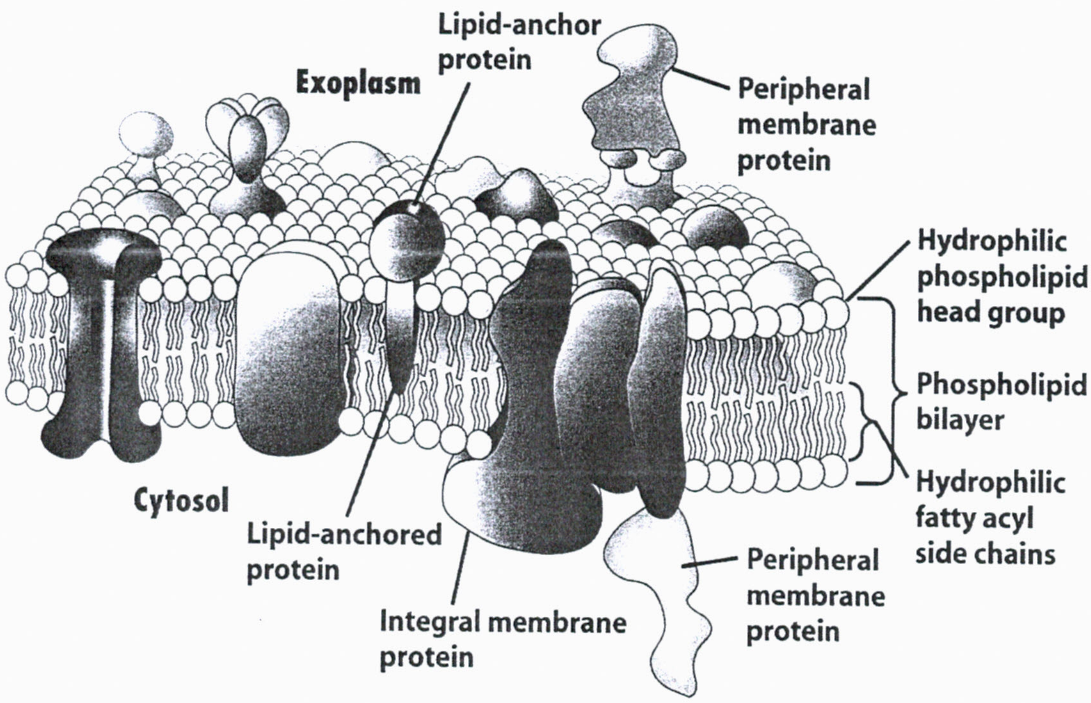


Figure 10-1
Molecular Cell Biology, Sixth Edition
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Function of Plasma Membrane

1. It separates the contents of the cell from its outside environment and it regulates what enters and exits the cell.
2. Plasma membrane plays a vital role in protecting the integrity of the interior of the cell by allowing only selected substances into the cell and keeping other substances out.

3. It also serves as a base of attachment for the cytoskeleton in some organisms and the cell wall in others. Thus the cell membrane supports the cell and helps in maintaining the shape of the cell.
4. The cell membrane is primarily composed of proteins and lipids. While lipids help to give membranes their flexibility and proteins monitor and maintain the cell's chemical climate and assist in the transfer of molecules across the membrane.
5. The lipid bilayer is semi-permeable, which allows only selected molecules to diffuse across the membrane.

2-Nucleus

Nucleus is the largest and most easily seen of the components within the eukaryotic cell (4-10 μm in diameter). it contains the majority of the cell's genetic material. This material is organized as DNA molecules, along with a variety of proteins, to form chromosomes.

Nuclei are roughly spherical, although some are oval or irregular in shape. They are typically located in the central region of the cells. The majority of cells have one nucleus, but some cells or unicellular animals have two or more nuclei. Mammalian RBCs lose their nucleus when they mature and hence they lose their ability to grow, change and divide and become merely passive vessels for the transport of hemoglobin

The nucleus is composed of four parts:

1-nuclear envelope
2-nucleoplasm
3- chromatin
4-nucleolus

1-Nuclear Envelope:

The nuclear envelope or nuclear membrane represents the surface of the nucleus, which is bounded by two phospholipid bilayer membranes similar in structure with that of plasma membrane. The outer membrane of the nuclear envelope is occasionally continuous with the endoplasmic reticulum. The outer and inner membranes fuse together to form gaps, known as the nuclear pores. Nuclear pores are filled with proteins that act as molecular channels, permitting certain molecules to pass into and out of the nucleus. The space between both membranes (perinuclear cisterna) is filled with a fluid. The inner membrane is firmly attached to clumps of heterochromatin.

2- Nucleoplasm:

The nucleoplasm, karyoplasm or nuclear sap is a fluid filling the inside of the nucleus. Within this fluid both nucleolus (or sometimes nucleoli) and the chromatin are found.

3- Nucleolus:

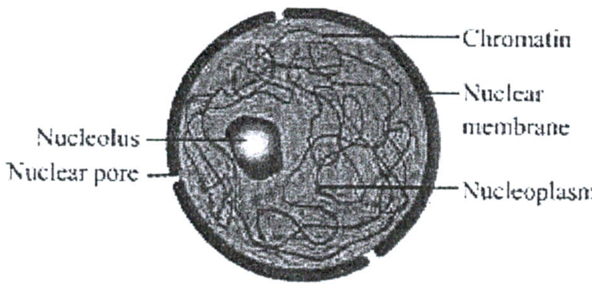
Nucleolus appears as a small dense body immersed in the nucleoplasm. Two nucleoli are sometimes present in the nucleus. The nucleolus is considered as the ribosomal factory as it consists of RNA and protein (ribosomal subunits) in the process of maturation. These subunits are synthesized in the nucleolus and then move through the nuclear pores to the cytoplasm, where they assemble. Ribosomes serve as the site of protein synthesis.

4- Chromatin:

The chromatin is the nuclear material which is made up of DNA and large protein molecules (histones). This is basophilic in staining. It can be distinguished into two types:-

A- Euchromatin or noncondensed chromatin which is loosely packed and thus is very lightly basophilic. This is metabolically active with regard to RNA synthesis.

