UNIVERSITY OF SCIENCES AND TECHNOLOGY HOUARI BOUMEDIENE
FACULTY OF BIOLOGICAL SCIENCES
TCE-ANGLAIS

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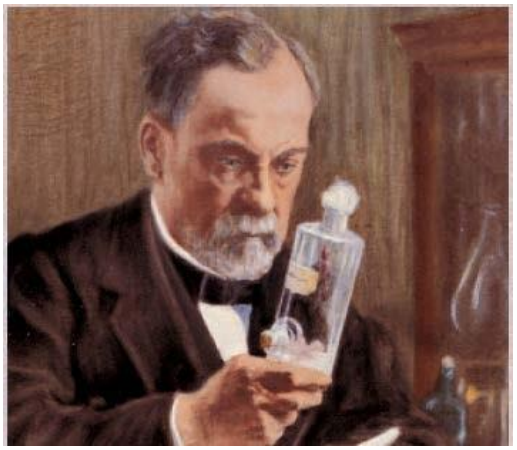


Louis Pasteur, one of the greatest scientists of the nineteenth century, maintained that "Science knows no country, because knowledge belongs to humanity, and is a torch which illuminates the world."

Foreword

The English for SNV (TCE-Anglais) group is a teaching team which is made of seven lecturers from different disciplines within the Faculty of Biological Sciences at the University of Sciences and Technology Houari Boumediene. We work with colleagues in providing lectures and other learning material for second year undergraduate biology students.

We promote the innovative idea of introducing basic biology sciences in English as a starter which will offer the students an insight into the scientific English language and encourage progression to scientific reading/writing and ultimately, research.

Our team prepares and support students in the areas where the learning of the language may be challenging. The education material is studied carefully by each member of staff to ensure an interesting and easy communication.

The lectures are presented through a range of subjects; (Biochemistry, Botanics, Ecology, Genetics, Immunology, Microbiology and Zoology). It is aimed for the students to gain knowledge of the most crucial scientific vocabulary amongst other areas that are complementary to their academic programme.

The provided support here is a complement to lectures with a fuscous on divers activities (fill in the gaps, complete figures, and pick keywords) to practice the acquired knowledge and vocabulary. It should not be considered in any way as an alternative to lectures.

We look forward to welcoming you to the English for SNV (Sciences de la nature et de la Vie) (LNS) LIFE AND NATURAL SCIENCES module and working with you to realise your full potential at USTHB.

Outline

GENETICS PART:

- What is a cell?
  - Organelles and Components
- What is a nucleus?
- What is DNA?
  - What is DNA made of?
  - Shape of the DNA Molecule
- What is a gene**?**
  - How do cells know what to do?
- What is a mutation?
- What is a chromosome?

IMMUNOLOGY PART:

Introduction:

- The concept of innate and adpatative immunity:
  - Epithelial barriers:
  - Leukocytic phagocytes:
  - Dendritic cells ity.
  - Natural killer cells
  - Plasma proteins:
  - Cytokines:
  - Memory cells
- Innate immunity vs adaptive immunity
- Humoral immune response:
- Different classes of antibodies:
- T cell-mediated immune response :
- Phases of immune response:

MICROBIOLOGY PART:

- Microorganism world, Part 1:
  - Microbiology
  - Taxonomy and principal groups.
  - Methods in microbiology.
    - Classical microbiology
    - Methods of destruction (see lecture)
    - Fermentation (see lecture)
- Microbes Interactions, Part2:
  - Microbial ecology:

- Clinical microbiology:
- Microbiology of food:
- Industrial microbiology and biotechnology:

ZOOLOGY PART

- PART I: INTRODUCTION
  - What is Zoology?
  - Why study Zoology?
    - Cells as units of life
      - Kinds of cells
      - Kinds of eukaryotic cells
      - Organisms show variety in cell number
  - Binomial Nomenclature
    - Rules for writing scientific names
  - Classification of animals
  - Symmetry in animals

- PART II: Invertebrate Zoology
  - The role of freshwater invertebrates in the foodweb
  - Porifera
  - Cnidaria
  - Worms
  - Mollusks
  - Arthropods
  - Echinoderms
  - The main characteristics of animals

- PART III: Vertebrate Zoology
  - Vertebrate characteristics
  - Reptiles
  - Amphibians
  - Fish
  - Birds
  - Mammals

BOTANY PART

PART I. INTRODUCTION

1. Definition of Botany
2. History of Botany
3. Plant systematic
4. Role of microscope in botany
5. Study of different groups

Algae
Fungi
Lichens

PART II. EMBRYOPHYTA

1. Definition
2. Importance of photosynthesis process
3. Different groups of Embryophytes

Bryophytes (Mosses)
Pteridophytes (Ferns)
Coniferophytes (Pinaceae)
Angiosperms
Morphology of plants
Definition of flower
Pollination, fertilization and seed dispersal
Different classes of Angiosperms

PART III INTERESTS OF PLANTS AND USES

1. Plants and Ecology
2. Plant biotechnology
3. Phytopharmacy

ECOLOGY PART

- What is ecology?
- Habitat, microhabitat and niche
- Component of an ecosystem
- Levels of organization in ecology
- Interspecific interactions in an ecosystem
- Food webs and feeding relationships in an ecosystem
- Exercises

BIOCHEMISTRY PART

I-Definition
II. The chemical basis of life.
1. Functional Groups on Molecules.
2. Many biomolecules are polymers.

III- Structures of the Major Compounds of the Body

1. Lipids
2. Nitrogen-containing compounds.

A. Nucleic acids.
B. Proteins.

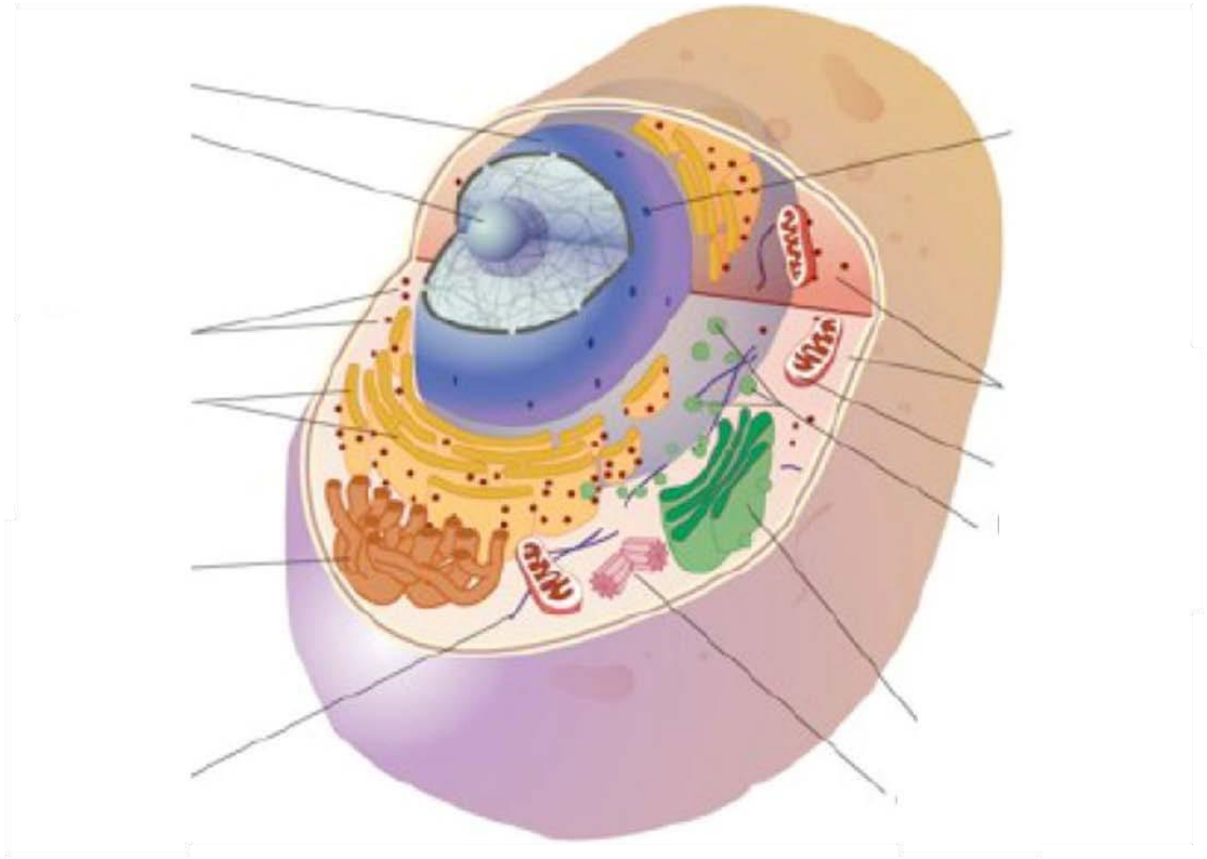
IV. The energetics of life.

Genetics Part

I- What is a cell?

Animal cells are ……, or cells with a membrane-bound nucleus. Unlike……., **DNA** in animal cells is housed within the nucleus. In addition to having a nucleus, animal cells also contain other membrane-bound organelles, or tiny cellular structures, that carry out specific functions necessary for normal cellular operation.

Organelles have a wide range of responsibilities that include everything from producing ……..and …… to providing energy for animal cells.



Organelles and Components

The following are examples of structures and organelles that can be found in typical animal cells:

- …… - thin, semi-permeable membrane that surrounds the **cytoplasm** of a cell, enclosing its contents.

- …… - cylindrical structures that organize the assembly of microtubules during **cell division**.

- …….. - gel-like substance within the cell.

- ……- extensive network of membranes composed of both regions with ribosomes (rough ER) and regions without ribosomes (smooth ER).

- …… - also called the Golgi apparatus, this structure is responsible for manufacturing, storing and shipping certain cellular products.

- …… - sacs of enzymes that digest cellular macromolecules such as **nucleic acids**.

- ……. - hollow rods that function primarily to help support and shape the cell.

- …….. - Cell components that generate energy for the cell and are the sites of **cellular respiration**.

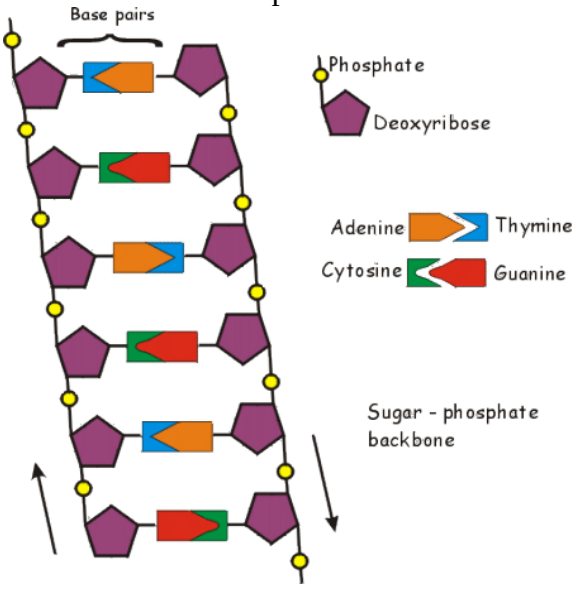
- …….. - Membrane bound structure that contains the cell's hereditary information.
    - **…….** - Structure within the nucleus that helps in the synthesis of ribosomes.
    - **……** - tiny hole within the nuclear membrane that allows nucleic acids and proteins to move into and out of the nucleus.
- …… - consisting of RNA and proteins, responsible for protein assembly.

II- What is a nucleus?

Nucleus contains most of the cell's ……., organized as multiple long linear ……. molecules in complex with a large variety of ……., such as **histones**, to form ……... The ……. within these chromosomes are the cell's nuclear genome. The function of the nucleus is to maintain the integrity of these genes and to control the activities of the cell by regulating …….. The nucleus is, therefore, the control center of the cell

III- What is DNA?

DNA is an essential molecule for life. It acts like a recipe holding the instructions telling our bodies how to develop and function.



a- What is DNA made of?

DNA is a long thin molecule made up of something called nucleotides. There are four different types of nucleotides: adenine, thymine, cytosine, and guanine. They are usually represented by their first letter:

- A- ……..
- T- ……..
- C - …….
- G - ……

Holding the nucleotides together is a backbone made of **phosphate** and **deoxyribose.** The nucleotides are sometimes referred to as **"bases".**

b- Shape of the DNA Molecule

Although DNA looks like very thin long strings under a microscope, it turns out that DNA has a specific shape. This shape is called a ……. On the outside of the double helix is the backbone which holds the DNA together. There are two sets of backbones that twist together. Between the backbones are the nucleotides represented by the letters A, T, C, and G. A different nucleotide connects to each backbone and then connects to another nucleotide in the center.

> Only certain sets of nucleotides can fit together: A only connects with T and G only connects with C.
>…….

IV- What is a gene?

Within each string of DNA are sets of instructions called genes. A gene is transcribed to an RNA which may then be translated to a protein. Proteins are used by the cell to perform certain functions, to grow, and to survive.

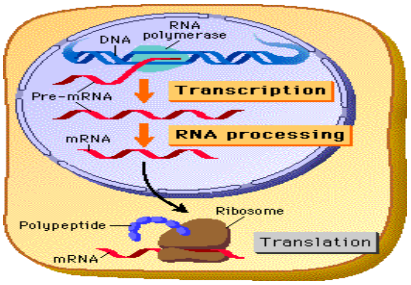
a- How do cells know what to do?

>> The DNA Code

The DNA code is held by the different letters of the nucleotides. As the cell "reads" the instructions on the DNA the different letters represent instructions. Every three letters makes up a word called **a codon**. A string of codons may look like this:

ATC TGA GGA AAT GAC CAG

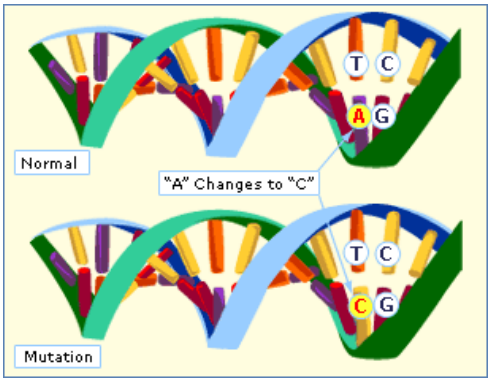
>> Gene expression



It first involves ……., in which DNA is used as a template to produce RNA. In the case of genes encoding proteins, that RNA produced from this process is …… , which then needs to be ……. by ……to form a protein. As ribosomes are located outside the nucleus, mRNA produced needs to be exported.

