L.2 Introduction

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The cell (*cellula* – Latin, *kytos* – Greek) is the basic morphological, functional and reproductive unit of all unicellular and multicellular organisms. It is autonomous and dynamic system which is characterized by basic life manifestations (metabolism, growth, irritability, reproduction and development). Science which deals with the study of cells is called **cytology**.

According to *Cell Theory*, first proposed by Schleiden and Schwann in 1839,

1- The cell is the smallest unit of life.
2- All organisms are composed one or more cells.
3- New cells arise from previously existing cells.

Cell types:

According to the organization of nucleus and other structures, we distinguished **prokaryotic** and **eukaryotic cells**.

Prokaryotic cell

Prokaryotic cells have a simple structure(Fig.1) . Which is not separated from the cytoplasm by membrane. They do not have any membrane organelles and cytoskeleton .They are composed of cytoplasm, nukleoid (meaning nucleus-like), cytoplasmic membrane, and on the surface they have a cell wall. Nucleus of prokaryotic cell, assigned as **nukleoid**, is formed by a single circular DNA which is connected with internal part of cytoplasmic membrane. Cytoplasm contains prokaryotic ribosomes, which are smaller when compared to ribosomes in eukaryotic cell. They are composed of three types of rRNA and 52 proteins. Their sedimentation constant is70S. The cytoplasm of prokaryotic cells may contain plasmids (episomes) – small circular molecules of DNA. Photosynthetic bacteria and cyanobacteria have simple vesicles from cytoplasmic membrane with enzymes responsible for photosynthesis (thylakoids). Some prokaryotic cells may also have locomotive organelles (e.g. flagellum, cilia etc.)Prokaryotic cells form only single-cell organisms (e. g. bacteria ,cyanobacteria and Archaea).

Bacteria:

bacteria are most important. They are frequently reproduced by asexual reproduction – by **amitosis (**binary fission) which occurs immediately after DNA replication. Some bacteria should be reproduced by **conjugation**. It is based on the ability of transfer genetic material between bacteria through the conjugative plasmid. The genetic information transferred is often beneficial to the recipient bacteria.

Benefits may include antibiotic resistance which has serious negative consequences for the possible treatment of bacteria related diseases. Bacteria display a wide diversity of sizes (0.3 to9 μm) and shapes(Fig.2) . Most bacterial species are either spherical, called **cocci** , which can be arranged in chain (streptococci) or clusters (staphylococci). Other bacteria are rod-shaped, called **bacilli** . They vary in length and thickness; some may have spiral shapes (such as *Treponema*) and special locomotive organelles. Some bacteria are essential for human being (e. g. *Escherichia coli*) and some of them are parasites which cause purulent inflammatory diseases.

Archaea

Under a microscope, archaea look very similar to bacteria. The walls of archaea lack peptidoglycan, and their membranes contain different lipids. The DNA sequences of key archaea genes are more like those of eukaryotes than those of bacteria. Based on these observations, scientists have concluded that archaea and eukaryotes are related more closely to each other than to bacteria.

Eukaryotic cell

have nucleus which is separated from cytoplasm by the nuclear envelope. Cytoplasm contains various membrane organelles, cytoskeleton and ribosomes. The cells of plants and fungi have cell wall on the surface.
Eukaryotic cells form unicellular (e.g. amoeba)and multicellular organisms. According to way of nutrition we distinguish autotrophic and heterotrophic (protozoa) organisms. Eukaryotic multicellular organisms are fungi, plants and animals. They undergo process of differentiation and specialization. They are composed from tissues, which are organizes to organs and organ system.

Cell structure of eukaryotic cell:

Improvement of light microscopy and introduction of electron microscopy helped to a more accurate understanding of the structure of cells. In general it can be claimed that all cells are composed of **nucleus, cytoplasm** and **cytoplasmic membrane(Fig.1)**. In some specialized cells in their differentiation some component should be reduced or disappeared. Each cell contains ribosomes. The presence of other organelles is dependent on cell type.

Plasma membrane: is a phospholipid bilayer in which proteins are embedded. The cell membrane also acts as a selectively permeable barrier for the transport of nutrients into and out of the cell. In addition it encloses the cell's organelle and cell to cell recognition

Nucleus :is a spherical structure bounded by a double membrane, its contains the cell's DNA .Is control center of the cell.

