A lecture: 1 المحاضرة الاولى

Stage: first المرحلة الاولى

Human Biology بايلوجي بشري/ النظري

Introduction to biology

Biology: is the science of life. Its name is derived from the Greek words "bios" (life) and "logos" (study). Biologists study the structure, function, growth, origin, evolution and distribution of living organisms.

Sub-disciplines of biology

Sub-disciplines of biology are defined by the research methods employed and the kind of system studied: theoretical biology uses mathematical methods to formulate quantitative models while experimental biology performs empirical experiments to test the validity of proposed theories and understand the mechanisms underlying life and how it appeared and evolved from non-living matter about 4 billion years ago through a gradual increase in the complexity of the system.

There are generally considered to be at least nine "umbrella" fields of biology, each of which consists of multiple subfields.

- **Biochemistry**: the study of the material substances that make up living things
- **Botany:** the study of plants, including agriculture
- **Cellular biology**: the study of the basic cellular units of living things
- **Ecology:** the study of how organisms interact with their environment

- **Evolutionary biology:** the study of the origins and changes in the diversity of life over time
- **Genetics:** the study of heredity
- **Molecular biology:** the study of biological molecules
- **Physiology:** the study of the functions of organisms and their parts
- **Zoology:** the study of animals, including animal behavior

Adding to the complexity of this enormous idea is the fact that these fields overlap. It is impossible to study zoology without knowing a great deal about evolution, physiology and ecology. You can't study cellular biology without knowing biochemistry and molecular biology as well.

Framework of understanding

All the branches of biology can be unified within a framework of five basic understandings about living things. Studying the details of these five ideas provides the endless fascination of biological research:

- **Cell Theory**: There are three parts to cell theory — the cell is the basic unit of life, all living things are composed of cells, and all cells arise from pre-existing cells.
- **Energy**: All living things require energy, and energy flows between organisms and between organisms and the environment.
- **Heredity**: All living things have DNA and genetic information codes the structure and function of all cells.
- **Equilibrium**: All living things must maintain homeostasis, a state of balanced equilibrium between the organism and its environment.
- **Evolution**: This is the overall unifying concept of biology. Evolution is the change over time that is the engine of biological diversity.

Biology and other sciences

Biology is often studied in conjunction with other sciences, such as mathematics and engineering, and even social sciences. Here are a few examples:

- **Biophysics** involves matching patterns in life and analyzing them with physics and mathematics, according to the Biophysical Society.
- **Astrobiology** is the study the evolution of life in the universe, including the search for extraterrestrial life, according to NASA.
- Biogeography is the study of the distribution and evolution of life forms and the causes of the distribution, according to Dartmouth College.
- **Biomathematics** involves creating mathematical models to better understand patterns and phenomena within the biology world, according to North Carolina State University.
- **Bioengineering** is the application of engineering principles to biology principles and vice versa, according the University of California Berkeley.
- **Sociologists** often study how biology can shape social structures, cultures, and interactions, according to the American Sociological Association.

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Human Biology بايلوجي بشري/ النظري

Levels of Organization

Biosphere: The sum of all living things taken in conjunction with their environment.In essence, where life occurs, from the upper reaches of the atmosphere to the top few meters of soil, to the bottoms of the oceans. We divide the earth into atmosphere (air), lithosphere (earth), hydrosphere (water), and biosphere (life).

Ecosystem: The relationships of a smaller groups of organisms with each other and their environment. According to Darwin's theory, organisms adapt to their environment, they must also adapt to other organisms in that environment. We can discuss the flow of energy through an ecosystem from photosynthetic autotrophs to herbivores to carnivores.

Community: The relationships between groups of different species. For example, the desert communities consist of rabbits, coyotes, snakes, birds, mice and such plants as sahuaro cactus , etc.

Species: Groups of similar individuals who tend to mate and produce viable, fertile offspring. We often find species described not by their reproduction (a biological species) but rather by their form (anatomical or form species).

Populations: Groups of similar individuals who tend to mate with each other in a limited geographic area. This can be as simple as a field of flowers, which is separated from another field by a hill or other area where none of these flowers occur.