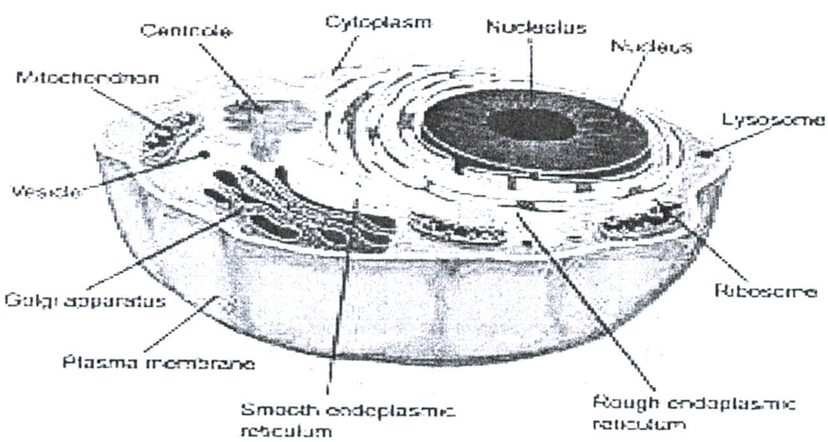
B- Heterochromatin or condensed chromatin which is tightly packed and thus is intensively basophilic. This is relatively inactive metabolically and consists of chromosomes.



Structure of a Nucleus

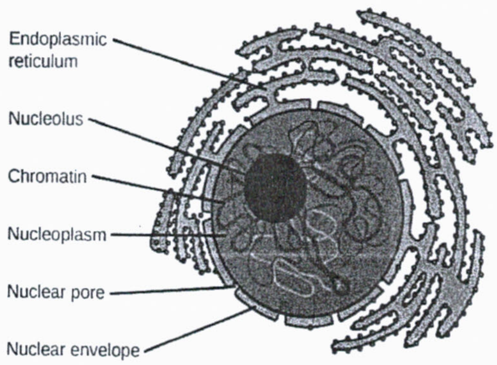
3- Cytoplasm

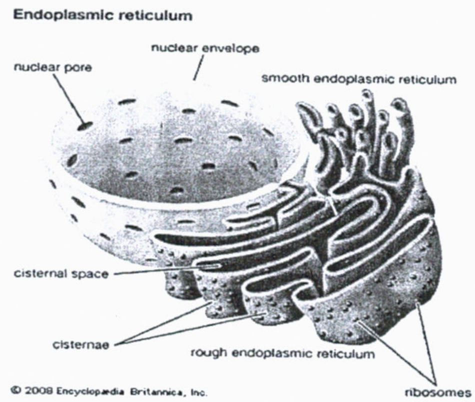
Cytoplasm is the space between the nucleus and cell membrane, which fills with the cytosol(fluid in which organelles reside)It is mainly composed of water, salts, and proteins. In eukaryotic cells, the cytoplasm includes all of the material inside the cell and outside of the nucleus. All of the organelles in eukaryotic cells, such as the nucleus, endoplasmic reticulum, and mitochondria, are located in the cytoplasm. Although cytoplasm may appear to have no form or structure, it is actually highly organized. A framework of protein scaffolds called the cytoskeleton provides the cytoplasm and the cell with their structure.

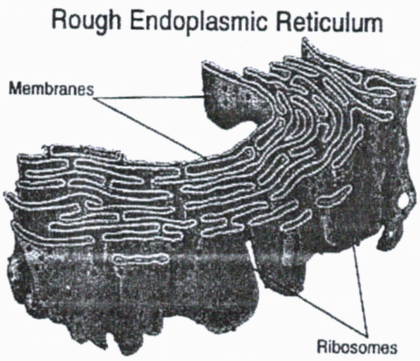


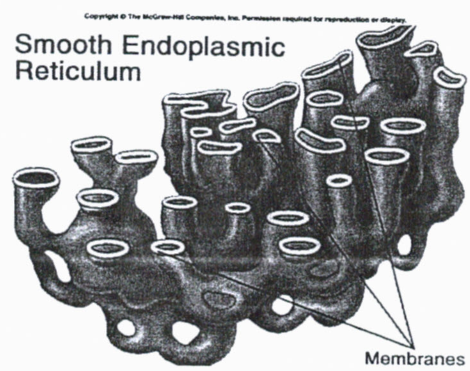
4- Endoplasmic reticulum

The endoplasmic reticulum is a network of double-membrane tubular canals running throughout the cytoplasm .It is continuous with the nuclear membrane. Regions of the endoplasmic reticulum without bounded ribosomes are referred to as smooth endoplasmic reticulum which represent the site of synthesis of lipid and a variety of carbohydrates, while those heavily studded with ribosomes are known as rough endoplasmic reticulum which is the site of protein synthesis ,Dangerous chemicals are destroyed (detoxified) by enzymes , located on membranes of endoplasmic reticulum. Various products are transported from one portion of the cell to another via the endoplasmic reticulum. Finally, it gives support to the cell.



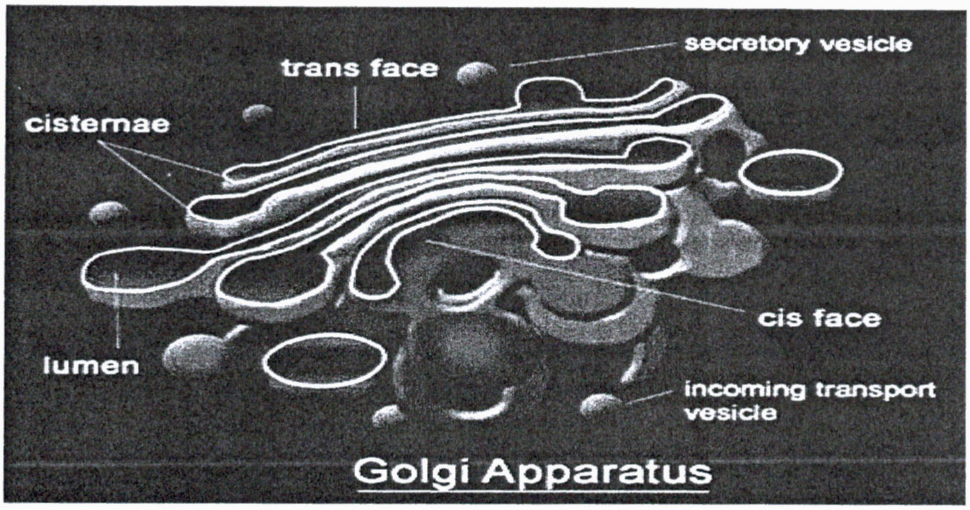






5- Golgi apparatus;