V- What is a mutation?

Mutation is a permanent alteration in the DNA sequence that makes up a gene, such that the sequence differs from what is found in most people. Mutations range in size; they can affect anywhere from a single DNA building block (gene mutation) to a large segment of a chromosome that includes multiple genes (chromosome mutations).



VI- What is a chromosome?

When a cell is not dividing (interphase of the cell cycle), the chromosome is in its chromatin form. In this form it is a long, very thin, strand. When the cell begins to divide, that strand replicates itself and winds up into shorter tubes. Before the split, the two tubes are pinched together at a point called the centromere. The shorter arms of the tubes are called the "p arms" and the longer arms are called the "q arms."

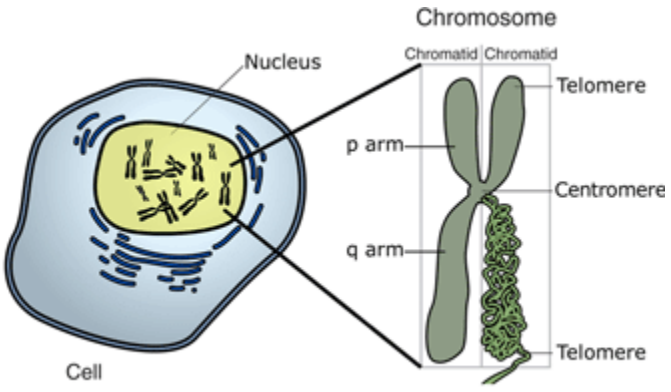
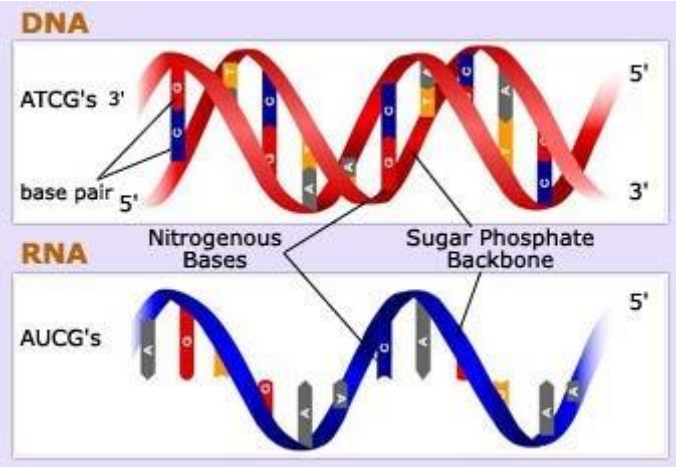


Image adapted from: National Human Genome Research Institute.

Where is the mistake on this figure?

……

Activity : Compare between DNA and RNA:



Similarities:

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Differences:

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- **Question:** can we use the presence of DNA as an argument to say that an organism is living?

  ……
  ……
  ……

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Immunology Part

Introduction:

Immunology is the study of immune system including its responses to microbial pathogens and damaged tissues and its role in disease

Immunity is the ability of the host to protect its self against exogenous or endogenous pathogens: viruses, bacteria, fungi, parasites and toxins.

The immune system comprises tissue, cells and molecules which mount **the immune response**

➔ **The concept of innate and adpatative immunity:**

The immune response consists of two types of responses:

Innate immune response also called natural or native immunity is the first line of defense against invading pathogens, it comes.....after the start of an infection and is mediated by cells and proteins.

The most components of innate immunity are always present in healthy individuals and ready to prevent the entry of pathogens in host tissues.

The innate immunity mechanisms rely on the ability **….** conserved microbial structures shared by large groups of pathogens, also called ….....or endogenous molecules that are produced or released from damaged and dying cells called **….**. Moreover, pattern associated molecular pathogen are essential for microbial survival, they are produced only by microbes and not by host cells.

The major components of the innate immune response are:

- **Epithelial barriers**: skin and other epithelial surfaces of the respiratory and gastrointestinal tract constitue a physical barrier that prevent the entry of microbes. These surfaces are covered by a mucus layer that provides a physical impediment. Natural antibiotics with broad spectrum of anti-microbial activity such as defensins and cathelicidins are also secreted by epithelia and kill pathogens or inhibit their growth.

- **Leukocytic phagocytes**: Microorganisms invading tissues are exposed to phagocytes when they do breach the epithelial barrier. phagocytes engulf and digest them. Phagocytes such as …..... display a variety of cell-surface receptors that enable them to recognize, ingest pathogens into vesicles and destroy them chemically. Macrophages secrete also proteins called cytokines that stimulate inflammation and lymphocytes response. These cells act as antigen presenting cells and activate the cells of adaptive immune response.

- **Dendritic cells** recognize molecular structures of microbes through pattern recognition receptors, they produce numerous cytokines in response to microbes that initiate inflammation and stimulate adaptive immune response. Moreover, dendritic cells provide initial defense against viruses. The major function of these cells is …..... They constitue therefore an essential link between innate and adaptive immunity.

- **Natural killer cells** are a class of lymphocytes that recognize and kill …..... They detect and kill self cells that have down-regulated class I molecule expression They also respond by secreting the macrophage activating cytokine Interferon- Interferon-γ (IFN–γ).

- **Plasma proteins:** the proteins of the complement system constitute the major plasma proteins among many circulating proteins that are important in defense against pathgens. Complement proteins coat pathogens and promote phagocytosis by interacting with complement protein receptors on the surface of macrophages. This process is called …..... Some complement proteins promote also the recruitement of monocytes and neutrophils at the site of infection. The complement system plays a role in adaptive immunity since it is activated by antibodies. The complement system is a group of circulating and membrane associated proteins. A number of these proteins are proteolytic enzymes that are themselves activated by proteolytic cleavage.

- **Cytokines:** are soluble proteins that stimulate and regulate immune and inflammatory responses and are responsible for communications between leukocytes and leukocytes with other cells. The binding of microbial products (PAMPs) to their receptors (PRR) on the surface of dendritic cells and macrophages induces cytokines secretion. In innate immunity , cytokines serve many functions, some cytokines act as chemmoattractant of neutrophils and monocytes to the site of infection, induce fever and stimulate the production of acute pahse reactants from hepatocytes. …..... produced by a subset of dencritic cells and some infected cells inhibit viral replication and limit the spread of the infection to uninfected cells.

However, many pathogens are able to overcome the innate immune response. Defense against that pathogens requires the activation of the ….....

Adaptive immune response, also called specific or acquired immunity, is a more …..... defense that operates later in the infection. It is activated against pathogens that resists innate immunity. The adaptive immunity is mainly mediated by ….....such as ….....These components requires **activation, expansion and differenciation** in response to microbes in order to provide effective defense.

Memory cells persist after a response and respond **rapidly and effectively** in a secondary response to the same antigen.

Adpative immunity is divided into two major types of immune responses:

Humoral immune response is mediated by **antibodies** produced by **B lymphocytes** and provides defense a**gainst ….....**

Cell-mediated immunity is mediated by **….....**and provides defense **against intracellular pathogens.**

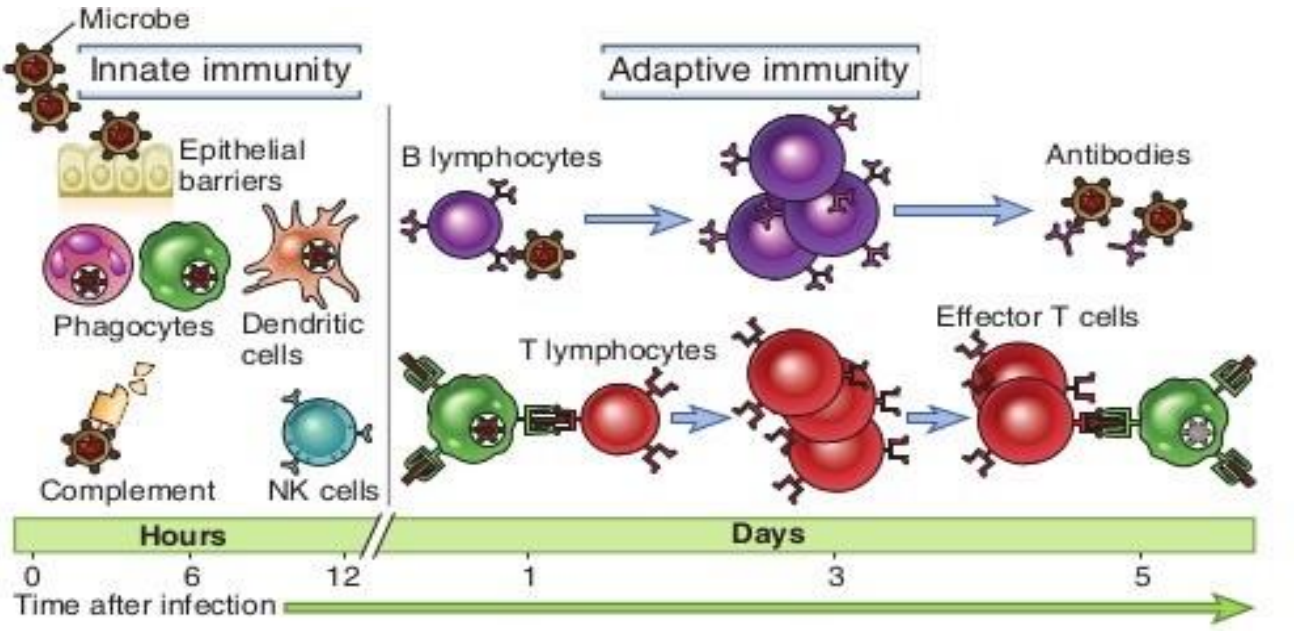
The major components of adative immunity are:

- **….....** derive and mature in **the bone marrow**, they are essentially present in lymphoid tissues, peripheral blood and bone marrow and other lymphoid tissues. These cells mediate **humoral immunity** since they are the only cells that produce **antibodies**. B cell receptor is membrane bound antibody (membrane bound

immunoglobulin) and known as **….**. Antigen binding to BCR intiate the process of B cell activation and differentiation into **….** which secrete a large amount of **antibodies**. **Antibodies** bind to microbial antigen, neutralize and eliminate microbes and microbial toxins that are present outside of host cells.

- **T lymphocytes** mature in **….**, they are essentially present in peripheral blood (60 to 70% of circulating lymphocytes), spleen and lymph nodes. T lymphocytes mediate **….**. The receptors of most T lymphocytes also called **T cell receptor (TCR)** recognize only **….** that are dispalyed by specialized peptide display molecules called **….** on the surface of **antigen presenting cells.** There are two major subsets of T lymphocytes, **$CD4^+$ T cells** called **….**, they help B lymphocytes to produce antibodies and phogocytes to eliminate ingested microbes. **….** called **cytotoxic T lymphocytes**, they kill host infected cells and tumor cells.

➔ **Innate immunity vs adaptive immunity**

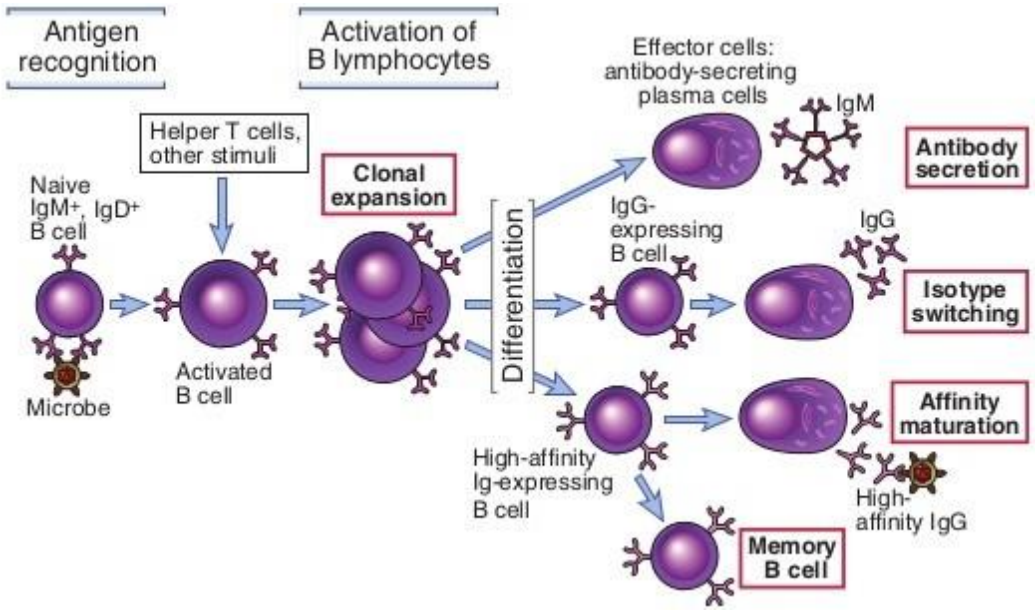


Abbas & al. Basic immunology: functions and disorders of the immune system. Elsevier Health Sciences, 2012

FIGURE 1 : Comparison between innate and adaptive immunity mechanisms

• Always present in healthy individuals and ready to block the entry of pathogens • …. • …… • receptors with..... encoded in …. • non clonal distribution of receptors • …. • no memory, response with equal potency to repeated exposures to the same antigen	• …. • Slower response (1-2 weeks) but more powerful • Highly specific receptors for structural details of microbial molecules : TCR/BCR • receptors with greater diversity generated by somatic recombination of gene segments • clonal distribution of receptors • clonal expansion of antigen specific lymphocytes • ……