Individuals: One or more cells characterized by a unique arrangement of DNA "information". These can be unicellular or multicellular. The multicellular individual exhibits specialization of cell types and division of labor into tissues, organs, and organ systems.

Organ System: (in multicellular organisms).A group of cells, tissues, and organs that perform a specific major function. For example: the cardiovascular system functions in circulation of blood.

Organ: (in multicellular organisms). A group of cells or tissues performing an overall function. For example: the heart is an organ that pumps blood within the cardiovascular system.

Tissue: (in multicellular organisms). A group of cells performing a specific function. For example heart muscle tissue is found in the heart and its unique contraction properties aid the heart's functioning as a pump.

Cell: The fundamental unit of living things. Each cell has some sort of hereditary material (either DNA or more rarely RNA), energy acquiring chemicals, structures, etc. Living things, by definition, must have the metabolic chemicals plus a nucleic acid hereditary information molecule.

Organelle: A subunit of a cell, an organelle is involved in a specific subcellular function, for example the ribosome (the site of protein synthesis) or mitochondrion (the site of ATP generation in eukaryotes).

Molecules, atoms, and subatomic particles: The fundamental functional levels

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Human Biology

المحاضرة الثانية

المرحلة الاولى

بايلوجي بشري/ النظري

Science is an objective, logical, and repeatable attempt to understand the principles and forces operating in the natural universe. Science is from the Latin word, *scientia*, to know.

Characteristics of living things

Living things have a variety of common characteristics.

1. **Organization:** Living things exhibit a high level of organization, with multicellular organisms being subdivided into cells, and cells into organelles, and organelles into molecules, etc.
2. **Homeostasis:** Homeostasis is the maintenance of a constant internal environment in terms of temperature, pH, water concentrations, etc. Much of our own metabolic energy goes toward keeping within our own homeostatic limits. If you run a high fever for long enough, the increased temperature will damage certain organs and impair your proper functioning. Swallowing of common household chemicals, many of which are outside the pH (acid/base) levels we can tolerate, will likewise negatively impact the human body's homeostatic regime. Muscular activity generates heat as a waste product. This heat is removed from our bodies by sweating. Some of this heat is used by warm-blooded animals, mammals and birds, to maintain their internal temperatures.

3. **Metabolism**: is the set of life-sustaining chemical reactions in organisms. The three main purposes of metabolism are: the conversion of food to energy to run cellular processes; the conversion of food/fuel to building blocks for proteins, lipids, nucleic acids, and some carbohydrates; and the elimination of nitrogenous wastes. These enzyme-catalyzed reactions allow organisms to grow and reproduce, maintain their structures, and respond to their environments. (The word metabolism can also refer to the sum of all chemical reactions that occur in living organisms, including digestion and the transport of substances into and between different cells, in which case the above described set of reactions within the cells is called intermediary metabolism or intermediate metabolism).
4. **Anabolism:** is the set of metabolic pathways that construct molecules from smaller units. These reactions require energy, known also as an endergonic process. Anabolism is the building-up aspect of metabolism, whereas catabolism is the breaking-down aspect. Anabolism is usually synonymous with biosynthesis.
5. **Catabolism**: is the set of metabolic pathways that breaks down molecules into smaller units that are either oxidized to release energy or used in other anabolic reactions. Catabolism breaks down large molecules (such as polysaccharides, lipids, nucleic acids and proteins) into smaller units (such as monosaccharides, fatty acids, nucleotides, and amino acids, respectively). Catabolism is the breaking-down aspect of metabolism, whereas anabolism is the building-up aspect.