Nucleolus: located within nucleus and play important role in synthesis and assembly of ribosomes**.**

Cytoplasm : Fills the space between the plasma membrane and the nuclear membrane. A water-like substance that fills cells. Consists of **cytosol** and **cellular organelles** except for the cell nucleus.

Cytosol :is made up of water, salts, organic molecules and many enzymes that catalyze reactions.

Ribosome :small, complex assemblies of protein and RNA. often bound to ER. Is site of protein synthesis.
Endoplasmic Reticulum: is network of internal membrane. There are two types of ER—rough and smooth. **Rough ER** – uses ribosomes to make proteins, modifies them, and sends them to the Golgi.

Smooth ER – makes new membranes and detoxifies dangerous chemicals.

Golgi apparatus :is stacks of flattened vesicles. Receives, modifies, and packaging of proteins.

Lysosome : a vacuole that contains digestive enzymes that are used to break down nutrients into units small enough to be utilized by the cell.

Mitochondria: Enclosed by two membranes, an outer one and another that is folded up inside the mitochondrion. Is the powerhouse of the cell, Convert the chemical energy from food into energy that can be used by the cell.

Cytoskeleton: network of protein filaments, fiber and tubules .Play important role in structural support and cell movement.

Centrioles: Found in pairs in animal cells and made of microtubules. Its help to organize the cytoskeleton during cell division.

The following table shows many differences between prokaryotic and eukaryotic cells :

Basis for comparison	Prokaryotic cells	Eukaryotic cells
Size	**0.5-3um**	**2-100um**
Kind of Cell	**Single-cell**	**Multicellular**
Cell Wall	**Cell wall present, comprise of peptidoglycan or mucopeptide (polysaccharide).**	**Usually cell wall absent, if present (plant cells and fungus), comprises of cellulose (polysaccharide).**
Presence of Nucleus	**Well-defined nucleus is absent, rather 'nucleoid' is present which is an open region containing DNA.**	**A well-defined nucleus is present enclosed within nuclear membrane.**
Shape of DNA	**Circular, double-stranded DNA.**	**Linear, double-stranded DNA.**
Mitochondria	**Absent**	**Present**
Ribosome	**70S**	**80S**
Golgi Apparatus	**Absent**	**Present**
Endoplasmic Reticulum	**Absent**	**Present**
Mode of Reproduction	**Asexual**	**Most commonly sexual**
Cell Division	**Binary Fission, (conjugation, transformation, transduction)**	**Mitosis**
Lysosomes and Peroxisomes	**Absent**	**Present**
Transcription and Translation	**Occurs together.**	**Transcription occurs in nucleus and translation in cytosol.**
Organelles	**Organelles are not membrane bound, if present any.**	**Organelles are membrane bound and are specific in function.**
Replication	**Single origin of replication.**	**Multiple origins of replication.**
Number of Chromosomes	**Only one (not true called as a plasmid).**	**More than one.**
Examples	**Archaea, Bacteria.**	**Plants and Animals.**

Shape and size of cells

The shape and size of cells is genetically determined and is related to their location and function in the body. The basic cell shape is spherical (e.g. human oocyte, leukocytes) and other shapes are derived from it biconcave disc (e.g. human erythrocytes), squamous (e.g. epithelial cells of skin or oesophagus), cuboidal (e.g. epithelium of ducts of many glands), columnar (e.g. epithelial cells of small intestine),polygonal (hepatocytes), spindle-shaped (e.g. fibroblast, myocytes), multi-polar (e.g. neurons, astrocytes), pear-shaped (e.g. Purkinje cells), pyramidal cells (e.g. pyramidal neurons) (Fig.4)etc.

Cells may have different projections. For example cells with fibrous projections (e.g. motor neurons, astrocytes); with irregular cytoplasmic projections (e.g. leukocytes);with flattened projections (e.g. cells of

tendons); with cilia and microvilli (e.g. cells of the small intestine, respiratory tract and uterus); with flagellum (e.g. sperm).

Cells according size are:

• **Small,** which reach size to 10 μm (e.g. erythrocytes, lymphocytes).

•**Middle sized**, their size varied from 10 to 30 μm (e.g. chondrocytes).Most of cells in human tissues are of this size.

• **Big**, with size over 30 μm (human ova, motoric neurons).