➔ **Humoral immune response:**



Abbas & al. Basic immunology: functions and disorders of the immune system. Elsevier Health Sciences, 2012

FIGURE 2: phases of humoral immune response

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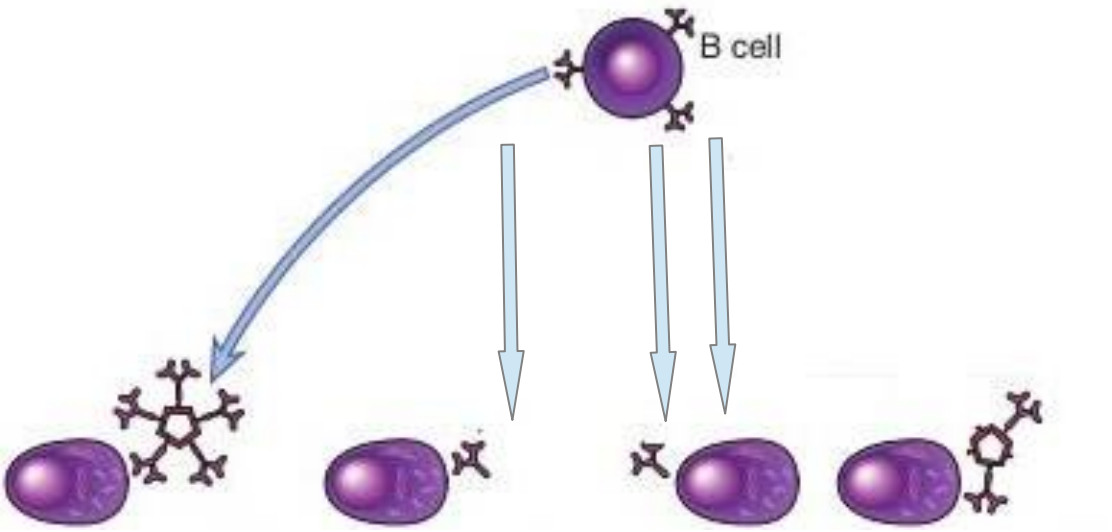
➔ **Different classes of antibodies:**



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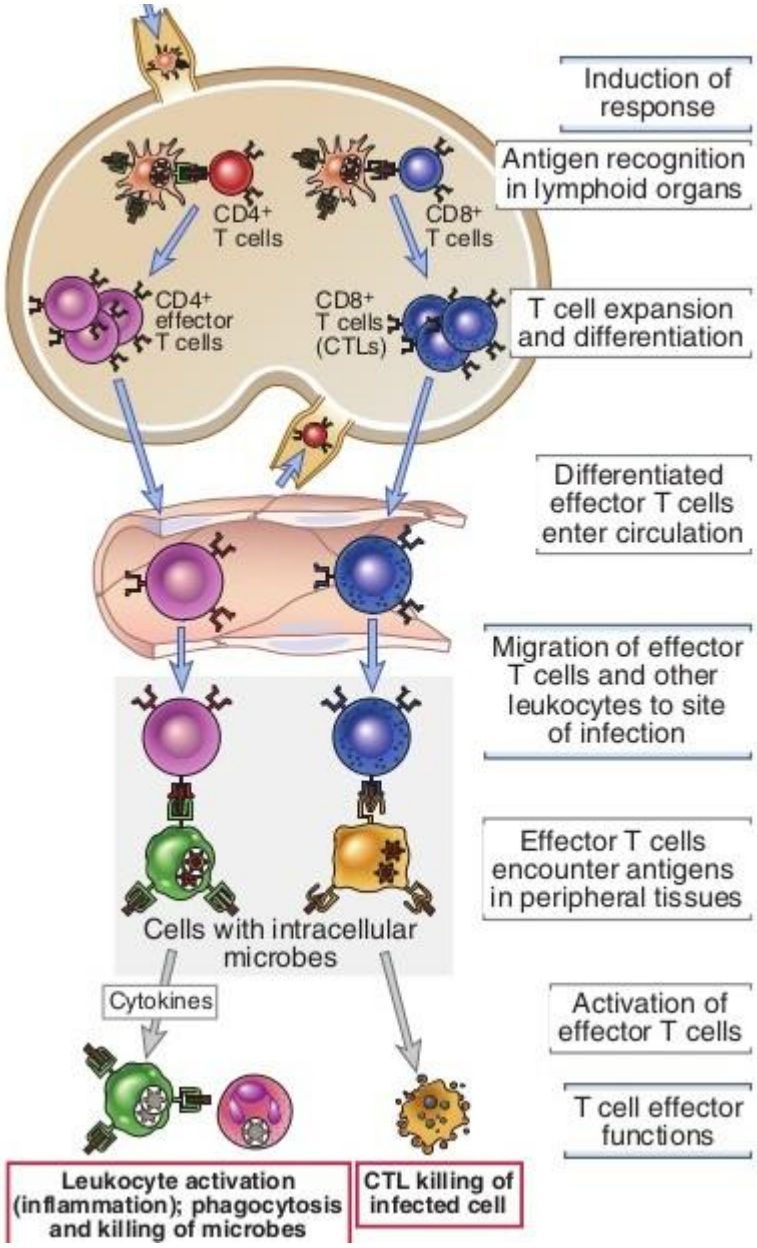
IgM	IgG	IgE	IgA
-	-	-	-
-	-	-	-
-	-	-	
	-	-	
	-		

FIGURE 3 : different antibody classes and their functions

➔ **T cell-mediated immune response :**



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1-

T cell CD4+

T cell CD8+

2-

T cell CD4+

T cell CD8+

3-

T cell CD4+

T cell CD8+

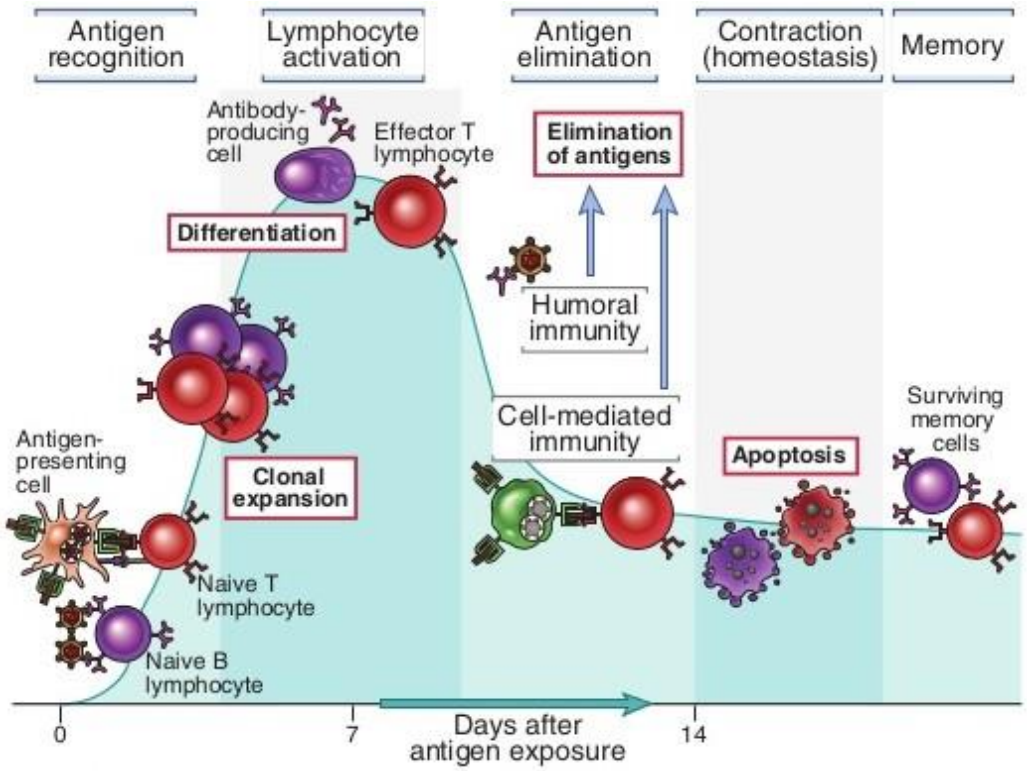
4-

T cell CD4+

T

cell

➔ **Phases of immune response:**



Abbas & al. Basic immunology: functions and disorders of the immune system. Elsevier Health Sciences, 2012

FIGURE 5: phases of immune response

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Microbiology Part

Definitions:

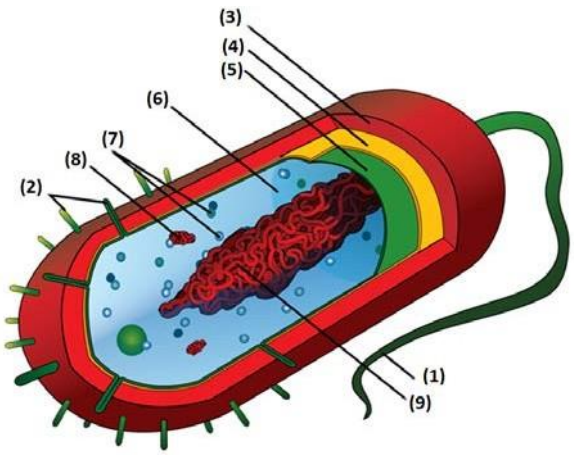
- **Microbiology** is the study of microscopic organisms (.....). They are also referred to as ....., or more commonly, ... , especially to ordinary people. Principal groups of microorganisms are: bacteria, viruses, archaea, fungi and protozoa. This discipline includes fundamental research on the biochemistry, physiology, cell biology, ecology, evolution and clinical aspects of microorganisms, including the host response to these agents.

- **Sterilization**: [Latin *sterilis*, unable to produce offspring or barren] is the process by which all ..... cells, viable ..... , viruses, and viroids are either ..... or ..... from an .....or .....

- **Disinfection** is the killing, inhibition, or removal of microorganisms that may cause ..... . The primary goal is to destroy potential ....., but disinfection also substantially ..... the total microbial population.

- It is frequently necessary to control microorganisms on living tissue with chemical agents. ..... [Greek anti, against, and sepsis, putrefaction] is the prevention of infection or sepsis and is accomplished with ..... These are ..... agents applied to tissue to prevent infection by killing or inhibiting ..... growth; they also reduce the total .... Because they must not destroy too much ..... tissue, antiseptics are generally not as toxic as .....

Activity: Name the different cellular structures of a bacterium (Figure below)



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Principal groups of Microorganisms:

Bacteria: Bacteria are single celled microbes. The cell structure is simpler than that of other organisms as there is no nucleus or membrane bound organelles. Their control centre containing the genetic information is contained in a single loop of DNA (circular chromosome). Some bacteria have an extra circle of genetic material called a plasmid. The plasmid often contains genes that give the bacterium some advantage over other bacteria. For example, it may contain a gene that makes the bacterium resistant to a certain antibiotic.

Principal shapes: Bacteria are classified into 5 groups according to their basic shapes: spherical (cocci), rod (bacilli), spiral (spirilla), comma (vibrios) or corkscrew (spirochaetes). They can exist as single cells, in pairs, chains or clusters.

Archaea: Archaea can be spherical, rod, spiral, lobed, rectangular or irregular in shape. Some exist as single cells, others form filaments or clusters. Until the 1970s this group of microbes was classified as bacteria. They are similar to bacteria by the lack of nuclear membrane (prokaryotes), yet they are different by the lack of peptidoglycan.

Virus: Viruses are the smallest of all the microbes although there might be some exceptions (Mimivirus). They are unique because they are only alive and able to multiply inside the cells of other living things. The cell they multiply in is called the host cell.

Algae: Most algae are found in freshwater and marine environments; a few grow in terrestrial habitats. They are a diverse, polyphyletic assemblage of unicellular, colonial, and multicellular eucaryotic organisms. Most are photoautotrophs and store carbon in a variety of forms, including starch, oils, and various sugars.

Fungi: Fungi can be single celled or very complex multicellular organisms. They are found in just about any habitat but most live on the land, mainly in soil or on plant material rather than in sea or fresh water. A group called the decomposers grow in the soil or on dead plant matter where they play an important role in the cycling of carbon and other elements. Some are parasites of plants and can lead to significant monetary loss for the farmer. A very small number of fungi cause diseases in animals. In humans these include skin diseases such as athletes' foot.
(Yeast, Mold, Mushrooms)

Protozoa: *Protozoa* are single celled organisms. They come in many different shapes and sizes. *Protozoa* live in a wide variety of moist habitats including fresh water, marine environments and soil as free-living organisms such as *Paramecium*, some others take a parasitic lifestyle by infesting biological organisms such as *Leishmania*.

Multicellular Parasites: Helminths are large, multicellular organisms that are generally visible to the naked eye in their adult stages (while also microscopic stages in life cycles occur). Like protozoa, helminths can be either free-living or parasitic in nature (see chapter zoology for more details).

☺ Activity:

- ❖ Find the problems (illnesses, symptoms) that may cause the following microbes:

Salmonella ( ):

Aspergillus ( ):

Trypanosoma ( ):

Plasmodium (Mother-to-child (congenital)):

H5N1 ( ):

- ❖ Find the benefits (products) that may be produced the following microbes:

Penicillium:

Lactococcus and *Lactobacillus*:

Streptomyes:

Algae:

- ❖ Look for the definition and the translation of the below vocabularies:

Bunsen burner.....

Food spoilage.....

Gram Stain (dye).....

Lab bench:.....

Lab coat.....

Media agar.....

Petri dishes.....

Sampling:.....

Screening.....

Spread.....

Strains Isolation.....

Target.....

☺ **Reading: Read and color (underline) the keywords.**

Microbes Interactions:

They are found almost everywhere on planet. They are on our skin, in the air we breathe, on every surface we touch, and even inside our bodies. Usually, we do not notice microorganisms until they cause physical damage (illness). We often forget microbes play beneficial role in human health; benefits are greater than problems created by microbes.

Microbial ecology:

Most microorganisms in complex communities have not been grown or characterized. This has limited our understanding of microorganism interactions and their roles in nature and disease. Molecular techniques are providing a better understanding of these uncultured organisms.