6. **Adaptation:** Living things are suited to their mode of existence. Charles Darwin began the recognition of the marvelous adaptations all life has that allow those organisms to exist in their environment.
7. **Reproduction and heredity:** Since all cells come from existing cells, they must have some way of reproducing, whether that involves asexual (no recombination of genetic material) or sexual (recombination of genetic material). Most living things use the chemical DNA (deoxyribonucleic acid) as the physical carrier of inheritance and the genetic information. Some organisms, such as retroviruses (of which HIV is a member), use RNA (ribonucleic acid) as the carrier. The variation that Darwin and Wallace recognized as the wellspring of evolution and adaptation, is greatly increased by sexual reproduction.
8. **Growth and development:** Even single-celled organisms grow. When first formed by cell division, they are small, and must grow and develop into mature cells. Multicellular organisms pass through a more complicated process of differentiation and organogenesis (because they have so many more cells to develop).
9. Energy acquisition and release. One view of life is that it is a struggle to acquire energy (from sunlight, inorganic chemicals, or another organism), and release it in the process of forming ATP (adenosine triphosphate).
10. Detection and response to stimuli (both internal and external).
11. Detection and response to stimuli (both internal and external).
12. Interactions. Living things interact with their environment as well as each other. Organisms obtain raw materials and energy from the environment

or another organism. The various types of symbioses (organismal interactions with each other) are examples of this.

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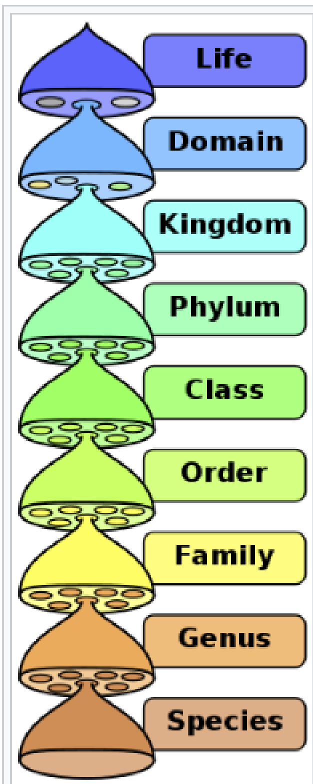
Human Biology بايلوجي بشري/ النظري

The Kingdom of Living Things



In biology, kingdom (Latin: regnum, plural regna) is the second highest taxonomic rank, just below domain. Kingdoms are divided into smaller groups called phyla.

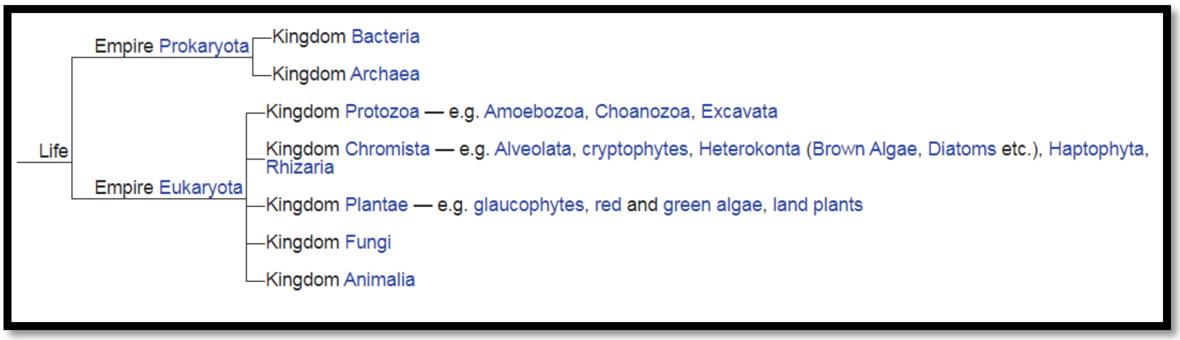
Definition and associated terms

When Carl Linnaeus introduced the rank-based system of nomenclature into biology in 1735, **the highest rank was given the name "kingdom" and was followed by four other main or principal ranks: class, order, genus**

and species. Later two further main ranks were introduced, making the sequence kingdom, phylum or division, class, order, family, genus and species. In 1990, the rank of domain was introduced above kingdom.

Seven kingdoms

Cavalier-Smith and his collaborators revised their classification in 2015. In this scheme they reintroduced the division of prokaryotes into two kingdoms, Bacteria and Archaea . This is based on the consensus in the Taxonomic Outline of Bacteria and Archaea (TOBA) and the Catalogue of Life.