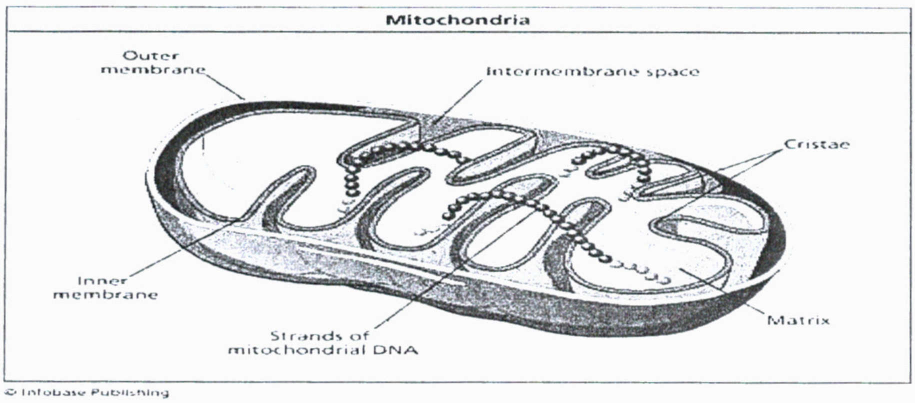
Golgi apparatus or Golgi complex or Golgi body is a small, irregular structure as flattened stacks of flattened membranes situated near the middle of the cell. This complex is known as the delivery system of the cell as it collects, packages and distributes molecules that are synthesized at one location within the cell and used at another. Transport vesicles bring the concerned material from the endoplasmic reticulum to Golgi apparatus. The formed material inside this apparatus are transported outside this apparatus through secretory vesicles. The number of these bodies in the cell depends on the activity of that cell. Golgi apparatus also forms lysosome bodies (lysosomes).



6- Mitochondria:

Mitochondria are typically tubular or sausage-like organelles, 1 to 3 pm long, found in all types of eukaryotic cells. Mitochondrion is bounded by two membranes: the outer one is smooth and the inner one is folded into numerous contiguous layers called cristae. The cristae partion the mitochondrion into two compartments: a matrix lying inside the inner membrane and an outer compartment or inter membrane space lying between the two mitochondrial membranes. On the surfaces of the inner membrane and also submerged within it, are the proteins that carry out oxidative metabolism, the oxygen-requiring process by which the energy in macromolecules in stored in ATP.

Mitochondria are frequently called the power houses of the cell or the cell's chemical furnaces as in which the high energy ATR is produced. ATP is produced in mitochondria by breakdown of organic compounds such as glucose and is sent to other parts of cell for providing energy. Active cells such as muscles and liver cells have a large number of mitochondria due to their high energy demands.



7- Ribosomes

Are small, complex assemblies of protein (35%) and ribosomal RNA (65%).The rRNA is manufactured by the DNA in the nucleolus. The ribosome consists of a large and a small subunit. Some ribosomes are scattered, singly or in clusters, in the cytoplasm and they are concerned with synthesizing protein for use inside the cell, while other ribosomes are attached to the rough endoplasmic reticulum and hence they are concerned with the synthesis of the proteins for export from the cell.

8- Centrioles:

Centrioles are cylindrical structures that are composed of groupings of microtubules , each centriole consists of a bundle of microtubules arranged as threes in a circle of nine (9 + 3 pattern). Found in animals cell, they occur in pairs near the nuclear membrane. The pair together is referred to as a centrosome.

The centrioles play a major role in cell division, Centrioles are also important to the formation of cell structures know as cilia and flagella

Centrioles

9-Lysosomes

Lysosomes are membrane-enclosed organelles that contain an array of enzymes capable of breaking down all types of biological polymers— proteins, nucleic acids, carbohydrates, and lipid. Lysosomes function as the digestive system of the cell, serving both to degrade material taken up from outside the cell in a process called heterophagy and to digest old cellular organelles as debris of the cell itself in a process called autophagy. when cells get old, lysosomes autolysis the cell and therefore known as suicide bags

10- Peroxisomes:

Peroxisomes also called microbodies: are enzyme –bearing, membrane bounded vesicles similar in structure to lysosomes but they are smaller. The name peroxisome refers to hydrogen peroxide that is produced as by-product of the activities of many of oxidative enzymes. H_2O_2 is dangerous to cell and peroxisome contain catalase enzymes that breaks down hydrogen peroxide into harmless water and oxygen for this reason, peroxisomes are known as detoxifiers for hydrogen peroxide.

11-Cilia and flagella

Cilia are short cellular projection from the cell membrane often organized in rows. Cilia are more numerous on cell surface than flagella which are more longer. Both cilia and flagella have the same internal structure as they consist of a circle of nine peripheral microtubule pairs surrounding two central microtubules. This arrangements is known as 9+2 structure. Cilia line human oviduct and hence they drive the fluid in which egg is transported all so trachea is lined with cilia which move the slimy mucous that traps dust particles and prevents getting into lung

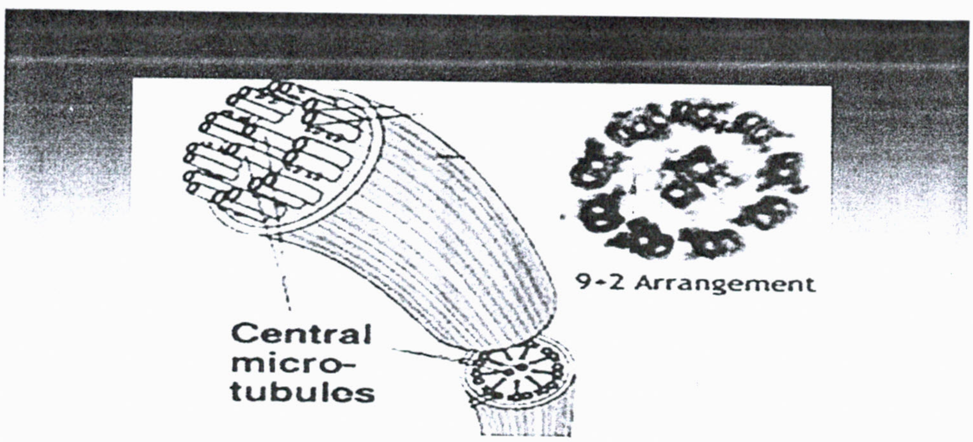
12- Microfilaments and microtubules

The cytoplasm of all eukaryotic cells is crossed by a network of protein fibers that supports the shape of the shape of the cell and anchors organelles to fixed location. This network is known as cytoskeleton or the interior framework of the cell

A- Microfilaments are rod-like structure of variable length and may occur in bundles, they are randomly scattered throughout the cytoplasm or arranged in a meshwork. Some microfilaments consist of proteins called actin, while other consist of myosin. In muscles the actine(thin myofilament) and myosin(thick myofilament) are involved in the contraction of the muscle cells.