Microbial ecology is the study of microbial relationships with other organisms and also with their nonliving environments. The term symbiosis, or "together-life," can be used to describe many of the interactions between microorganisms, and also microbial interactions with higher organisms, including plants and animals. These interactions may be positive or negative.

Extreme environments restrict the range of microbial types able to survive and function. This can be due to physical factors such as temperature, pH, pressure, or salinity. Many microorganisms found in "extreme" environments are especially adapted not only to survive, but to function metabolically under these particular conditions.

Most microorganisms associated with the human body are bacteria; they normally colonize specific sites. There are both positive and negative aspects of these normal microorganisms. Sometimes they compete with pathogens; other times they are capable of producing opportunistic infections. The host's ability to resist infection depends on a constant defense against microbial invasion. Resistance arises from both nonspecific and specific body defense mechanisms.

Clinical Microbiology:

Clinical microbiologists and clinical microbiology laboratories perform many services, all related to the identification and control of microorganisms.

Success in clinical microbiology depends on (1) using the proper aseptic technique; (2) correctly obtaining the clinical specimen from the infected patient by swabs, needle aspiration, intubation, or catheters; (3) correctly handling the specimen; and (4) quickly transporting the specimen to the laboratory.

One of the challenging issues in clinical microbiology is antibiotic resistance.

Microbiology of Food:

Foods often provide an ideal environment for microbial survival and growth. Microbial growth in foods involves successional changes, with intrinsic, or food-related, and extrinsic, or environmental, factors interacting with the microbial community over time.

Food spoilage is a major problem in all societies. This can occur at any point in the course of food production, transport, storage, or preparation. Food-borne toxins are of increasing concern, especially with increases in international shipments and extended storage of food products before use. Growth of fungi can result in the synthesis of toxins. Algal-derived toxins can be transmitted to humans through freshwater and marine-derived food products.

Foods can be preserved by physical, chemical, and biological processes. Refrigeration does not significantly reduce microbial populations but only retards spoilage. Pasteurization results in a pathogen-free product with a longer shelf life. Chemicals can also be added to foods to control microbial growth.

Industrial Microbiology and Biotechnology:

Microorganisms are used in industrial microbiology and biotechnology to create a wide variety of products and to assist in maintaining and improving the environment.

Most work in industrial microbiology has been carried out using microorganisms isolated from nature or modified through mutations "natural genetic engineering.". In modern biotechnology, microorganisms with specific genetic characteristics can be constructed to meet desired objectives. A major challenge in biotechnology is to be able to grow and characterize these observed but uncultured microorganisms in what is called "bioprospecting."

The development of growth media and specific conditions for the growth of microorganisms is a large part of industrial microbiology and biotechnology.

Additional materials and references:

http://www.nature.com/subjects/microbiology
http://www.microbiologyonline.org.uk/
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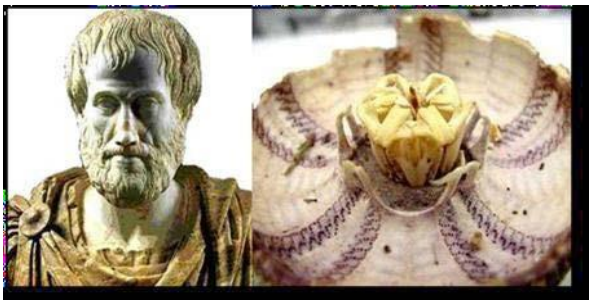
Zoology Part

PART I: INTRODUCTION

The Greek philosopher **Aristotle** (384-322 BC) devotes many treaties to the animal world. Thus, his book [*History of Animals*] is adefense of his method of investigating zoology. **Aristotle** investigates four (4) types of differences between animals: Differences in particular body parts[1] (Books I to IV); differences in ways of life [2] and types of activity[3] (Books V, VI, VII and IX); and differences in specific characters[4] (Book VIII).



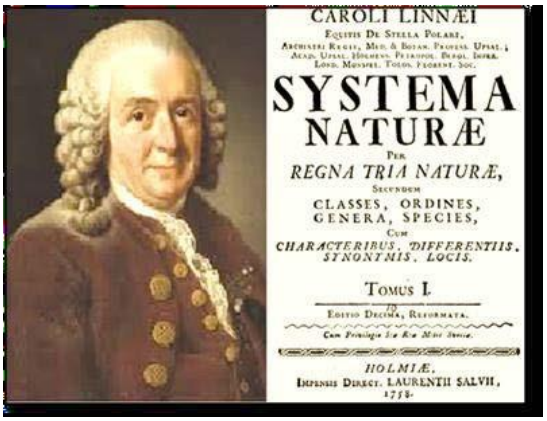
Al-Jāḥiẓ (full name Abū ʿUthmanʿAmr ibn Baḥr al-Kinānī al-Baṣrī) born in Basra 776, wasan Arabic prose, writer and author of works of literature.

He sold fish along one of the canals in Basra in order to help his poor family. Financial difficulties, however, did not stop Al-Jāḥiẓ from continuously seeking knowledge. Hecontinued his studies. Over a span twenty-five years, he would acquire considerable knowledge on Arabic poetry, Arabic philology, and pre-Islamic Arab and Persian history. He also studied the Qur'an and the Hadiths. Additionally, **Al-Jāḥiẓ** read translated books on Greek sciences, especially that of Greek philosopher **Aristotle**. [*Kitāb al-Hayawān*], Book of Animals is one of his most important books. It is an encyclopedia of seven volume of

anecdotes, poetic descriptions and proverbs describing over 350 varieties of animals. He died in Basra in January 869 at the age of 93, in his private library.

Carl Linnaeus (23 May 1707- 10 January 1778), also known as Carl von Linn, was a Swedish botanist, physician, and zoologist, who laid the foundations for the modern biological naming system of binomial nomenclature. He is known as the father of modern taxonomy and is considered one of the fathers of modern ecology.

Many of his writings were in Latin, and his name in Latin is *Carolus Linnæus*. He published *Species Plantarum*, the work that is now internationally accepted as the starting point of modern botanical nomenclature, in 1753. *Systema Naturae* [System of nature] was one of the major works of *Carolus Linnaeus* and introduced the Linnaean taxonomy.



The 1st Edition was published in 1735. The 10th Edition of this book (1758) was considered the starting point of zoological nomenclature. It was also officially regarded by the International Commission on Zoological Nomenclature as the 13th edition of *Systema Naturae*.

1. WHAT IS ZOOLOGY?

Zoology (zō-ŏl'ə-jē) or animal biology is the scientific study of …….. in the kingdom ……, including their ……., structure,evolution, habitat and behavior.

2. WHY STUDY ZOOLOGY?

We know that zoology is the black ……. of most…….. in second-year biology (L2/SNV). But, please note that study Zoology is good at all levels. Look, briefly there are three reasons that show the importance of Zoology:

- If you study Zoology, you will get to work on to the animals themselves. Moreover, working with ……. can be extremely challenging and rewarding.
- Zoology is important to us to understand the urgency of preserving the animals. This …… would help us learn the needs that animals lack and we can respond by thinking of solutions we can give to the ……..species of animals.
- Studying zoology would help people achieve clarity over the common myths we have on different……. animals. In this ……..,we can be able to learn the natural behavior as well as their habitats so we would completely understand why they would behave in a defensive manner when they seem ……..

3. CELLS AS UNITS OF LIFE

The body of all living organisms is made up of one or more cells which carry out certain basic functions. Thus, cells are called "Basic structural and functional units of living organisms". The branch of biology that deals with the study of structure, function and life history ofa cell is called "Cell Biology".

Kinds of cells

There are two basic kinds of cells: …….cells and …….cells.

Prokaryotes, bacteria and archaea, are…… cells that have no nucleus. However, **Eukaryotes** are ……. cells with many organelles and other structures in the cell.They store their genetic information (*DNA*) on …….. in the nucleus.

Kinds of Eukaryotic cells

There are two types of eukaryotic cells:…….. (for more comprehension of plant cell, form and function, please refer to the chapter Botany) and …… cells (Fig.1: Please, give a title to the figure).

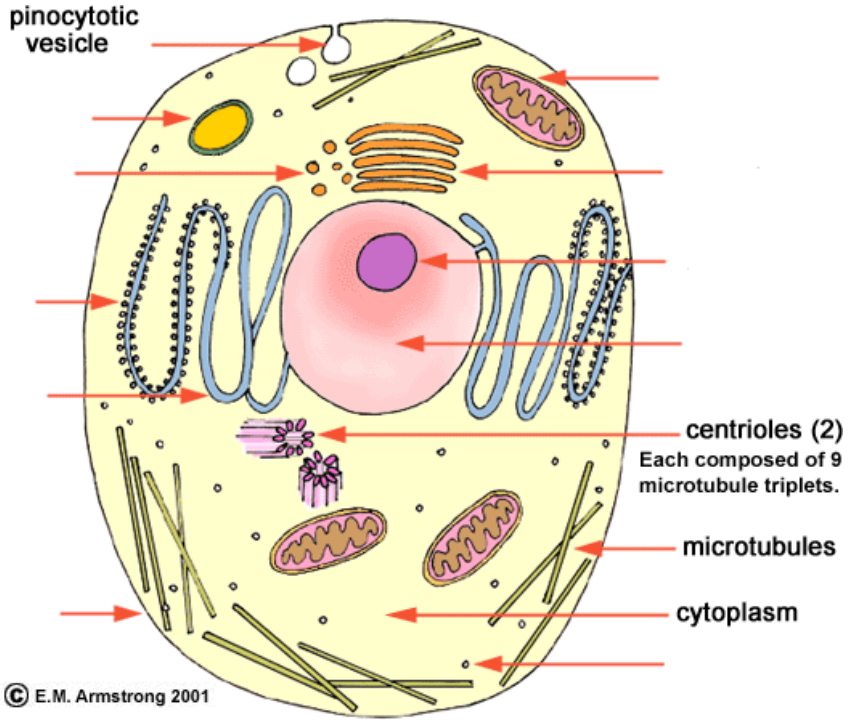


Fig.1. …….

Organisms show variety in cell number

The organisms made up of a single cell are called ……. organisms. Eg: Protozoa as *Amoeba*, *Paramecium* etc… However, others made up of more than one cell are called ……organisms.

4. BINOMIAL NOMENCLATURE

In biology, we traditionally classify animals by the structure of their ……., in a descending hierarchy of …….: kingdom, phylum, class, order, family, genus, and species.

For example, human beings are classified as belonging to the:

……	Animal
Phylum	Chordates
……..	Mammals
Order	……
……	Hominidae
Genus	……..
……	*Sapiens*

The Swedish scientist **……**developed a system of naming living things in the eighteenth century. He invented the binomial nomenclature (2 Latin names: Genus-species).

Ex. Scientific name of humans is *Homo sapiens* L., 1758. Thus, Homo is the …… name and sapiens is the …….name.

-Rules for writing scientific names

The Latin scientific name of a species, whether it is a plant, animal, bacterium, fungus, etc., is a …… name consisting of the genus name first (by the way: one genus, two genera) and the species name second. For example, the domestic cat is known as *Felis catus*. Although the genus name can be used on its own but the species name never appears on its own.

For writing a scientific name, we must

Use both ……. and ……. name: *Felis catus*.
Italicize the …….. name.

Capitalize only the …… name.

5. CLASSIFICATION OF ANIMALS

Classification is a way of …….. living things. According to the presence/ absence of the ……., scientists have divided the Animal Kingdom into two main groups:

1/ …… are animals without a backbone

2/ ……. are animals with a backbone

Based on the …… of ……forming the body, the Animal Kingdom is generally divided into two Sub-Kingdoms:

1/……. (First animals): unicellular, microscopic animals, no tissues.

2/…….: Multi cellular animals. Cells arranged in tissues

6. SYMMETRY IN ANIMALS

Symmetry means an arrangement of body parts into a …….. design. It refers to the division of body into …….. parts by lines or planes. A plane of symmetry is a straight line that divides organisms into corresponding …….

An animal is called ……..when a plane passing through its center will divide it into similar halves. When an animal cannot be divided into like parts by a plan, it is called

……..(Fig.2: Please fill the legend by following the course).

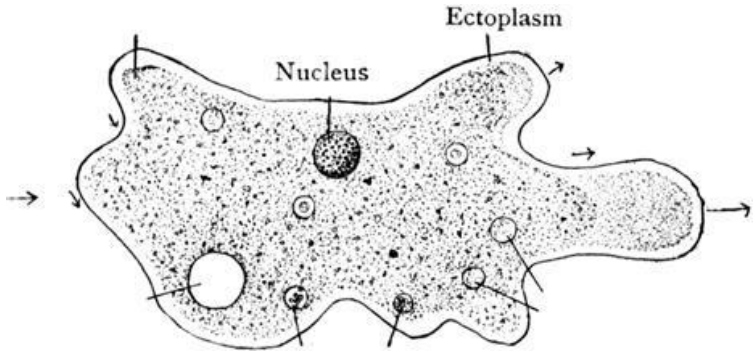


Fig. 2. Structure of an Amoeba

Other ……..of symmetry are also recognized……(Please follow the course in the amphitheater).

PART II: Invertebrates Zoology

1. THE ROLE OF FRESHWATER INVERTEBRATES IN THE FOOD WEB

Invertebrates are a cornerstone (base) of our ecosystems, providing vital services such as ……and acting as important environmental ……. (for instance of water quality in rivers).These animals do not possess a……..; they are an important link in the food web (Fig.3) as they convert the energy in plant and other organic matter into protein (their own bodies). This allows larger predators such as fish to live in fresh water as they feed on the

……...