Biochemistry

Biochemistry, sometimes called **biological chemistry, is the study of chemical processes within and relating to living organisms.** Biochemical processes give rise to the complexity of life.

A sub-discipline of both biology and chemistry, **biochemistry can be divided in three fields; structural biology, enzymology and metabolism.**

Biochemistry is closely related to molecular biology, the study of the molecular mechanisms of biological phenomena.

Much of biochemistry deals with the structures, functions and interactions of biological macromolecules, such as proteins, nucleic

acids, carbohydrates and lipids, which provide the structure of cells and perform many of the functions associated with life.
The chemistry of the cell also depends on the reactions of smaller molecules and ions. These can be inorganic, for example water and metal ions, or organic, for example the amino acids, which are used to synthesize proteins.

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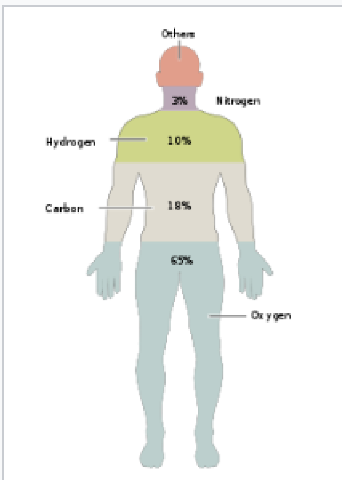
Human Biology

المحاضرة الخامسة

المرحلة الاولى

بايلوجي بشري/ النظري

The chemical elements of life



The main elements that compose the human body are

Just six elements—carbon, hydrogen, nitrogen, oxygen, calcium, and phosphorus—make up almost 99% of the mass of living cells, including those in the human body . In addition to the six major elements that compose most of the human body, humans require smaller amounts of possibly 18 more.

Biomolecules

The four main classes of molecules in biochemistry (often called biomolecules) are carbohydrates, lipids, proteins, and nucleic acids.

Many biological molecules are polymers: in this terminology, monomers are relatively small micromolecules that are linked together to create large macromolecules known as polymers.

Carbohydrates

Carbohydrate, Monosaccharide, Disaccharide, and Polysaccharide.

Two of the main functions of carbohydrates are energy storage and providing structure. Sugars are carbohydrates, but not all carbohydrates are sugars. they are used to store energy and genetic information, as well as play important roles in cell to cell interactions and communications.

The simplest type of carbohydrate is a monosaccharide, which among other properties contains carbon, hydrogen, and oxygen, mostly in a ratio of 1:2:1 (generalized formula $C_nH_{2n}O_n$, where n is at least 3).

Glucose ($C_6H_{12}O_6$) is one of the most important carbohydrates; others include **fructose** ($C_6H_{12}O_6$), the sugar commonly associated with the sweet taste of fruits, and **deoxyribose** ($C_5H_{10}O_4$), a component of DNA.

A monosaccharide can switch between acyclic (open-chain) form and a cyclic form.

Two monosaccharides can be joined together by a glycosidic or ether bond into a disaccharide through a dehydration reaction during which a molecule of water is released. The best-known disaccharide is **sucrose or ordinary sugar**, which consists of a glucose molecule and a fructose molecule joined together. Another important disaccharide is lactose found in milk, **consisting of a glucose molecule and a galactose molecule. Lactose** may be hydrolysed by lactase, and deficiency in this enzyme results in lactose intolerance.

When a few (around three to six) monosaccharides are joined, it is called an **oligosaccharide (oligo- meaning "few")**. These molecules tend to be used as markers and signals, as well as having some other uses.

Many monosaccharides joined together make **a polysaccharide**. They can be joined together in one long linear chain, or they may be branched. Two of the most common polysaccharides are **cellulose and glycogen,** both consisting of repeating glucose monomers.

Cellulose is an important structural component of plant's cell walls and glycogen is used as a form of energy storage in animals.

Lipids

Lipid, Glycerol, and Fatty acid.