In other cells microfilaments help to provide support and shape and assist in the movement within cells.

B-Microtubules are relatively straight, slender and cylindrical structures .They are consist of tubulin protein. Microtubules are found in the cytoplasm together with Microfilament, this help to provide support and shape for cells. Also, they form conducting channels through which various substances can move throughout the cytoplasm as in nerve cells. Microtubules form the structure of cilia, flagella and centrioles



13- Cytoplasmic inclusions

In addition to the living organelles found in the cytoplasm, other cellular components are found. Inclusions, considered to be nonliving components of the cell that do not possess metabolic activity and are not bounded by membranes. The most common inclusions are glycogen, lipid droplets, crystals and pigments. These may be synthesized by the cell itself or taken up from surrounding.

Lysosomes are vacuoles that probably snip-off from the Golgi apparatus. They contain enzymes (lysozymes) that break down the cell material it self by a process of “self-digestion” or autolysis.They are therefore a danger to the life of the cell if released. For this reason lysosomes are sometimes known as “suicide bags” because they self-destruct. Dissolving cell materials is a useful function after a cell dies but not before.

The plasma membrane(cell membrane) encloses all the cell components. It is a double structure like the endoplasmic reticulum. And the electron microscope plus biochemical studies show it as a sandwich of fatty material (phospholipids) between tow layers of protein. This sandwich structure is called a unit membrane. More recent studies suggest that the membrane in life may be rather less rigid than this, and talk about the fluid mosaic model.This is a complicated title for a simple idea as can be seen from the diagrams.

The cell membrane is not identical wherever it is found because it has different jobs to do in different places.

The fluid mosaic model allows to explain the changing permeability of membrane from time to time and place to place. The large globular proteins can float sideways in the oily lipid layer and thus create “pores” through which molecules can enter or leave the cell.

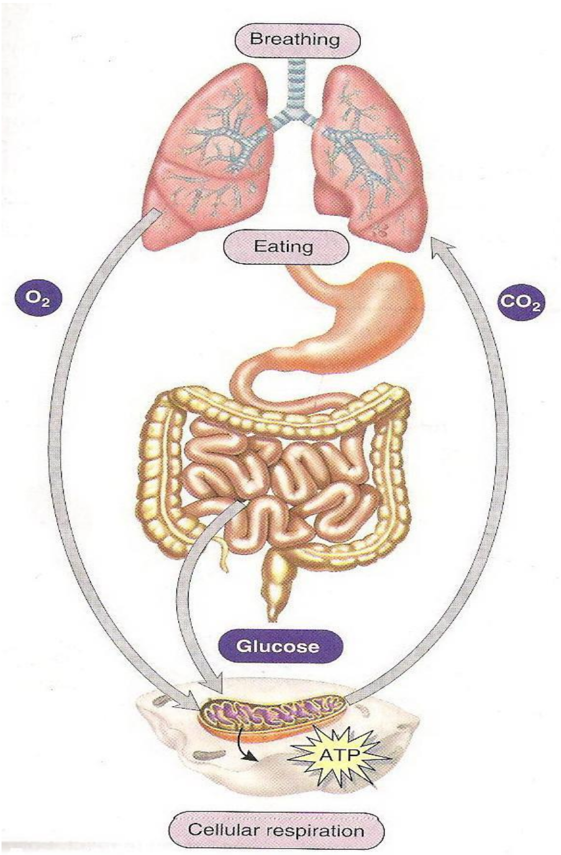
3.4 THE ENERGY—PRODUCING ORGANELES-MITOCHONDRIA

Energy needed by cell is manufactured by chemical reactions which take place in the mitochondria.

They are present in both animal and plant cells. (plants in addition have chloroplasts.

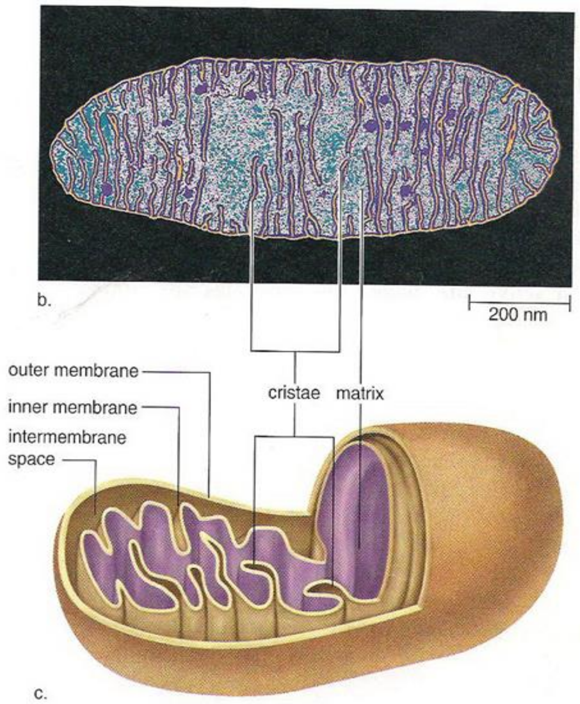
Organelles containing the green pigment chlorophyll that is able to transform sunlight energy into chemical energy that can be used by the plant).Mitochondria are frequently described as the “powerhouses” of the cell because here cellular respiration takes place and energy. Stored in the molecule ATP is produced. It is called cellular respiration because the cells take up the oxygen that we respire (breath in) and the glucose produced by digestion of the food that we eat and convert it to carbon dioxide and water in a chemical reaction that gives off energy. It is summarized by this equation.

Glucose +oxygen $\rightarrow$ carbon dioxide + water + energy



A mitochondrion is a fluid-filled tubular structure surrounded by a double membrane.

The inner membrane is folded into projections called cristae and it is on these cristae that the energy – producing enzymes are located.



There is an odd similarity between the cross-section of a centriole described earlier (9+ 0 pattern) and the cross-section of a cilium and a flagellum. These latter organelles have bundles of microtubules arranged in nine pairs and an extra central pair of tubules(9+2 pattern).

3.6 TRANSPORT BETWEEN CELIS AND THEIR SURROUNDINGS

Cells are grouped together to form tissues. Where the membrane of one cell touches that of another they tend to join up .they become “glued cell junctions of different sorts :

1. Tight junctions : proteins from each membrane fuse and thereby seal in the cell contents.
2. Desmosomnes: cell to cell links by means to thin filaments.
3. Gap junctions: the cell are joined by means of protein channels between the membranes across which substances as salts. Sugars. Amino acids .vitamins water may be transported .