Cells are the smallest independent units of living matter and there are trillions of them within the body. They are too small to be seen with the naked eye, but when magnified using a microscope different types can be distinguished by their size, shape and the dyes they absorb when stained in the laboratory. Each cell type has become specialized, enabling it to carry out a particular function that contributes to body needs. For example:

The specialized function of nerve cells is to transmit electrical signals (nerve impulses); these are integrated and co-ordinated allowing the millions of nerve cells in the body to provide a rapid and sophisticated communication system. In complex organisms such as the human body, cells with similar structures and functions are found together, forming tissues

Organs are made up of a number of different types of tissue and have evolved to carry out a specific function. Example: the stomach is lined by a layer of epithelial tissue and that its wall contains layers of smooth muscle tissue. Both tissues contribute to the functions of the stomach, but in different ways. Systems consist of a number of organs and tissues that together contribute to one or more survival needs of the body. For example the stomach is one of several organs of the digestive system, which has its own specific function. The human body has several systems, which work interdependently carrying out specific functions.

All are required for health(Fig.5).

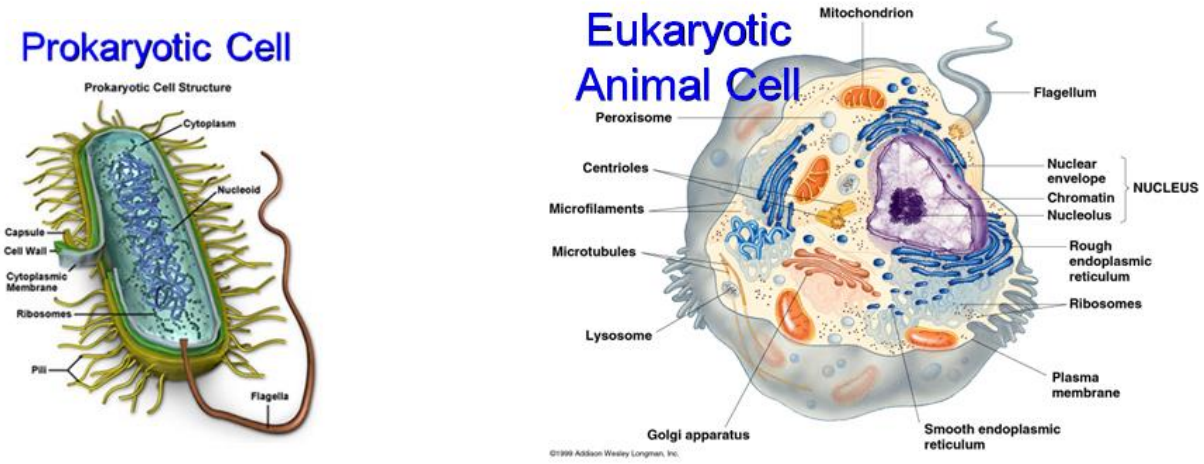

Figure 1

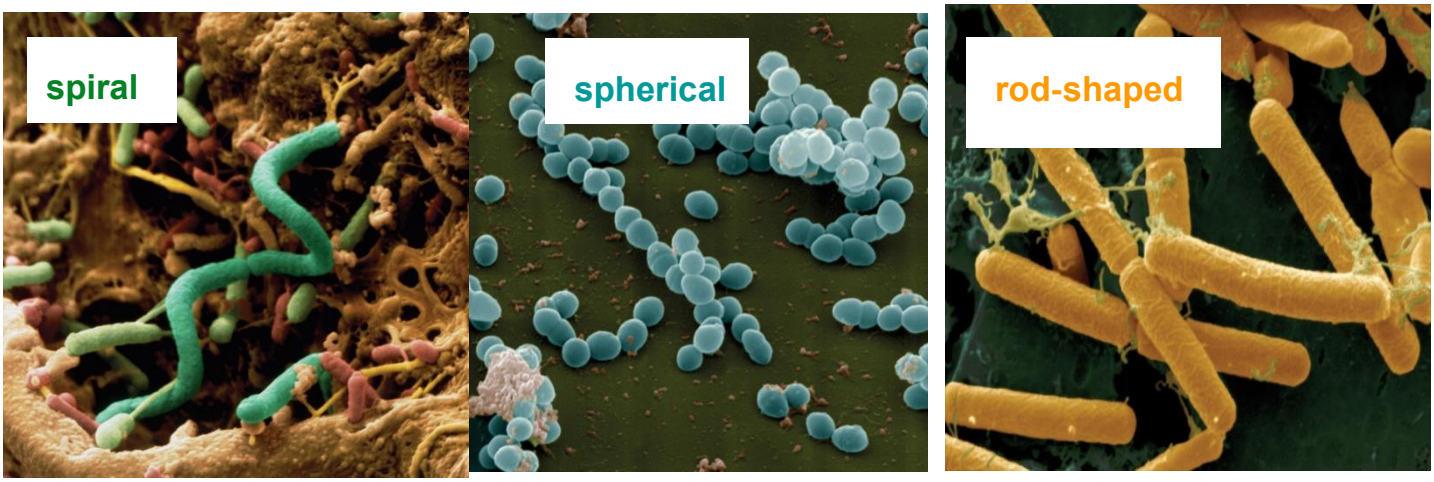

Figure (2)