Lipids comprises a diverse range of molecules and to some extent is a catchall for relatively water-insoluble or nonpolar compounds of biological origin, including **waxes, fatty acids, fatty-acid derived phospholipids, sphingolipids, glycolipids, and terpenoids (e.g., retinoids and steroids).** Some lipids are linear, open chain aliphatic molecules, while others have ring structures. Some are aromatic (with a cyclic [ring] and planar [flat] structure) while others are not. Some are flexible, while others are rigid.

Lipids are usually made from one molecule of **glycerol** combined with other molecules. In triglycerides, the main group of bulk lipids, there is one molecule of glycerol and three fatty acids.

Fatty acids are considered the monomer in that case, and may be **saturated** (no double bonds in the carbon chain) or **unsaturated** (one or more double bonds in the carbon chain).

Proteins

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Human Biology

المحاضرة السابعة

المرحلة الاولى

Structures outside the cell membrane

Cell wall

Many types of prokaryotic and eukaryotic cells have a cell wall. The cell wall acts to protect the cell mechanically and chemically from its environment, and is an additional layer of protection to the cell membrane. *Different types of cell have cell walls made up of different materials; plant cell walls are primarily made up of cellulose, fungi cell walls are made up of chitin and bacteria cell walls are made up of peptidoglycan.*

Prokaryotic

Capsule

A gelatinous capsule is present in some bacteria outside the cell membrane and cell wall. *The capsule may be polysaccharide as in pneumococci, meningococci or polypeptide as Bacillus anthracis or hyaluronic acid as in streptococci*.

Flagella

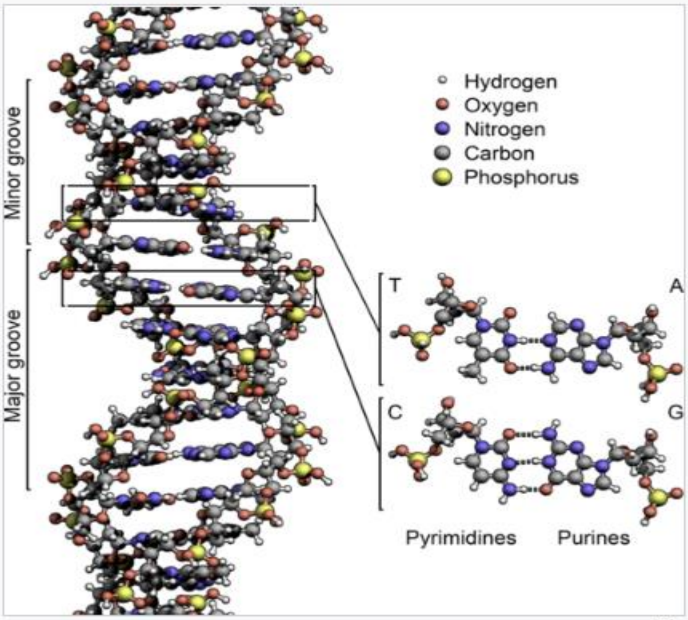
Flagella are organelles for cellular mobility. The bacterial flagellum stretches from cytoplasm through the cell membrane(s) and extrudes through the cell wall. They are long and thick thread-like appendages, protein in nature. A different type of flagellum is found in archaea and a different type is found in eukaryotes.

Fimbriae

A fimbria (plural fimbriae also known as a pilus, plural pili) is a short, thin, hair-like filament found on the surface of bacteria. Fimbriae are formed of a protein called pilin (antigenic) and are responsible for the attachment of bacteria to specific receptors on human cells (cell adhesion). There are special types of pili involved in bacterial conjugation.