Cell membranes do not allow all molecules to pass through them. They are often described as semi-permable but a better term is selectively permeable. This means that some small and large molecules can past through the pores whilst other large and small molecules cannot.

Cell membranes have a very important job because they must prevent potential poisons from entering the cell but allow foods .water and oxygen to enter.

The methods of passing through cell membranes can be summarized as follows:

1. Endocytosis
2. Exocytosis
3. Diffusion
4. Osmosis
5. Active and facilitated transport.

1. **Endocytosis**.

larger molecules or other materials can enter the cell by this method . the way it works can be seen in the illustration opposite.

Liquids can be packaged into a vacuole or vesicle which is then taken into the cell. This “cell drinking” is called pinocytosis.

Solids can also be taken up in this way “cell eating” is called phagocytosis. It is the method used by white blood cells when they “eat up” harmful microbes that may invade our bodies.

2.**Exocytosis:**

There are many substances that must exit from a cell. For example the secretions produced by the Golgi apparatus need to leave the cell if they are going to do their job. Exocytosis is the reverse of endocytosis. The secretion or enzymes are packagedinto vacuoles and then moved towards the cell membrane where they are discharged, as shown in the illustration.

3. diffusion:

This physical process is mot in any way related specifically to living organisms. Diffusion occurs in many day to day situations. For example perfume molecules or unpleasant or unpleasant smells will diffuse through the atmosphere of a room, and coloured dyes added to water will diffuse throughout the water.

When diffusion takes place molecules move from an area of high concentration to an area of lower concentration. This movement from high to low concentration is called movement down a diffusion gradient or concentration gradient.

Water molecules seem to be able to diffuse back and forth across cell membrane and so do oxygen molecules. Mostly, though, substances do not simply diffuse across membranes because, as we said before, membranes are able to control what molecules pass through them.

4. osmosis.

This is the diffusion of water across aselectively permeable membrane from an area of high concentration of water to an area of low concentration. Only the water molecules are able to cross the membrane, any larger molecules being held back.

A demonstration of osmosis may be set up in the laboratory. This experiment involves separating water from a sugar or salt solution by a selectively permeable membrane. The water is able to pass through the membrane and thereby dilute the salty or sugary solution on the other side. As the water accumulates on the solution side of the membrane it produces a pressure, called the osmotic pressure.

The effects of osmosis depend upon the difference in concentration between the solutions on either side of the membrane. The osmotic effect is extremely important for the normal functioning of our bodies. Take an elementary example. If we leave our hands in fresh water for any length of time we notice an effect caused by osmosis. If we are immersed in salty sea water for a long period of time our skin tends to get shriveled because some water is drawn out of our tissues.

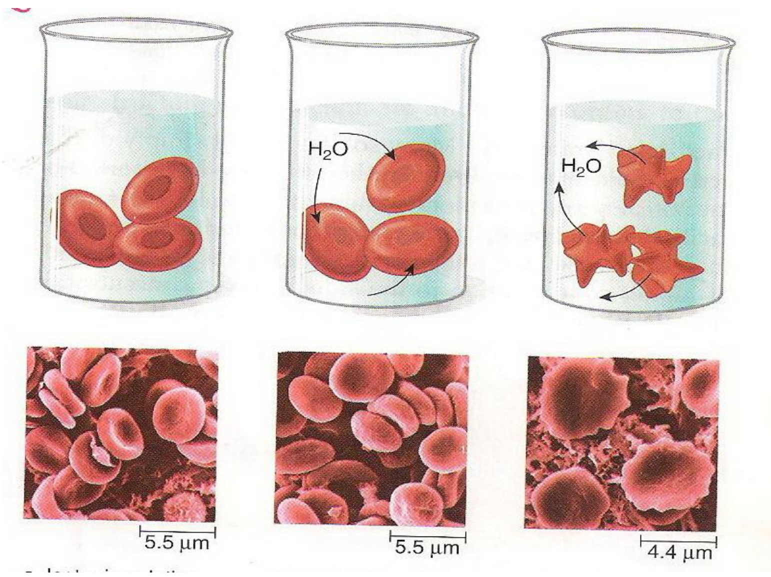
When we give blood or other body fluids to patients we must be very careful that the osmotic concentration is correct.

Solutions have an osmotic effect on our tissues that is dependent upon the strength of the solution compared with that of the body fluids:

Isotonic colutions are those of equal strength to our body fluids. They therefore cause neither shrinking nor swelling of cells and tissues. A 0.9% solution of blood cells.

Hypotonic solutions contain less dissolved material and more water than the body fluids. This water passes into the cells by osmosis and causes them to swell up and eventually burst. A solution of salt weaker than 0.9% is hypotonic to red blood cells and so water will pass into the cells and cause haemolysis (swelling and eventual bursting) .

Hypertonic solutions contain more dissolved material and less water than the body fluids. Water therefore leaves the cells by osmosis and causes them to shrink.



A 10% solution of sodium chloride is hypertonic to red blood cells and will cause them to shrink (crenate; the process is called crenation) because of the withdrawal of water.

v. active transport. We have just said that chemicals-water and so forth-tend to move down a concentration gradient, that is from a high concentration to a lower concentration. Not always. They can move by active transport, which uses energy to “pump” materials into the cell against the concentration gradient. Cells that accumulate and store materials use this transport method. Below are some examples.

The thyroid gland cells collect iodine from the blood. Glucose sugar is soaked into the gut cells from the intestinal fluids. Surplus sodium is taken out of body fluids by the kidney cells to be excreted in the urine. A “sodium pump” is an energy-using process that pushes sodium out of cells and takes potassium inside. This active transport method is used to “prime” nerves and muscles ready for action.

5. facilitated transport.

This is a sort of faster diffusion. It takes place along special protein path-ways in the cell membrane, across which chemicals can pass more quickly. These protein “carriers” take glucose and amino acids into the cell quicker than would be expected for normal diffusion processes.

CHAPTER FOUR

TISSUES

4.1 TYPES OF TISSUE

The four main types of tissue are:

1) Epithelial tissues cover surfaces, inside and outside the body, The inside epithelium coats the intestines and the body cavities, The outside epithelium is represented by the outer layers of skin .

2) Connective tissues connect one structure to another, They can be found in most parts of the body as gristle, bone or blood .

3) Muscular tissues contract when stimulated These are the tissues that move parts of our body such as the skeleton, intestines or heart .

4) Nervous tissues conduct impulses when stimulated, They pass "information" from one organ to another.