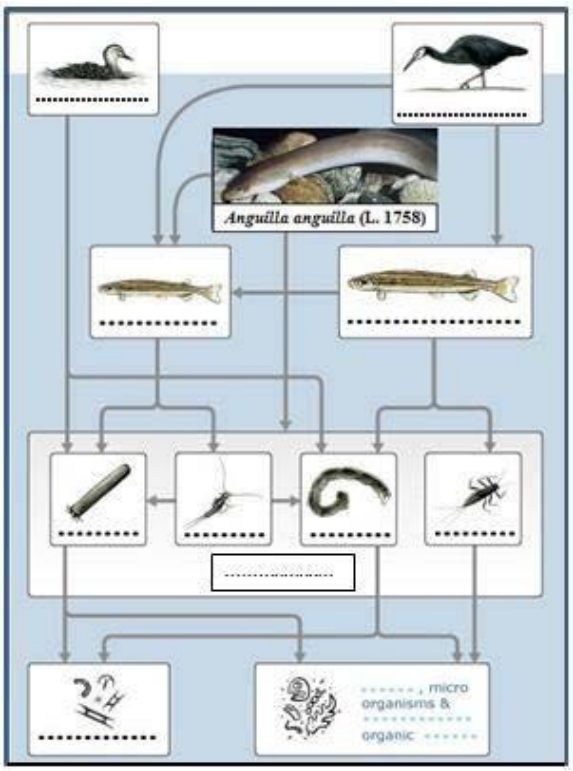


Fig. 3. The role of freshwater invertebrates in the ……. …….

Over 95% of all animals on the earth are ……... Invertebrates are found everywhere in both soil, water and air, and include animals ranging from sponges, corals and seastars to insects, crabs and worm

2. PORIFERA

Sponges are ……animals (Follow the water circulation in the course). Most of them are marine. They live attached to ……..or rocks. The body is perforated by ……and supported by small ……..called spicules. They have an internal cavity with an upper hole called …….and can reproduce sexually or…….. They are filtering animals.

3. CNIDARIA

Most of Cnidaria are marine animals. They have two body forms:

- Sessile polyps (Fig. 4A).- Swimming medusae (Fig. 4B).

They have a mouth with tentacles with stinging cells called cnidocytes and a gastrovascula r cavity. Cnidaria are carnivores. They can reproduce sexually or asexually.

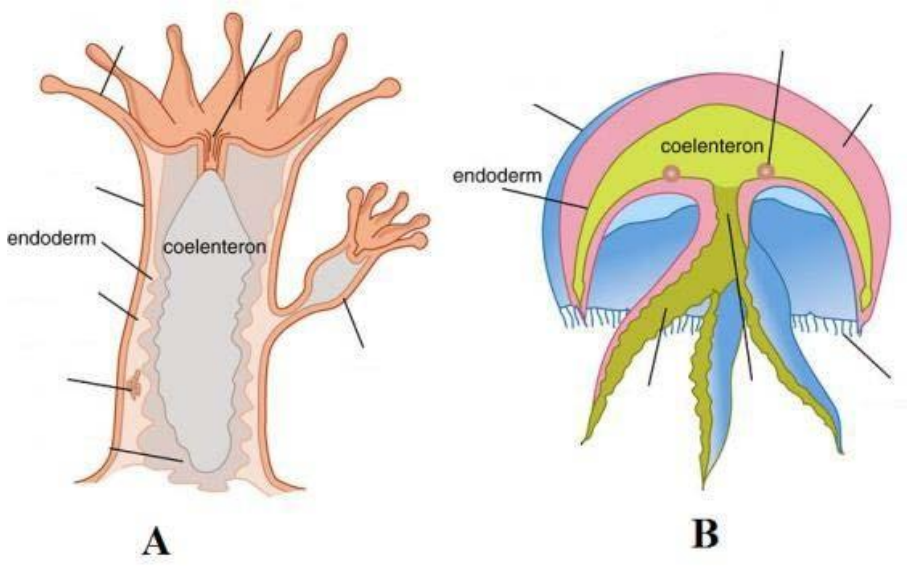


Fig.4: ……..

4. PLATYLMINTHES

Photo A

Photo B

This phylum has three common names: Flat worms, …… and Flukes. There are over 20,000 species of flatworms. Most Platy helminthes organisms are hermaphrodites and reproduce sexually. Asexual reproduction (fission) is also common. Flatworms can be free

(photo A) or parasites (photo B). Follow the explanation of the parasite *Ligula intestinalis* (in the course).

5. MOLLUSKS

They are aquatic and terrestrial animals (snails, slugs). Their body comprises three parts: - The head: contains the sense organs -The visceral mass: contains the internal organs -The muscular food: to move around, excavate or catch the prey. They reproduce sexually. Main groups are: Gastropods (snail, slugs), Bivalves (mussels, clams), Cephalopods (squid, octopus, nautilus).

6. ARTHROPODS

They are terrestrial (spiders) or aquatic animals. The body is segmented. They have hard appendages (antennas, legs, palps). The body is covered by a rigid and articulated exoskeleton. They breathe by gills (aquatic) or tracheas (terrestrials). They reproduce sexually and some of them have complete (Follow the life cycle of the lady beetle -photo C- in the course) or incomplete metamorphosis.

Photo C

7. ECHINODERMS

They are marine animals (starfish, sea urchins, sea cucumber, brittle star (Photo D). Generally with …….. and a hard …….. They have an …….. system to move around. They reproduce ……. or by fragmentation like starfish.

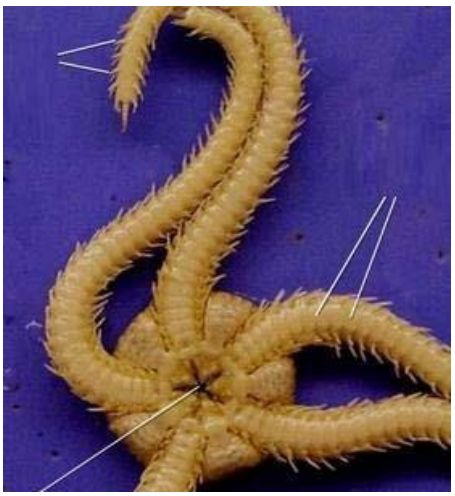


Photo D

8. THE MAIN CHARACTERISTICS OF ANIMALS

Animals are the most complex living things.
They usually have organs and systems.

They can perform the three vital functions:……, interaction and reproduction.

They can……. and …… with other living things.

Animal reproduction can be: Asexual (Budding) and fragmentation or sexual.
Animals can be:

- viviparous: develop the embryo ……. the mother's body.

- Oviparous: lay eggs …….the body.

- Ovoviviparous: develop ……. eggs that remain inside the mother's body.

PART III: Vertebrate Zoology…

(Follow the course in the amphitheater)

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Botany Part

From plants, we get vegetables and drugs which are crucial and beneficial to our health".

PART I. INTRODUCTION

1. Definition of BotanyBot·a·ny(bŏt′n-ē); Botane, comes from ……and means ……, it is the …… interesting to plants.

Different areas are studied in botany, ……(study of different forms and shape of plants), plant physiology (metabolic reactions), molecular and cell biology (cellular and genetic structures) and ……(chemical compounds isolated from plants).

2. History of Botany In the…… century, **……**has presented a system of 24class based on numerous characteristics as counting stamens, and 67 orders on order and number of pistils. He developed "binomial nomenclature" and wrote the first …….called "Species plantarum" published in 1753 within 40000 genus.

3. Plant systematic: Plant classification, botanic systematic basis: <u>Genus species</u>
Carl Linnaeus invented the……; each plant, animal, bacteria or fungi are classified in ……and…….. Ex. ***U**lva **l**actuca* (Chlorophyceae).

Many classifications were proposed in botany as those of **Engler et Prantl (1887), Bessy (1915), Hutchinson (1926), Emberger (1960), Takhtajan (1968), Dahlgreen (1975), Croquist(1981).**
Since 1985, the development of ……has made a revolution by using sequences of…….. Nowadays, there are ……based on ……existed in all living things in the world. **(Woese et *al.*, 1990)**, named

● …….. ● Archaea ● ……

4. Role of Microscope in botany

Larger efforts were made in 20th century……. It has boosted the plant studies. The use of microscopic observation was used as a powerful tool to determining cell constitution. Some organelles are lonely observed in plant cell as……, chloroplasts (amyloplasts) , …… and cell wall. **Vacuole** is responsible to storage water and salts in the cell, storage bubble that holds food, water and wastes - small in animal cells, large in plant cells. **Chloroplast** is used in photosynthetic activity by its chlorophyll, traps sunlight to make food - plant cells only. **Lack of centrosome (**has a key role in efficient mitosis in animal cells). **Cell wall** provides support and protection for a plant cell.

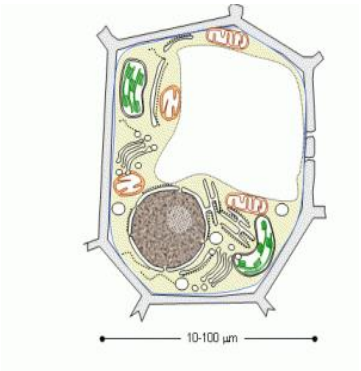

Fig 1. Plant cell constitution under microscopic observation.

After observation, it is necessary to calculate a magnification of each observation done. There are two kind of magnification for each observation X: Size of sample

Weak magnification X 10. 10 (less power)

Strong magnification X 10. 40 (high power), X **10. 100 are used for very small particles as bacteria**.

How to calculate magnification of each microscopic observation done in your botany tutorials.

5. Study of different groups.

Algae: are a very large and diverse group of ……. organisms, ranging from unicellular genera such as Chlorella and the diatoms to multicellular forms such *Ulva lactuca* and others. They are characterized by a lack of complex organs andtissues.

Thallus: is characterized by absence of……., ……. And…….. It is very simple and could be formed by one or many cell. Ex. ***Corallina mediterranea (****Rhodophyceae),* ***Ulva lactuca*** *(Chlorophyceae),* ***Cystoseira sp.*** (Phaeophyceae*).*

Fungi, also called Mycota, are any organisms that ……chlorophyll, leaves, true stems, and roots, reproduce by……, and live as ……..or parasites. Most mushrooms do not require ……like plants do, since they ……to carryout photosynthesis. The main body of most fungi is made up of fine, branching, and usually colorless threads called ……..…..., all intertwining to make up a tangled web called the……. A mushroom is composed by two parts: **……..**is called the……. It gets food for the mushroom. Sometimes it dies quickly, but if it gets enough food it may live for hundreds of years. **……..**, the umbrella- shaped body of a mushroom, it only lives for a few days. The fruit starts out as a small button which grows into a **stalk** and a **cap**. The **stalk** or **stem** grows quickly because it can absorb a lot of water.

As the cap becomes larger it unfolds like an umbrella. Soon small plates, called gills, appear under the mushroom's **cap**. They have small **spores** on them.

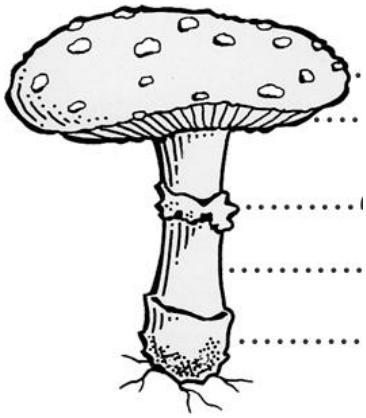

Fig 2. Morphology of Fungi (Sporophore or fruit and mycelium).

Fig 3. Morphology of lichen Ex. *Xanthoria parietina* sho wing apothecia.

Lichens are composite, symbiotic organisms made up from fungi and algae. The dominant partner is…….(Ascomycetes, basidiomycetes). The second partners are…….. (cyanobacteria, Chlorophyta).

PART II. EMBRYOPHYTA

1. Definition, are the most familiar subkingdom of green plants that form vegetation on earth. It called as "embryo"-phytes because they formed …….after reproduction.

2. Importance of photosynthesis process Most species are terrestrial, land plants are mostly photosynthetic. Although photosynthesis is performed differently by different species, the process always begins when energy from light is absorbed by proteins called reaction centres that contain green chlorophyll pigments.

Photosynthesis is the process by which **plants** …….. From light, ……., nutrients, and……. Chlorophyll is the green pigment, or color, found in **plants** that help the **plant** to make food.

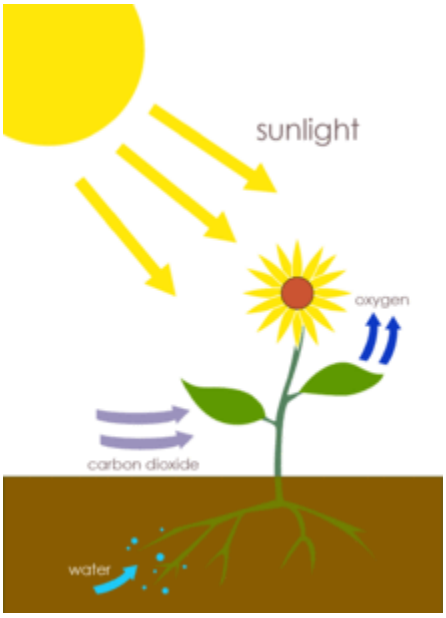

Fig 4. Schematic of photosynthesis in plants. The carbohydrates (starch) produced are stored in or used by the plant.

3. Different groups of Embryophytes

Bryophytes (Mosses); **S**implest plants of damp terrestrial land with……. No true roots, they have……. and no ……..... Like all bryophytes mosses have two forms of reproduction: asexual or vegetative reproduction and sexual reproduction. The normal plant is gametophyte to which the small sporophyte attaches.

Pteridophytes (Ferns) A **fern** is a member of ……plants that reproduce via spores and have neither seeds nor flowers. They differ from mosses by being …….(i.e. having water-conducting vessels). They have stems, leaves and roots like other vascular plants (corms).

Coniferophytes; Conifer (cone-bearer) + *-ophyta:* Organisms collectively called Conifers because all of them can produce…….. They have a …….., the plant producing …….Naked seed means that the seed is exposed in air, or not totally enclosed with other structures, as the pericarps. **Ex. *Pinus halepensis***.

Angiosperms; are ……. in which the …… is fertilized and develops into…… in an enclosed hollow ……... The ovary is usually enclosed in……, that part of the angiospermous plant that contains the male or female ……..organs or both.