DNA structure

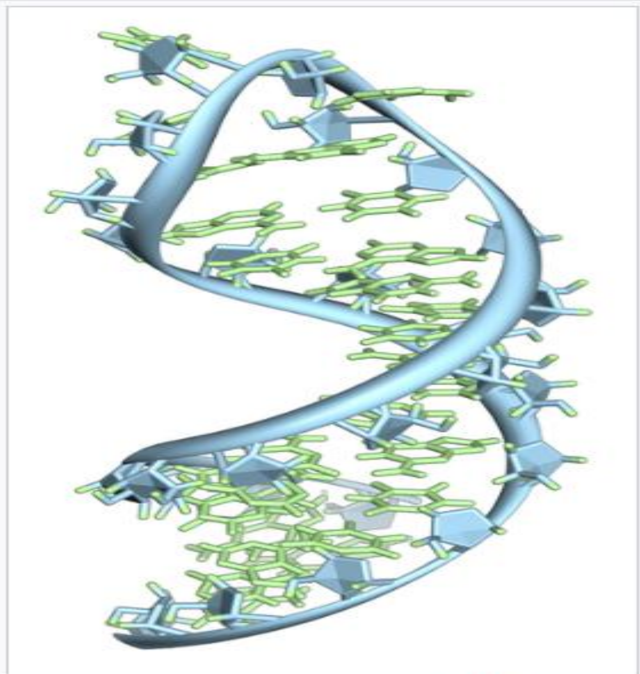
DNA exists as a double-stranded structure, with both strands coiled together to form the characteristic double-helix. Each single strand of DNA is a chain of four types of nucleotides. Nucleotides in DNA contain a deoxyribose sugar, a phosphate, and a nucleobase. The four types of nucleotide correspond to the four nucleobases adenine, cytosine, guanine, and thymine, commonly abbreviated as A, C, G and T. Adenine and guanine are purine bases, while cytosine and thymine are pyrimidines. These nucleotides form phosphodiester bonds, creating the phosphate-deoxyribose backbone of the DNA double helix with the nucleobases pointing inward (i.e., toward the opposing strand). Nucleobases are matched between strands through hydrogen bonds to form base pairs. Adenine pairs with thymine (two hydrogen bonds), and guanine pairs with cytosine (three hydrogen bonds).



The structure of the DNA double helix. The atoms in the structure are colour-coded by element and the detailed structures of two base pairs are shown in the bottom right.

RNA

Ribonucleic acid (RNA) is a polymeric molecule essential in various biological roles in coding, decoding, regulation and expression of genes. RNA and DNA are nucleic acids, and, along with lipids, proteins and carbohydrates, constitute the four major macromolecules essential for all known forms of life. Like DNA, RNA is assembled as a chain of nucleotides, but unlike DNA,RNA is found in nature as a single strand folded onto itself, rather than a paired double strand. Cellular organisms use messenger RNA (mRNA) to convey genetic information (using the nitrogenous bases of guanine, uracil, adenine, and cytosine, denoted by the letters G, U, A, and C) that directs synthesis of specific proteins. Many viruses encode their genetic information using an RNA genome.



A hairpin loop from a pre-mRNA. Highlighted are the nucleobases (green) and the ribose-phosphate

Some RNA molecules play an active role within cells by catalyzing biological reactions, controlling gene expression, or sensing and communicating responses to cellular signals. One of these active processes is protein synthesis, a universal function in which RNA molecules direct the synthesis of proteins on ribosomes. This process uses transfer RNA (tRNA) molecules to deliver amino acids to the ribosome, where ribosomal RNA (rRNA) then links amino acids together to form coded proteins.

Protein and Amino acid

Proteins are very large molecules—macro-biopolymers—made from monomers called amino acids.

The structure of proteins is traditionally described in a hierarchy of four levels.

Intermediate products of **glycolysis, the citric acid cycle, and the pentose phosphate pathway** can be used to make all **twenty amino acids**, and most bacteria and plants possess all the necessary enzymes to synthesize them.

Humans and other mammals, however, can synthesize only half of them. **They cannot synthesize isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine.** These are the essential amino acids, since it is essential to ingest them.