4.2 EPITHELIAL TISSUES

These tissues resemble flat sheets of cells that cover exposed surfaces, There are no blood vessels running into these tissues so oxygen and food enters the tissue cells by diffusion, Epithelium is called simple if it is only one cell layer thick.

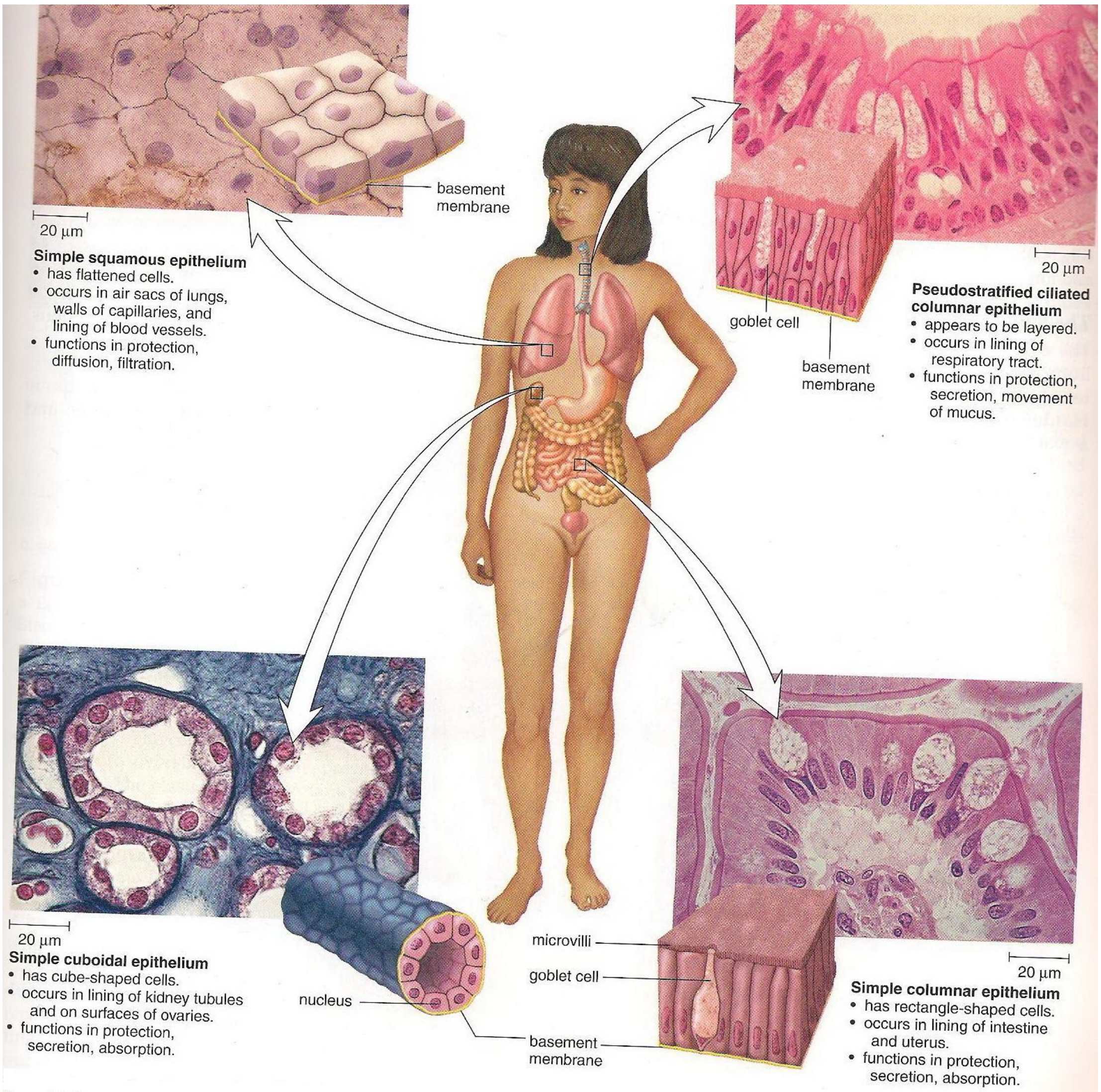
Squamous epithelium is a squashed (pavement slaps) type of tissue layer that lines the inside of blood vessels (endothelium) .the inside of the lung cavities (mesothelium) and the insider of the mouth and oesophagus .

It is quite a simple task to prepare a microscope slide of this type of epithelium using cells taken from your own inner cheek lining (p.383).

Columnar epithelium consists of cells with a column shape. These cells line the stomach and intestines. Amongst these cells are those that are described as goblet because of their shape. They secrete the slimy mucus that lubricates the inside of the stomach and intestines. The columnar cells are specialized to absorb most dissolved substances passing along the length of the intestines. The free cells membrane of a columnar cell is folded into hundreds Of finger-like microvilli toinercase the area for absorption.

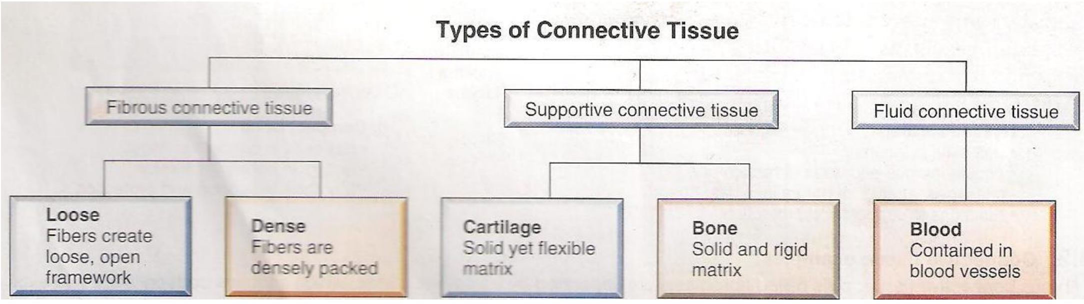
Ciliated columnar epithelium is found lining the inside of the windpipe (trachea). These whisker-like cilia beat to move the mucus over the lining of the windpipe and up to the back of the throat. This keeps the passageways clear of trapped particles.

Cuboidal epithelium is made up of cube-shaped cells. This type of epithelium lines the tubules within the kidneys. These cells have an important job to do because they absorb water and salts as urine is produced.



Stratified epithelium is a many layered epithelium. A good example is the skin which has an extremely thick outer layer called the epidermis.

4.3 CONNECTIVE TISSUES



These tissues bind body structures together or they provide a framework for the body. There are many types of connective tissue. The range of connective tissues and their function in the body are outlined on the next page.