Morphology of plants, is an interested tool used in the …….of plants. This concerns particularly vegetative and reproductive structures:

***The vegetative structures** of vascular plants are divided to two organ systems:

- **Shoot system** composed of **stems and leaves**
- **Root system** composed of two types of **roots: …… (Dicots)** and **…… roots (Monocots).**

***The reproductive structures** used for the ……..of plants than vegetative characters are varied; **Flowers** and fruits in the **angiosperms. Seed cones** in **Conifers and Other Gymnosperms** and **Sori** in **Ferns**

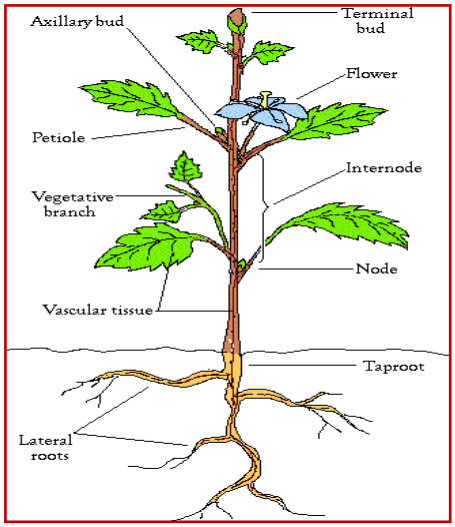

Fig 5. Vegetative structure of vascular plant (Shoot system and root system).

Many characteristics of the flower are important to be considered for classification of angiosperms

Definition of flower; it is a…….organ constituted from outside to inside by
Calyx +……+ Stamen +……..
Calyx of sepals, **C: Corolla** of petals, **S** = …….. Consisting of anther and filament, P =…….. Consisting of stigma, style and ovaries, with the terms carpels, locules, ovules, and/or placenta referring to parts of the ovary.

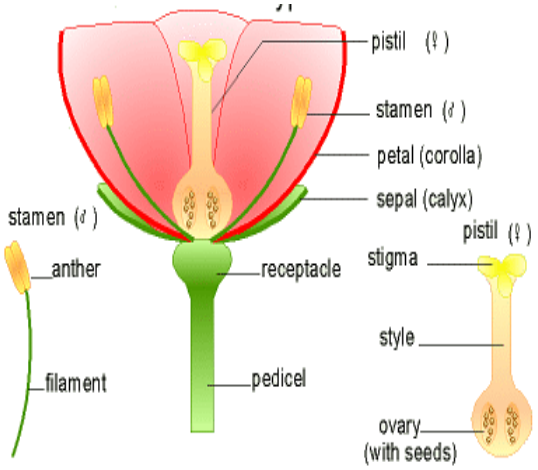

Fig 6. Longitudinal section of typical flower; Calyx (sepals) + Corolla (petals)+ Stamen(Anther and filament)+ Ovary.

Pollination, fertilization and seed dispersal

Pollination: The transfer of pollen grains from the anther to the stigma (usually of another plant), often facilitated by animals, wind or water movement

Fertilisation: Fusion of the male gamete nuclei (in the pollen grain) with the female gamete (in the ovule) to form a zygote.

Seed Dispersal: Fertilized ovules form seeds which move away from the parental plant before germination. There are a variety of seed dispersal mechanisms, including fruit, wind, water and animals

Different classes of Angiosperms Traditionally, the flowering plants have been divided into two major groups, or classes: the……..(Magnoliopsida) and the …….. (Liliopsida). Many characteristics of monocotyledons and Dicotyledons are summarized below:

Monocotyledons	Dicotyledons
Seeds only one ……	Two cotyledons
Root system is composed from fibrous roots	……
Leaves with parallel veins	……..veins
Flower with ……	Calyx and corolla
Absence of secondary structures	Presence of secondary structures

PART III. INTERESTS OF PLANTS AND USES

Plants and Ecology; Plants are considered as the base for ecological ……..chains, serve as the structural and functional foundation of natural and managed systems.

Ecology is the scientific study of the ……..between organisms and their…….. It was known as an observational science, often descriptive a natural history. An organism's environment has both ……..and……components. **Abiotic compone nts** are …….. such as temperature, light, water, and nutrients. **Biotic compone nts** are living factors such as other organisms.

Plant biotechnology; develops methods to produce adventitious plants efficiently…….. . Many vitroplants could be obtained from a small part of plants via callogenesis (plant cancer).

Fig 7. Important number of young plantlets obtained by in vitro culture.

Phytopharmacy (How to establish a drug discovery from natural plants).

Survey and Documentation of……plants of biosphere

Macroscopic and microscopic diagnostic features, Chromatographic ....

Herbal formulation development and standardization

Pharmacological studies to ascertain efficacy off herbal extracts

Isolation of new leads - development of marker compounds from plant sources

Acute, sub acute and chronic toxicity studies to ascertain safety of herbal extracts/formulations

…….. discovery from …… sources.

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1. What is ecology?

Ecology is the scientific study of the interactions that determine the distribution and abundance of organism. It study living organisms in the natural environment. How they interact with one another and how they interact with their non-living environment.

The word ecology comes from two Greek words – *oikos*meaning home and *logos* meaning understanding. In many ways, ecology is a relatively new science. Indeed, the word was coined by the German biologist Ernst Haeckel in 1869. Yet, in little over a century, ecology has grown to become one of the most important disciplines within biology.

Ecology is interdisciplinary scientific study; it can be subdivided into many fields of research. A few specialties include population ecology, community ecology, biosphere ecology, microbial ecology, biogeography, molecular ecology, ecology modeling, chemical and physical ecology…

2. Habitat, microhabitat and niche

A **habitat** is the place where an organism lives. Actually, organisms from a single species can live in a number of habitats. With small organisms, especially those living in a restricted area such as in the soil or on a single plant or animal, it is worth being more precise about exactly where they live. The term **microhabitat** 'a small habitat' is used to describe this. A single habitat may have many microhabitats.

A **niche**is the functional role of an organism in an ecosystem. It is a complete description of *how* the organism relates to its physical and biological environment. Therefore, each species has a unique niche the way it fits into its environment.

3. Component of an ecosystem

Part of what sustains an *ecosystem* is the constant interchange of matter between its living (***biotic***) and non-living or physical (***abiotic***) *components.*

***Biotic* factors** are all organisms in an ecological setting.*They*are the living *components* of an *ecosystem*. This refers to *animals*, *plants*, trees, grass, bacteria, algae, moldsand any materials they directly produce such as waste or falling leaves

Abiotic factors are geological, geographical, hydrological, and climatological parameters. They are non-living chemical and physical*parts* of the environment that affect living organisms and the functioning of ecosystems. Specific abiotic factors include: water, air, soil,

pH, salinity, sunlight, temperature……

- Water, which is at the same time an essential element to life.
- Air, which provides oxygen, nitrogen, and carbon dioxide to living species and allows the dissemination of pollen and spores
- Soil, at the same time a source of nutriment and physical support
- pH, salinity, nitrogen and phosphorus content, ability to retain water, and density are all influential
- Temperature, which should not exceed certain extremes, even if tolerance to heat is significant for some species
- Light, which provides energy to the ecosystem through photosynthesis

4. Levels of organization in ecology

Ecology study environments at different levels of organization. These levels are described below from lowest complexity to *highest*:

- **Species**is a group of organisms or individuals thatare genetically related and can breed to produce fully fertile offspring.
- A **population** is a group of individuals within a species that have the opportunity to breed with one another because they live in the same area at the same time. It follows from this definition that individuals from two different species cannot belong to the same population. This is because, with occasional exceptions, species are reproductively isolatedfrom one another.
- A **community** is all the populations of the different species living and interacting in the same ecosystem. It is an association of species that live together in some common environment or habitat. Most communities are composed of a mixture of prokaryotes, protoctists, fungi, plants and animals.
- An **ecosystem**: It consists of all the living beings living in a particular area, as well as all the non-living, physical components of the environment, such as air, soil, water, sunlight, etc,..and the relationship among them. There are three parts:
    - **Community** or **biocenosis**. This refers to all living beings that live in a specific area or region.
    - **Biotope**: This consists of the non - living, physical components of the environment, like soil, air, water, sunlight, temperature, etc...

- **Relationships:** There are two types, the relationship between living beings, and the relationship between living beings and the environment.

Ecosystems can be of different sizes and can be marine, aquatic, or terrestrial

- The **biosphere**it is the zone of life (where life can be found) on Earth and it is the global sum of all ecosystems. It can be divided into three parts:
  - **Troposphere**. It is the lowest part of the atmosphere. The average depth of it is approximately 11 Km.
  - **Lithosphere**. It is the outer layer of the Earth's crust. It is the solid part of the biosphere.
  - **Hydrosphere**. It is the aquatic part of Earth (oceans, lakes, etc....).

5. **Interspecific relationships**in an ecosystem are interactions among organisms of **different** species.They can compete, or they can be symbionts long-term partners with a close association. Or, one of them can eat the other. The table below summarize some of the interspecific interactions

Name	**Description**	**Effect**
Mutualism/Symbiosis	A relationship between two species where both benefit	**+ / +**
Competition	Organisms of two species use the same limited resource and have a negative impact on each other.	**- / -**
Predation	A member of one species, **predator**, eats all or part of the body of a member of another species, **prey**.	**+ / -**
Parasitism	A long-term, close association between two species in which one benefits (**parasite**)and the other (**host**) is harmed	**+ / -**
Commensalism	A long-term, close association between two species in which one benefits (**commensal**) and the other (**host**)is unaffected	**+ / 0**

6. **Food webs and feeding relationships in an ecosystem**

Every organism needs food in order to live and has to get that food from somewhere. Every organism can be classified by where it fits into the food chain. Most broadly, all organisms fit into one of three camps: producers, consumers, and decomposers.

- **Producers**: They are able to produce food from the energy of the sun through photosynthesis or, in some instances, from inorganic molecules through chemosynthesis. They are **autotrophs**. They are the beginning of every food chain. They are plants, some bacteria, algae and chemosynthetic organisms.
- **Consumers**: They are heterotrophs because they must consume other organisms in order to get the energy necessary for life. There are three types of consumers; the categories of consumers are based on which organisms a particular consumer preys on.
    - **Primary consumers (herbivores)**, such as sheep, grasshoppers, and rabbits, feed on producers. They are herbivores, which is the name for a plant-eating animal.
    - **Secondary consumers** eat primary consumers, making them **carnivores**. Foxes and insect-eating birds are examples of secondary consumers.
    - **Tertiary consumers** eat secondary consumers and are therefore carnivores. Polar bears that eat sea lions are tertiary consumers. There are also consumers called **omnivores**. Omnivores can either be secondary or tertiary consumers. Humans and bears are considered omnivores.
    - **Decomposers**: They are the last links in the chain and they feed on waste or dead material. They are **heterotrophs**. Decomposers break down nutrients in the dead bodies and return it to the soil to be used by producers.

These feeding relationships can be represented by **food chains** or by **food webs** that show the interrelationships between the various food chains in a community

The food web model is often used to demonstrate the interconnectivity of all species in an ecosystem.

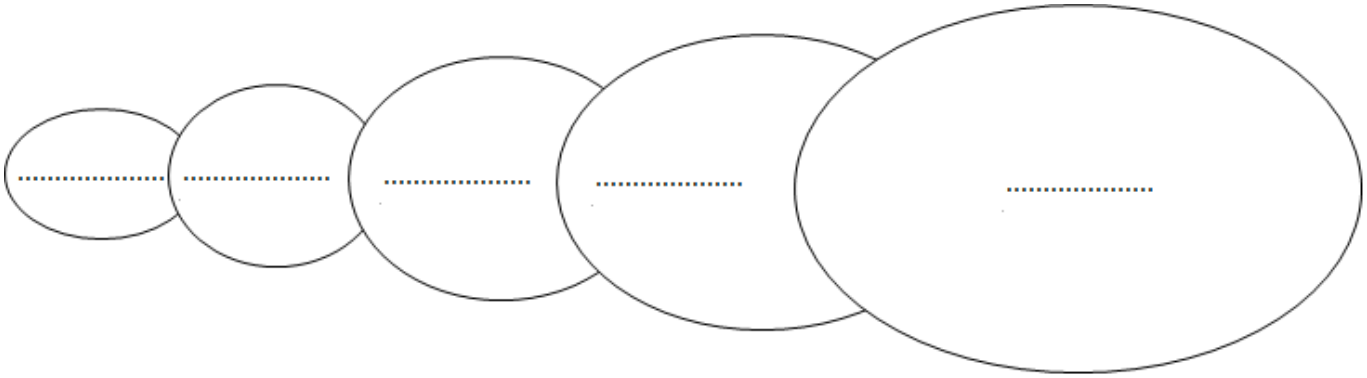
7. Exercises

7.1.Ecology study environments at different levels of organization

A. Write a description of each level of organization

Biosphere		
Ecosystem		
Community		
Population		 Bison herd
Organism		 Bison

B. Arrange the following terms in a hierarchy of Ascending size and complexity: community, ecosystem, population, biosphere, organism



7.2.An ecosystem includes both biotic and abiotic factors. Producers provide energy for other organisms in the ecosystem

- **Complete the following sentences with the correct term from the list below**

plants eating nonliving heterotrophs abiotic living temperature producers moisture animals biotic consumers nonliving autotrophs

- All ecosystem are made up of …….. and ……. Components.
- ……factors are living organism, such as …….. or …….....
- …….factors are nonliving things, such as wind, ……., or, ……
- ……. are organisms that get their energy from ……..resources, meaning their make their own food. These organisms are also called ……..
- ……. are organisms that get their energy by ……. Other organisms. These organisms are also called ……;
- Whey are producers so important in ecosystem? ……