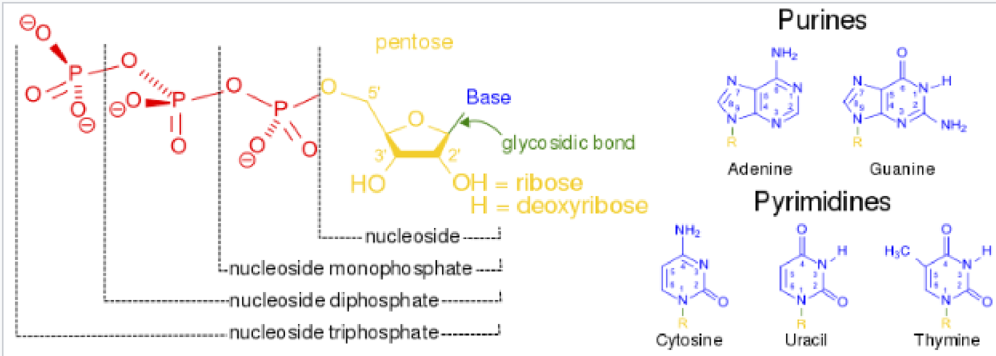
Mammals do possess the enzymes to **synthesize alanine, asparagine, aspartate, cysteine, glutamate, glutamine, glycine, proline, serine, and tyrosine,** the nonessential amino acids.

While they can synthesize **arginine and histidine**, they cannot produce it in sufficient amounts for young, growing animals, and so these are often considered essential amino acids.

Nucleic acids

Nucleic acid, DNA, RNA, and Nucleotide

Nucleic acids, so called because of their prevalence in cellular nuclei, is the generic name of the family of biopolymers. **They are complex, high-molecular-weight biochemical macromolecules that can convey genetic information in all living cells and viruses**. The monomers are called nucleotides, and each consists of three components: a nitrogenous heterocyclic base (either a purine or a pyrimidine), a pentose sugar, and a phosphate group



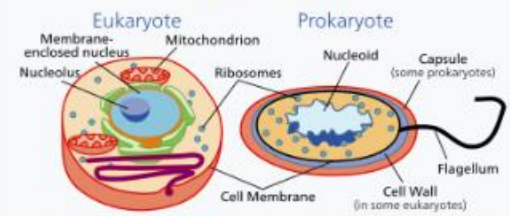
Structural elements of common nucleic acid constituents. Because they contain at least one phosphate group, the compounds marked *nucleoside monophosphate*, *nucleoside diphosphate* and *nucleoside triphosphate* are all nucleotides (not simply phosphate-lacking nucleosides).

The most common nucleic acids are deoxyribonucleic acid (DNA) and ribonucleic acid (RNA).**The phosphate group and the sugar of each nucleotide bond with each other to form the backbone of the nucleic acid, while the sequence of nitrogenous bases stores the information.** The most common nitrogenous bases are **adenine, cytosine, guanine, thymine, and uracil.**
Also, the nitrogenous bases possible in the two nucleic acids are different: adenine, cytosine, and guanine occur in both RNA and DNA, while thymine occurs only in DNA and uracil occurs in RNA.

Cell Structure and Function

The **cell** (from Latin *cella*, meaning "small room") is the basic structural, functional, and biological unit of all known organisms. A cell is the smallest unit of life. Cells are often called the "building blocks of life". The study of cells is called cell biology, cellular biology, or cytology.

Cells consist of cytoplasm enclosed within a membrane, which contains many biomolecules such as proteins and nucleic acids. Most plant and animal cells are only visible under a microscope, with dimensions between 1 and 100 micrometres. Organisms can be classified as unicellular (consisting of a single cell such as bacteria) or multicellular (including plants and animals). Most unicellular organisms are classed as microorganisms.



A eukaryotic cell (left) and prokaryotic cell (right)

The number of cells in plants and animals varies from species to species, it has been estimated that humans contain somewhere around 40 trillion (4×1013) cells.The human brain accounting for around 80 billion of these cells.

Prokaryotic cells

Main article: Prokaryote

Structure of a typical prokaryotic cell

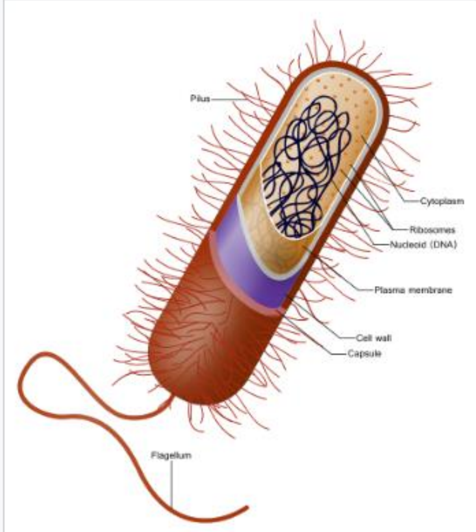
Prokaryotes include bacteria and archaea, two of the three domains of life.