The greatest part of connective tissue is an inter-cellular material which can be fluid as in the case of blood, or hard and rigid as in bone .

Some of the cells within connective tissue serve an important defensive function. Such cells are phagocytes which means that they are capable of engulfing foreign particles like bacteria.

Reticular tissue is a network tissue found within such structures as the liver. Spleen and lymph nodes. It forms support tissue for many organs. It also has a defensive function because it contains phagocytic cells that destroy invading foreign particles.

Areolar tissue is a loose general packing tissue. There are elastic and non-elastic fibres running throughout this tissue giving it strength as well as flexibility. It also contains cells such as macrophages (phagocytes) and other cells that produce antibodies and anti-coagulants. His tissue is found all over the body. Such as beneath the skin (subcutaneous) supporting organs. Lying under membranes and within the walls of blood vessels .

Adipose tissue is fatty tissue. It has cells that are able to store fat within the cytoplasm area, pushing the nucleus to one side .

This tissue is found beneath the skin, around the heart and kidneys as well as acting as a padding around joints .

This is a padding, insulating and energy storage tissue which supports and protects many parts of the body .

Fibrous connective tissue (collagen) is white in appearance and runs in bundles throughout many organs and other structures. It is non-elastic. It is found making up the composition of tendon (muscle to bone connectors). And ligaments (bone to bone connectors). It is also found within the moveable scalp or aponeurosis. Elastic fibrous connective tissue is yellow in appearance and has much branched fibres running throughout organs that are capable of changing shape. This type of tissue is found in the vocal cords, lung tissue, walls of the arteries, and the windpipe. It also makes up part of the inter-virtebral discs located between the vertebrae of the backbone.

Cartilage tissue exists in three main forms :

I. Fibro-cartilage
II. Elastic cartilage
III. Hyaline cartilage

I. Fibro-cartilage is a tough flexible tissue which contains non-elastic fibres. It is found in the discs between the vertebrae as well as in the symphysis pubis (front of pubic bones) .

II. Elastic cartilage is much more flexible because it contains yellow elastic fibres. This is located in the pinna (external ear), the larynx and in the nasal septum .

III. Hyaline cartilage is the most common type of cartilage. It is a glossy, bluish-white flexible material which has a gel-like background or matrix in which there are cell spaces (lacunae) containing cartilage producing cells (chondrocytes). Cartilage is covered by its own membrane called the perichondriun. This type of cartilage is found at the ends of bone and in the trachea and bronchi. The flexible parts of the rib cage are also made up from hyaline cartilage.

Bone is a tough and more brittle tissue than cartilage. It is formed in the body by a process known as ossification. The bones of an adult are formed upon the cartilage and fibrous framework in the embryo. This process begins at about week 6 of embryonic life and it continues into adult life. The areas that are destined to become bone tissue are invaded by bone-building cells called osteo-blasts. The whole bone surface is covered by a membrane called the periosteum. The microscopic structure of bone tissue is peculiar is that the spaces between the cells contain the salts calcium phosphate and calcium carbonate. These salts cause the hardness of bone. There are two recognizable types of bone tissue, dense bone and spongy bone .

1) Dense or compact bone is located in the outer surface of the bone and shows concentric rings called the Haversian systems. Each ring of calcified caterial is called a Lamella between whivh are cell spaces(Lacunae) containing mature bone cells called Osteoyres .

Running down through the lamellae is the Haversian canal which is linked up to all the cell spaces by canals called canaliculi. These canals carry blood vessels that supply foods and remove wastes from the growing bone .

2) Spongy bone has no Haversian systems. It consists of a honeycomb of bony divisions called trabeculae. It is within these spaces that red marrow is found at the ends of bone or yellow marrow in the shaft area.

4.4 MUSCULAR TISSUES

These are contractile tissues which contract and shorten their length when stimulated by nerve action. They return to their original length after they have done their job. There are three main types of muscle tissues .

(a) skeletal(striated) muscle

(b) visceral(un-striated)muscle

(c) cardiac (striated) muscle

Skeletal muscle as seen under the microscope is striped or striated in pattern. These are the muscles that are under our conscious control and enable us to move our arms and legs .

Visceral muscle as seen under the microscope is unstriped or smooth. These are the muscles found in those organs over which we have no conscious control(involuntary muscle). They move the walls of the digestive tract, the walls of the uterus and the bladder. They are also responsible for the fine adjustments in diameter of the blood vesscle .

Cardiac muscle can be seen to ve striped or however not under our conscious on the skeleton. It is unvoluntar. Heart muscle is responsible for the constant pumping action of the heart. The fibers of this muscle show a branching structure.

Tissues	Locality	Functions
Epithelial		
Simple squamous	Lining the lung air sacs Linings of blood vessels (endothelium) and pleural cavities (mesothelium)	To permit the passage of gases by diffusion To absorb by diffusion and osmosis
Stratified squamous	Lining the mouth and oesophagus Epidermis of the skin	Both are protective
Simple columnar	Lining the stomach and intestines	Protection, secretion absorption
Simple cuboidal	Found in the kidney tubules	Absorbs water and salts
Connective		
Reticular tissue	In lymph nodes, spleen and bone marrow	Defends against micro-organisms by phagocytosis
Areolar tissue	Found between tissues and organs	Support and connection
Adipose tissue	Found under the skin	Protection, insulation, support, energy storage
Fibrous tissue	Found in tendons, ligaments, beneath the scalp and within the dermis	Connectors with flexibility
Cartilage (hyaline)	Covers the surface of bone ends at joints. Forms the voice box (larynx) and the hoops of the windpipe and bronchi	Tough, flexible support
Cartilage (fibrous)	Forms the intervertebral discs	
Cartilage (elastic)	Supports the external ear (pinna)	
Bone	Skeletal structures	Protective framework. Attachments for muscle. Support for organs
Blood	Circulates in blood vessels	Defensive and transportation
Muscle		
Skeletal (voluntary striated)	Attached to bones	Move bones under conscious control
Visceral (involuntary non-striated)	Found in the walls of the digestive tract, of blood vessels and the respiratory tracts. Found in the ducts of glands and the urino-genital tracts	Move materials along tubes or ducts. Not under conscious control
Cardiac (involuntary striated, branched)	Found in the wall of the heart	Heart pumping action. Not under conscious control
Nervous	Nerves Spinal cord Brain	Conduction of stimuli

4.5 NERVOUS TISSUE

The nervous tissue is sensitive to stimulation and conducts impulses from point A to B. The microscopic detail of nerve tissue shows it to be made of two components. The neurons which conduct the impulses, and the connective binding that binds many thousands of neurons to make up the whole nerve. This "neural glue" (neuroglia) will not be covered here because it does not carry nerve impulses .