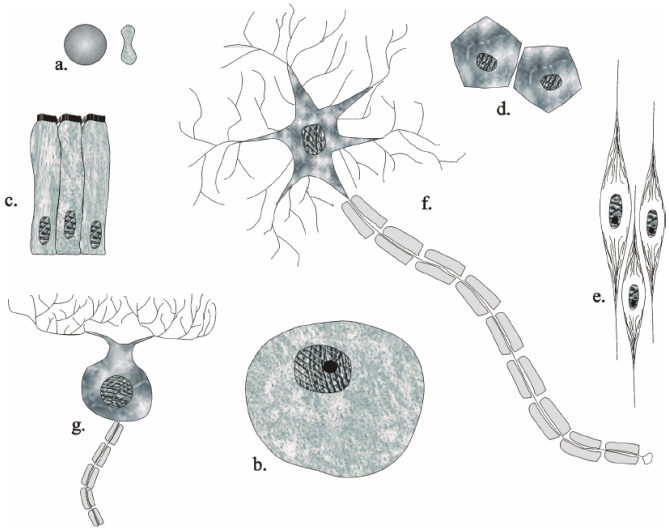

Figure (3)

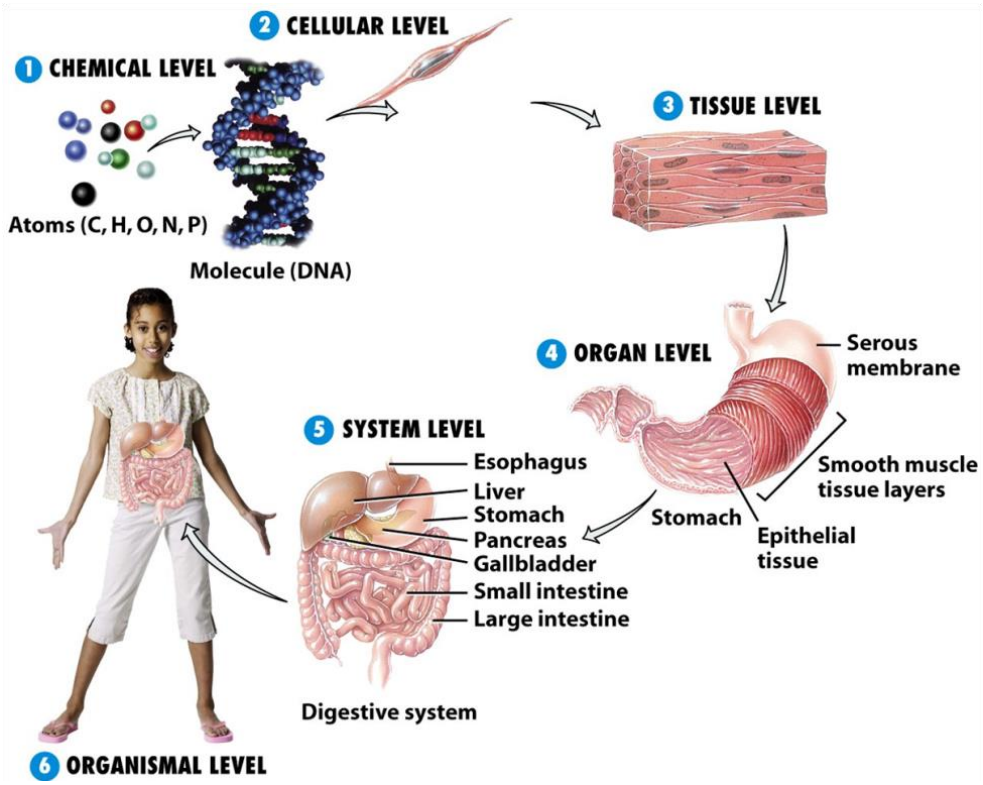

Figure (4)