Prokaryotic cells were the first form of life on Earth, characterized by having vital biological processes including cell signaling.

They are simpler and smaller than eukaryotic cells, and lack a nucleus, and other membrane-bound organelles.

The DNA of a prokaryotic cell consists of a single circular chromosome that is in direct contact with the cytoplasm.

The nuclear region in the cytoplasm is called the nucleoid. Most prokaryotes are the smallest of all organisms ranging from 0.5 to 2.0 µm in diameter.



Structure of a typical prokaryotic cell

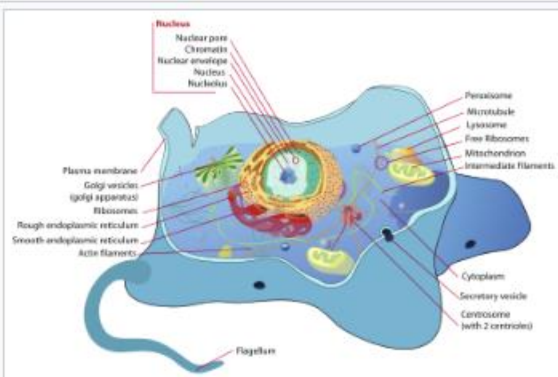
Eukaryotic cells

Plants, animals, fungi, slime moulds, protozoa, and algae are all eukaryotic.

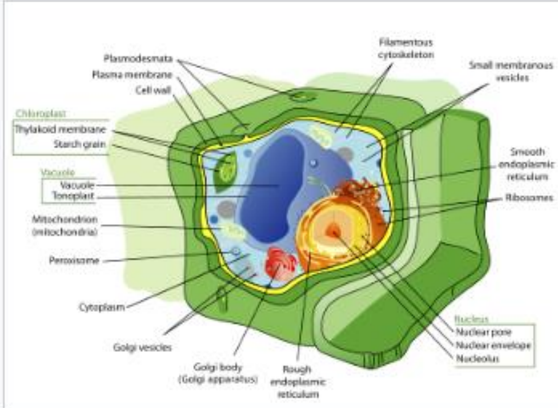
These cells are about fifteen times wider than a typical prokaryote and can be as much as a thousand times greater in volume.

The main distinguishing feature of eukaryotes as compared to prokaryotes is compartmentalization: the presence of membrane-bound organelles (compartments) in which specific activities take place. Most important among these is a cell nucleus, an organelle that houses the cell's DNA.

This nucleus gives the eukaryote its name, which means "true kernel (nucleus)".



Structure of a typical animal cell



Structure of a typical plant cell

Comparison of features of prokaryotic and eukaryotic cells		
	Prokaryotes	**Eukaryotes**
Typical organisms	bacteria, archaea	protists, fungi, plants, animals
Typical size	~ 1–5 µm[18]	~ 10–100 µm[18]
Type of nucleus	nucleoid region; no true nucleus	true nucleus with double membrane
DNA	circular (usually)	linear molecules (chromosomes) with histone proteins
RNA/protein synthesis	coupled in the cytoplasm	RNA synthesis in the nucleus protein synthesis in the cytoplasm
Ribosomes	50S and 30S	60S and 40S
Cytoplasmic	very few	highly structured by endomembranes and a cytoskeleton

structure	structures	
Cell movement	flagella made of flagellin	flagella and cilia containing microtubules; lamellipodia and filopodia containing actin
Mitochondria	none	one to several thousand
Chloroplasts	none	in algae and plants
Organization	usually single cells	single cells, colonies, higher multicellular organisms with specialized cells
Cell division	binary fission (simple division)	mitosis (fission or budding) meiosis
Chromosomes	single chromosome	more than one chromosome
Membranes	cell membrane	Cell membrane and membrane-bound organelles