Nerve cells or neurons have three recognizable parts, the neuron cell body, the dendrites and the axon. The neuron cell body is a nucleated structure which receives incoming stimuli through the branching dendrites. Once the stimulus is "picked up" by the cell body an impulse is transmitted along the axon. These axons can be up to 3 feet or one meter long in some parts of the body .

The axon terminates in fine filament "neuron endings" which come into close contact (they do not touch) with another cell's dendrites (synapse) , or they form nerve-muscle junctions (myoneural junctions) .

The structures and functions of the different types of neurons may for convenience be described as follows :

(a) Sensory neurons carry impulses from sense-organ receptors into the brain or spinal cord. They may also known as afferent neurons .

(b) Motor neurons (also known as efferent neurons) carry impulses from the brain and spinal cord to muscles or glands (effectors) .

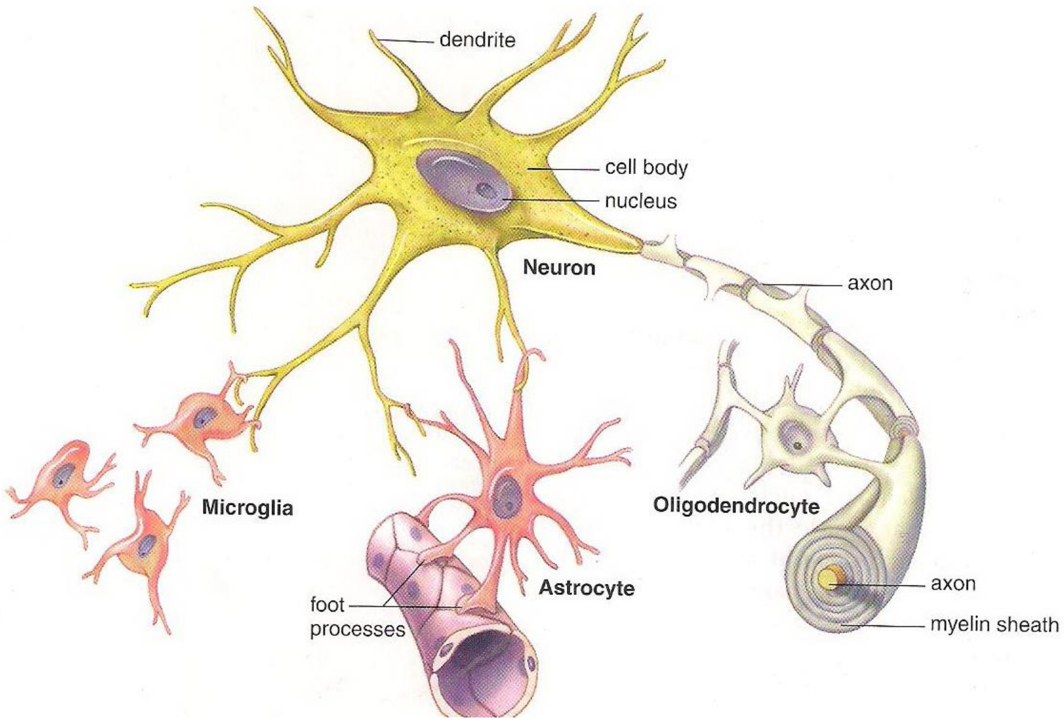
(c) Intermediary or association neurons are those found within the brain or spinal cord. They link up the sensory and motor neurons .

There are different types of neuron with different numbers of dendrites coming off the cell body .

Multipolar neurons are those that have many dendrite processes on the cell body and one axon. These are found within the brain or spinal cord.

Bipolar neurons have one dendrite and one axon and are typical of the sense receptors in the eye or ear .

Seen under the microscope a neuron can be seen to have its axon insulated from other axons by a fatty sheath called the myelin or medullated sheath. At points along the length of these sheaths it pinches in to form an exposed area of axon called the node of Ranvier. The whole sheath is enclosed in a fine membrane or neurilemma. This membrane has an important function in the regrowth or regeneration of damaged axon. Nerve impulses travel from the cell body towards the nerve endings.



4.6 MEMBRANES

Membranes are epithelial tissues overlying connective and other tissues.

1. Serous membranes are characterized by the secretion that they produce which is a serum-like lubricating fluid. These membranes line those internal body cavities that have no opening to the outside. They also cover the organs lying in those cavities.

Examples: the lining membrane of the thoracic cavity and the covering of the lungs (the pleural membranes).

Covering membrane of the heart (the pericardium).

The lining of the abdominal cavity covering the abdominal organs (the peritonewn)

The lubricating fluid reduces the friction as internal organs move one over another.

2. Mucous membranes are characterized by the thicker, syrup-like secretion they produce called mucus. This fluid keeps surfaces damp and lubricates them. These membranes are found lining those body cavities that have an opening to the outside .

Examples: the lining membrane of the mouth

The entire digestive tract lining

The respiratory passage linings

The reproductive passage linings

The mucus not only lubricates but also traps dirt particles in the nasal and respiratory passages. It has a protective function inside the urinary tubes and within the intestines

3. Synovial membranes are found lining the cavities of moveable joints (synovial joints). They secrete a thick lubricating synovial fluid which eases the passage of one bone over another during movement.

Example: knee and elbow joints.

4.7 INFLAMMATION OF TISSUES AND TISSUE REPAIR

Damaged tissue cells respond by becoming inflamed. There are many types of injury that may bring on the inflammatory response for example.

Physical damage or poisoning by bacterial waste-products (toxins)

Inflammation:

I. redness due to increased blood flow in the region

II. Pain due to pressure on surrounding nerves caused by the swelling.

III. heat due to increased blood flow in the area

IV. swelling resulting from fluid uptake by the tissues.

All these responses ate an attempt on the part of the injured tissues to restore normality to the area .

These tissue changes are brought about by a chemical called histamine which os liberated from injured cells .

During the inflammation response some white blood cells are killed off as they encounter the poisons given off by invading bacteria. These dead white cills may accumulate in or beneath the skin as pus which can be very painful if it has no way out of the tissues(abscess) .

Only after all the offending substances have been removed from the body will new cells form to heal the damaged tissue. When new connective tissue is put across the damaged area then we have a scar and tissue function at that point is impaired. This type of scar tissue with accompanying impaired function is called fibrosis.