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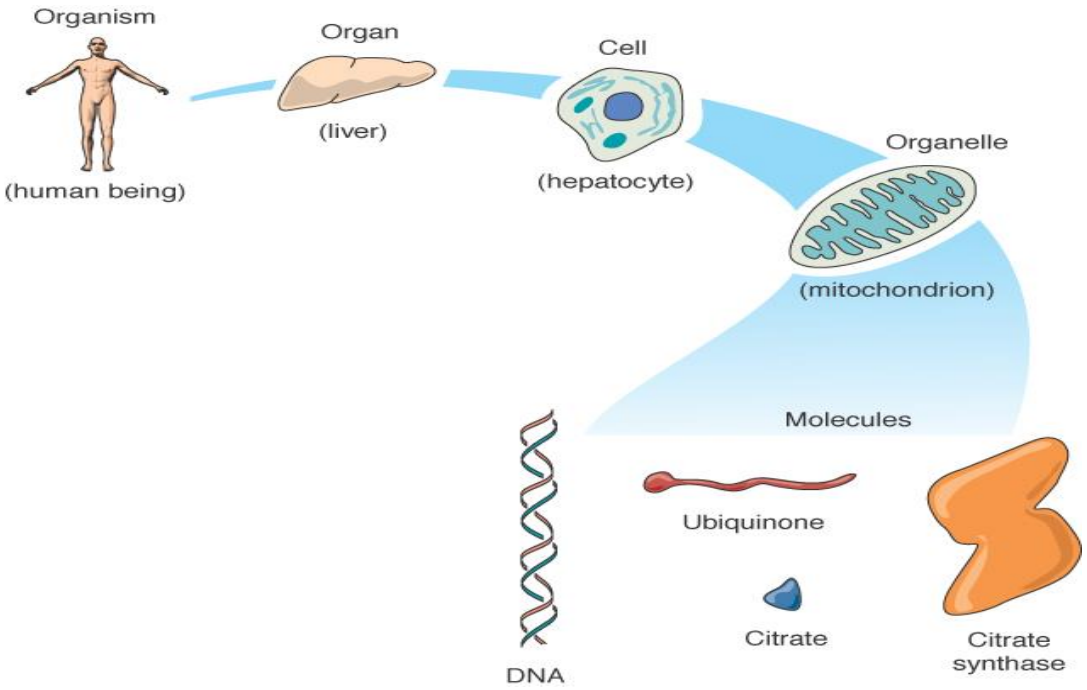
- S. T. A. Pickett, J. Kolasa, J. J. Armesto and S. L. Collins (**1989).** The ecological concept of disturbance and its expression at varioushierarchicallevels. *OIKOS* 54: 129-136. Copenhagen

Chapter: "Introduction to Biochemistry"

I-Definition

Biochemistry is the ---------- of living things.Itdeals with the ----------of chemical compounds that make up part of living matter, their ---------- and physico-chemical ----------that constitute the basis of vital activity.To understand and control or modify (for disease prevention or other purposes) chemical reactions of living organisms, we must understand life on the molecular level. Biochemistry encompasses large areas of ----------, of ----------, and of ----------.



Knowledge of biochemistry is essential to all life sciences.

Anything more than an extremely superficial comprehension of life – in all its diverse manifestations – demands the knowledge of biochemistry. The biochemistry of the nucleic acids lies at the heart of *genetics*; in turn, the use of genetic approaches has been critical for elucidating many areas of biochemistry. *Physiology*, the study of body function, overlaps with biochemistry almost completely. *Immunology* employs numerous biochemical techniques, and many immunologic approaches have found wide use by biochemists. *Pharmacology* and *pharmacy* rest on a sound knowledge of biochemistry and physiology; in particular, most drugs are metabolized by enzyme-catalyzed reactions. Poisons act on biochemical reactions or processes; this is the subject matter of *toxicology*. Many workers in *microbiology* employ biochemical approaches almost exclusively. Biochemical approaches are being used increasingly to study basic aspects of *pathology* (the study of disease), such as inflammation, cell injury, and cancer. Biochemistry and medicine are intimately related. Health depends on a harmonious balance of biochemical reactions occurring in the body, and disease reflects abnormalities in biomolecules, biochemical reactions, or biochemical processes. These relationships are not surprising, because life as we know it depends on *biochemical reactions*

and *processes.* Biochemical approaches are often fundamental in illuminating the causes of diseases and in designing appropriate therapies.

II. The chemical basis of life.

The biomolecules such as proteins that are present in living organisms are carbon-based compounds. Carbon is the third most abundant element in living organisms (relative abundance ----------). There isabout 29 elements found in living organisms. The most common ions are Ca^{+2}, K^{+}, Na^{+}, Mg^{+2}, and Cl-.

1. Functional Groups on Molecules.

The chemical reactions of biomolecules are dictated by the functional groups they contain. Organic molecules are composed principally of ----------. However, their unique characteristics are related to structures termed functional groups involving ----------.Each compounds and functional group has its own structure, charge properties, polarity and basic chemical reactivity.

2. Many biomolecules are polymers.

The principle biomolecules in cells (----------) arepolymer chains of amino acids, monosaccharides, and nucleotides, respectively. Biopolymers areformed by condensation reactions in which water is removed from the reacting monomer units. Each monomer unit of a biopolymer is referred to as a residue.

Since living things are extremely complicated then the chemical reactions and molecules must be very complex, however we can get an overview by understanding 4 types of biomolecules **(basic types and their role in cells):**

1) ---------- – cell membranes and energy storage in fats
2) ---------- energy source and cell surfaces
3) ---------- – molecules that do work of cell (carry out many reactions)
4) ---------- – molecules that contains instructions on how to make proteins (genetic information)

III- Structures of the Major Compounds of the Body

The body contains compounds of great structural diversity, ranging from relativelysimple sugars and amino acids to enormously complex polymers such as proteinsand nucleic acids. Many of these compounds have common structural featuresrelated to their names, their solubility in water, the pathways in which they participate,or their physiologic function. Thus, learning the terminology used todescribe individual compounds and classes of compounds can greatly facilitatelearning biochemistry.

3. Carbohydrates.

Carbohydrates are sugars and substances that hydrolyze to yield sugars.
(Hydrolysis is the ----------of a bond by adding a water molecule (H^{+} to one side and OH^{-} to the other)

They have formulas like ---------- where x, y may be from 3 up to thousands.Theycan be classifiedby their carbonyl group (----------or ----------), the number of carbons they contain(e.g., pentoses, hexoses), or the positions of the hydroxyl groups on their

asymmetriccarbon atoms (---- **or** ----------**,** ----------**,** or ----------). They can also becategorized according to their substitutents (e.g., ----------), or the number ofmonosaccharides (such as glucose) joined through ---------- **(**----------**,**----------and ----------).

They are also referred to as saccharides.

---------- – do not undergo hydrolysis (examples: glucose, fructose)

----------– hydrolyze to two monosaccharides (examples: sucrose, lactose)

---------- – hydrolyze to many monosaccharides (examples: starch, cellulose)

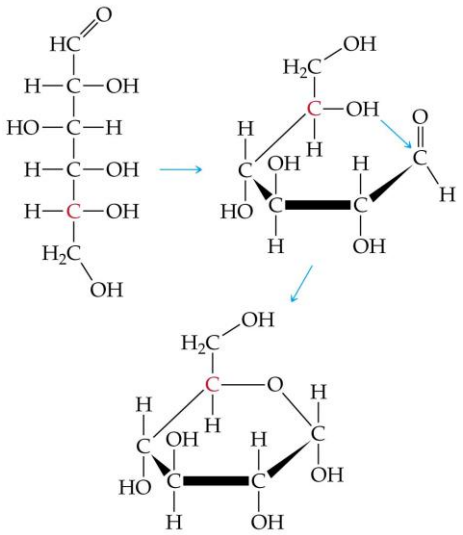
---------- **(Glucose):**

Glucose is a sugar found widely in nature. Starch and cellulose are both made of ---------- of linked glucose molecules. Glucose is the most common organic molecule in the world because it is found in ----------.

Other carbohydrates such as starch are converted in your body to glucose prior to ---------- in your body for ----------. Ultimately glucose undergoes ---------- to CO_2 and H_2O.

The formula of glucose is C-- H--O--and it can exist as chain or ring form as shown below.

---------- form is dominate (preferred).



Glucose contains 4 chiral carbons so the open chain form can have 16 possible structures depending on the orientation of each of the OH functional groups 24 = 16. Glucose is just one of these possibilities but it is the most common one in nature.

Intra-venous (IV) fluids contain glucose and some ----------.

---------- is a disaccharide that is a combination of two sugar molecules (glucose and fructose).

----------are composed of ---------- sugar molecules (monosaccharide units,e.g. glucose). Different ---------- perform either ----------(cellulose) or ---------- (glycogen starch) functions. ---------- and ---------- were some of the first biomolecules that were studied by organic chemists.

Starch is made of 200 to 3000 ---------- units. ---------- is joined with all molecules in branched chain pattern with all the glucose rings with the ---------- orientation.

Cellulose is made of 2000 to 4000 ---------- units. ---------- is attached end to end to

form long ----------molecules. Each glucose ring has the opposite orientation of the one before it.

A comparison of the ---------- starch and cellulose provides an excellent example of how structure is crucial to biological function. Namely, the structure of the ---------- bonds linking the ---------- units in cellulose and starch are very similar, yet the ----------difference in bond configuration determines whether the polymer is ---------- (starch) or not (cellulose).Unlike cows, horses, sheep, etc., humans cannot digest ---------- because we lack the enzymes necessary for this chemical reaction. The enzyme must have a certain ---------- that fits the molecule to undergo reaction and because of the different ----------of the glucoses, starch and cellulose require ----------enzymes.

4. Lipids

Lipids are water ---------- substances.

(a) Lipids provide ---------- of cell membranes

(b) Lipids provide for ----------for metabolism in fats

(c) Lipids or derivatives of lipids are found in ---------- and some ----------.

Lipidesare composed mostly of ---------- and ----------, i.e., ----------. Lipids contain relatively ---------- polar functional groups. Theyare a group of structurally diversecompoundsdefined by their----------; they are not very soluble in waterbutare more soluble in organic solvents. The primary building block of many lipids are the ----------, which are esterified to ----------to form ----------(triglycerides) or ----------(phosphoglycerides). In the ----------,a fatty acid is attached to sphingosine, which is derived from serine and anotherfatty acid. ----------contain sugars attached to a lipid hydroxyl group. Specific----------are precursors of ----------. The lipid ----------isa component of membranes, and the precursor of other compounds that containthe steroid nucleus, such as the ----------and ----------. Cholesterol isone of the compounds synthesized from a 5-carbon precursor called the ----------unit.

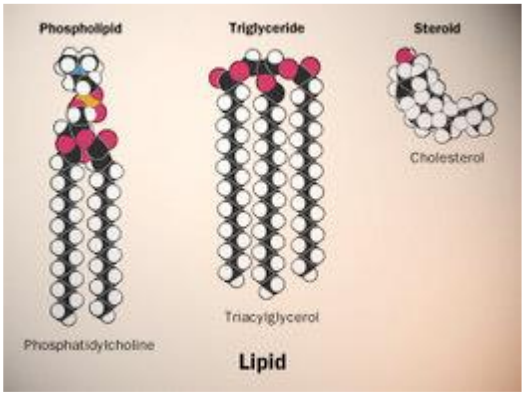


Figure 2: structureof some lipids

5. Nitrogen-containing compounds.

Nitrogen in ----------or ----------structures often carries a positive charge at neutral pH.----------containa carboxyl group, an amino group, and one or more additional carbons. ----------,----------, and ----------have heterocyclic nitrogen-containing ring structures.----------comprise one of these ring structures

attached to a sugar. The additionof a phosphate produces a ----------.

A. Nucleic acids.

Nucleic acids are composed of nucleotide monomer units. Nucleotides themselves are composed of a monosaccharide, a nitrogenous base, and one or more phosphate groups. The nucleotide ATP is the major energy currency of the cell which is used to power a huge variety of energy-requiring reactions. ATP and other ribonucleotides (containing ribose) also make up the biopolymer RNA. Deoxyribonucleotides (containing deoxyribose) make up DNA.

All nucleotides are held together by phosphodiester linkages where one phosphate group is attached to 2 sugar units in the backbone of the polymer. Nucleotides play key roles in information transfer in all organisms (DNA → RNA → protein). RNA also can carry out structural and enzymatic functions. For example, the formation of peptide bonds during protein synthesis actually is performed by one of the RNA constituents of the ribosome. In addition the main structural component of ribosomes is RNA.

B. Proteins.

Protein molecules are in all living tissues of plant and animals

Proteins contain C, H, N, O, and S atoms. They may contain other atoms as well.----------**-s** and **proteoglycans** have sugars attached to their protein components.

Proteins have many roles in our bodies and in all living things:

Covering – in hair, skin, and nails

Chemical reactions – enzymes that catalyze chemical reactions

Transport - Hemoglobin carries O_2 in blood

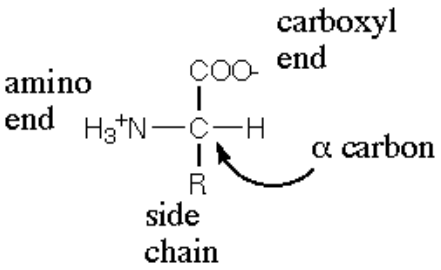
Motion – muscles are made of proteins

Coordinate chemical activities – insulin is used in glucose metabolism

Most of the chemical reactions of the cell are carried out by proteins. Proteins also are the major structural components of most cells and tissues. Proteins are often called polypeptides in reference to the fact that they are composed of amino acids held together by peptide bonds (**Fig.**). Peptide bonds actually are amide bonds which are formed by the condensation of the carboxyl groups and amino groups of consecutive amino acids in the polymer chain. The R-groups play a significant role in determining the 3D structure of a protein, i.e., its active conformation.Proteins are built up from repeated units of amino acids and may have molecular weights of 6,000 to 3,000,000 amu (or g/mol)

B.1. Amino acids

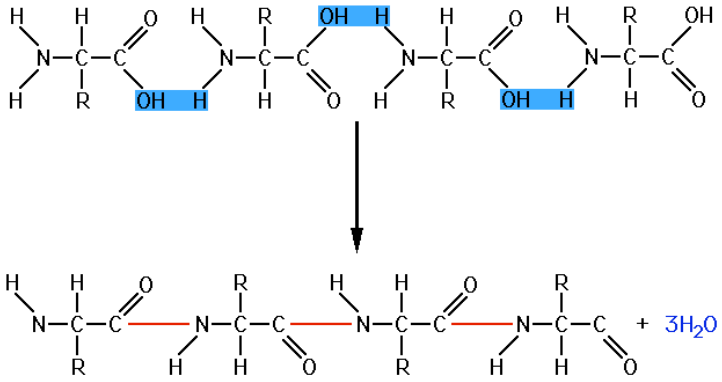
20 different amino acids are found in nature. All amino acids have amino group, carboxyl group, H atom and one other group (---------chain, R) attached to carbon atom. R may be –H, - CH_3, - CH_2-benzene etc.Only the side group various among different amino acids. So an amino acid is defined by its ---------- group. Ends may be --------- or ---------- depending on ---------- of solution.



B.2. Polypeptides

Several to many amino acids are ---------- together in a chain is called a polypeptide. Amino acids are held together by a peptide ----------.

A peptide linkage is formed when ---------- group and ---------- come together lose a ---------- molecule and form an ---------- group –C(=O)–N(–H)– as shown below.



B.3. 3-Dimensional Structure

Proteins have complex three-dimensional structure.

----------**structure** – order of amino acids in a long chain

---------- **structure** – (coiled or flat) spatial arrangement due to hydrogen bonding can give rise to alpha helix or beta sheets).

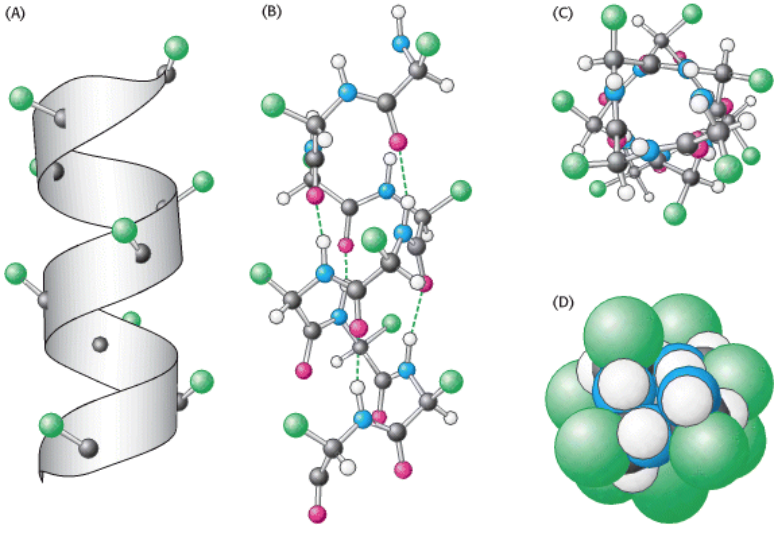


Figure 3. **Secondary structure of protein (α–structure)**

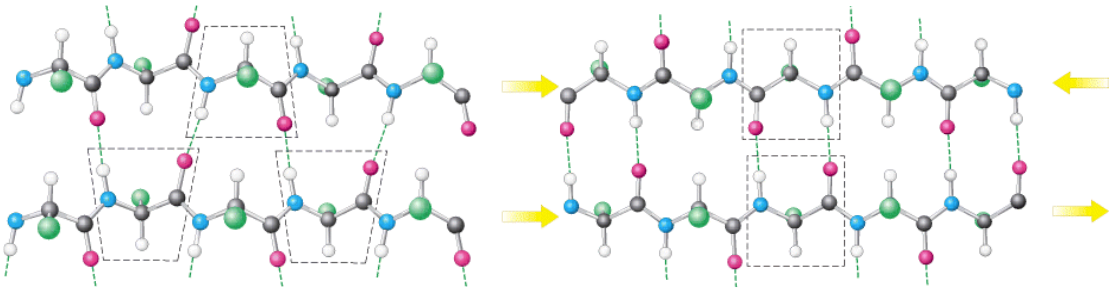


Figure 4. **Secondary structure of protein (β-structure)**

----------– arrangement of R groups gives rise to a still more complicated three dimensional structure. The different R groups are attracted by ---------- bonding, ---------- forces, ----------attraction, dipole interactions, ---------- ---------- S-S bonds that form, etc.)

Many vitamins are used by the body to make coenzymes.

Since cells require many many different chemical reactions to occur, the proteins that form enzymes can be thought of as the "biological machinery" of the cell. Sometime metal atoms are incorporated into enzyme structures.

Figure 5. **Tertiary structureand Quaternary structure of proteins (left: myoglobin, right: hemoglobin: 2**a **and 2**b **subunits)**

IV. The energetics of life.

Living organisms are highly complicated at the molecular level. A large amount of energy is invested in maintaining the ordered and complicated state of cells and tissues. In humans and animals, energy needed for work and biosynthesis of cellular structures is derived from organic molecules in the diet. Often these come from plant sources, who derived their energy for synthesis of biomolecules from sunlight. In animals, energy is derived from the breakdown of fuel molecules by processes referred to as catabolism. In turn, the energy released from catabolism is used to drive biosynthetic processes collectively referred to as anabolism.

The flow of energy in biological systems is covered in the discipline known as bioenergetics. Cells use enzymes that can only affect the kinetics not the thermodynamics. Bioenergetics is one of the tools used in animal and human nutrition. Weight gain or loss ultimately depend on the difference between caloric intake and expenditure.

Enzymes : The enzymes comprise one subclass of ----------. These proteins carry out ---------- with extraordinary ---------- and speed (up to 1017-fold enhancement in reaction rate). ---------- is achieved because the binding site for reactants--the active site--is highly complementary in shape to the reactants and products. Many of these ---------- and enzymes are the targets of poisons and drugs.

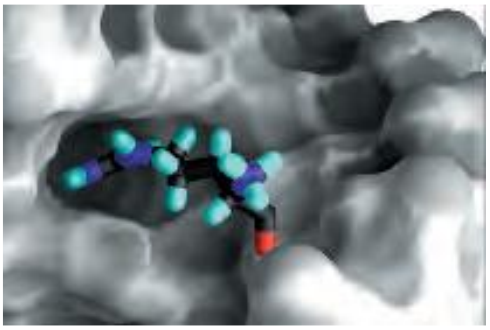


Figure6: Complementary fit between a macromolecule and a small molecule

Cell membrane.

The most common structural lipid in cell membranes----------contains 2 fatty acids, glycerol and a polar head group (**Fig. 1**). When collected as assemblies of millions of molecules, the classical biological structure known as a membrane is formed.Biological membranes usually contain ---------- and protein content and composition is highly variable and determined by membrane function.

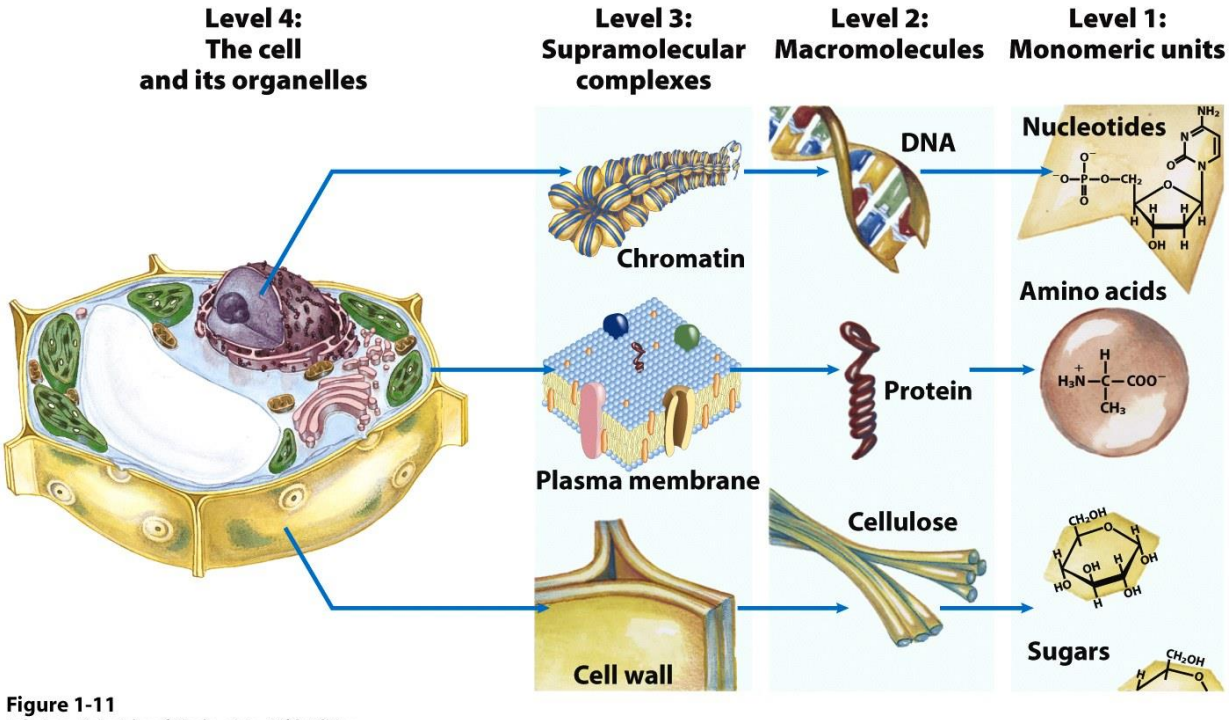


Figure 1-11
Lehninger Principles of Biochemistry, Fifth Edition
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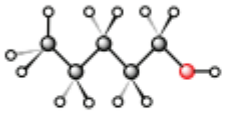
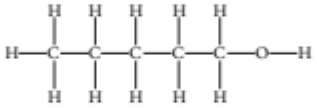
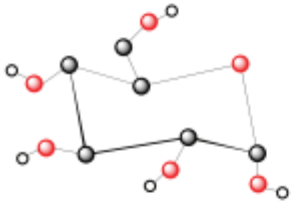
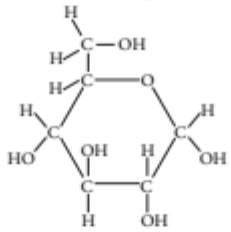
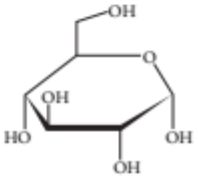
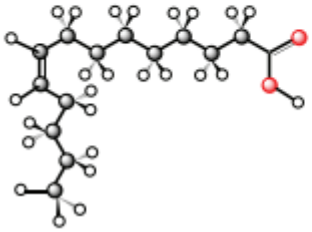
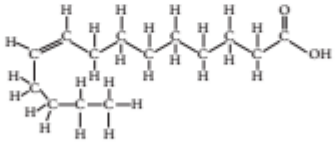
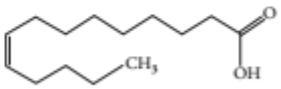
Figure 7: cell composition and molecular distribution

Model 1 – Molecular Drawings

Ball-and-stick model of 1-pentanol 	Lewis structure of 1-pentanol 	Line drawing of 1-pentanol 
Ball-and-stick model of glucose 	Lewis structure of glucose 	Line drawing of glucose 
Ball-and-stick model of unsaturated fatty acid 	Lewis structure of unsaturated fatty acid 	Line drawing of unsaturated fatty acid 

1. How many bonds are typically formed by each of the following atoms:
   Carbon ---------- Hydrogen ---------- Oxygen ----------
2. Which types of drawings in Model 1 provide more accurate images of the shape of a molecule? Justify your reasoning.

   ---

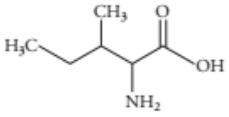
3. Refer to Model 1.
   a. Symbols or atoms of what element(s) are missing from the line drawings?

   ---

4. *b.* In reading a line drawing, how do you know where atoms of these elements are in the structure if they are missing from the drawing?

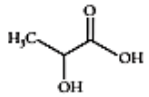
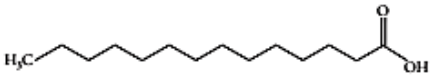
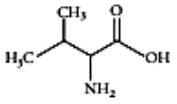
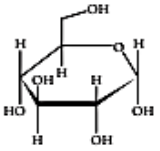
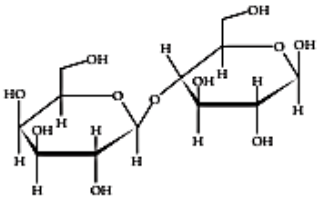
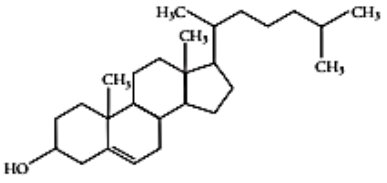
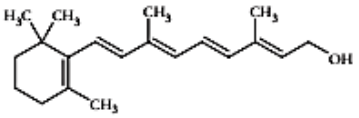
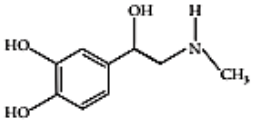
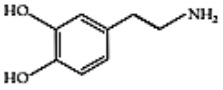
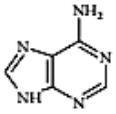
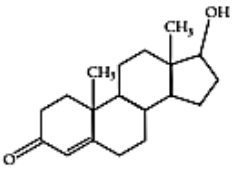
   ---

5. Locate the carbon and hydrogen atoms in the line drawing of isoleucine shown below and draw them in as if the drawing were a Lewis structure.



Isoleucine

Model 2 – Properties of Biological Molecules

Polar Molecules (hydrophilic)	Nonpolar Molecules (hydrophobic)
Acidic  Lactic acid	**Acidic**  Fatty acid
Neutral  Valine (amino acid)  Glucose  Lactose	**Neutral**  Cholesterol  Vitamin A
Basic  Adrenaline  Dopamine  Adenine	 Testosterone

Consider the polar molecules in Model 2.

1. In chemistry there is a saying "like dissolves like," which means things will mix with or dissolveinto each other best when their polarities are similar.

a. Is water polar or nonpolar? ----------

b. Is oil polar or nonpolar?----------

c. Which of the substances in Model 2 would dissolve well in water? Justify your reasoning.----------
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d. Which of the substances in Model 2 are more likely to dissolve well in oil? Justify your reasoning. ----------
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