Overview of Cells- Prokaryotic and Eukaryotic cells

1

Urbbi Devi
Duliajan College

2

Discovery of Cells

- 1665- English Scientist, Robert Hooke, discovered cells while looking at a thin slice of cork.
- He described the cells as tiny boxes or a honeycomb
- He thought that cells only existed in plants and fungi

3

- Anton van Leuwenhoek in1673 used a handmade microscope to observe pond scum & discovered single-celled organisms
- He called them "animalcules"
- He also observed blood cells from fish, birds, frogs, dogs, and humans
- Therefore, it was known that cells are found in animals as well as plants

4

Development of Cell Theory

- 1838- English Botanist, Matthias Schleiden, concluded that all plant parts are made of cells
- 1839- German physiologist, Theodor Schwann, who was a close friend of Schleiden, stated that all animal tissues are composed of cells.
- 1858- Rudolf Virchow, Russian physician, after extensive study of cellular pathology, concluded that cells must arise from preexisting cells

"All living organisms are made up of **cells**, that they are the basic structural/organizational unit of all organisms, and that all **cells** come from pre-existing **cells**."

5

3 Basic Components of the Cell Theory

1. All organisms are composed of one or more cells. (Schleiden & Schwann)(1838-39)
2. The cell is the basic unit of life in all living things. (Schleiden & Schwann)(1838-39)
3. All cells are produced by the division of preexisting cells. (Virchow)(1858)

6

Modern Cell Theory

Modern Cell Theory consists of the 3 basic components of cell theory, plus 4 additional statements:

4. The cell pass information from cell to cell during cell division using DNA.
5. All cells have basically the same chemical composition and metabolic activities.
6. All cells have basically the same chemical & physiological functions.(movement, digestion, etc)
7. Cell activity depends on the activities of structures within the cell. (organelles, nucleus, plasma membrane)

7

DIFFERENT CLASSES OF CELLS

There are two basic classes of cells—

- Prokaryotic — structurally simpler, mostly include bacteria
- Eukaryotic— structurally more complex, include protists, fungi, plants, and animals.

Distinguished by —

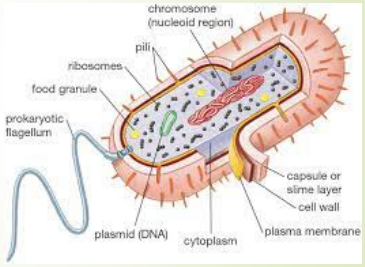
- Their size
- Types of internal structures, or **organelles**

8

Prokaryotic cells

Components

- Cytosol
- Ribosomes
- Nucleoid region
- Circular DNA
- Plasmid
- Cell Membrane
- Cell Wall
- Capsule (or slime layer)
- Pili
- Flagellum



9

Characteristics of Prokaryotes

- does not have a nucleus
- single celled organisms
- have few organelles
- perform few functions
  - Eat
  - Respire
  - Reproduce
- smaller than other cells (0.1 to 5.0 micrometers (μm) in diameter)

10

Types of prokaryotes

- Prokaryotes include bacteria and archaea.

- **Bacteria**
- Domain Bacteria contains 5 major groups: proteobacteria, chlamydias, spirochetes, cyanobacteria, and gram-positive bacteria.

- **Archaea** (Archaebacteria=Ancient bacteria)
- Types include

1. **Crenarchaeota** – *Crenarchaeota* are extremely heat-tolerant.

2. **Euryarchaeota** are able to survive in very salty habitats. They are also able to produce methane, which no other life form on Earth is able to do

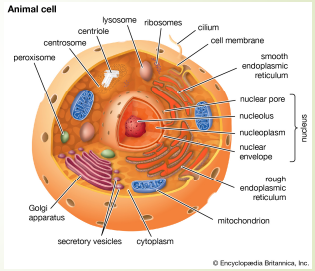
3. **Korarchaeota** are the least-understood, and thought to be the oldest lineage of archaebacteria. This makes them possibly the oldest surviving organisms on Earth!

11

Eukaryotic cells

Components

- Cytosol
- Nucleus
- Mitochondria
- Cytoskeleton
- Ribosomes
- Rough ER
- Smooth ER
- Golgi body
- Cell membrane
- Lysosomes
- Chloroplast
- Centriole
- Cilium and Flagellum
- Vacuoles
- Cell Wall



12

Characteristics of Eukaryotes

- has a nucleus
- can be single or multicellular
- have many organelles, performing complex functions
- specialized to perform specific functions
- larger than prokaryotic cells (10 to 100 μm).
- Animals, plants, fungi and protists are made of eukaryotic cells

13

Types of eukaryotes

- There are four types of eukaryotes: animals, plants, fungi, and protists.
- Protists are a group of organisms defined as being eukaryotic but not animals, plants, or fungi;
- this group includes protozoa, slime molds, and some algae.
- Protists and fungi are usually unicellular, while animals and plants are multicellular.
- Unicellular eukaryotes perform many of the same actions as multicellular eukaryotes, such as locomotion, respiration, digestion, excretion, and reproduction.

14

Features held in common by Prokaryotic and Eukaryotic Cells:

- Plasma membrane of similar construction
- Genetic information encoded in DNA using identical genetic code
- Similar mechanisms for transcription and translation of genetic information, including similar ribosomes
- Shared metabolic pathways (e.g., glycolysis and TCA cycle)
- Similar apparatus for conservation of chemical energy as ATP
- Similar mechanism of photosynthesis (between cyanobacteria and green plants)
- Similar mechanism for synthesizing and inserting membrane proteins
- Proteasomes (protein digesting structures) of similar construction

15

Features of eukaryotic cells not found in prokaryotes:

- Division of cells into nucleus and cytoplasm, separated by a nuclear envelope containing complex pore structures
- Complex chromosomes composed of DNA and associated proteins that are capable of compacting into mitotic structures
- Complex membranous cytoplasmic organelles (includes endoplasmic reticulum, Golgi complex, lysosomes, endosomes, peroxisomes, and glyoxisomes)
- Specialized cytoplasmic organelles for aerobic respiration (mitochondria) and photosynthesis (chloroplasts)
- Complex cytoskeletal system (including microfilaments, intermediate filaments, and microtubules) and associated motor proteins

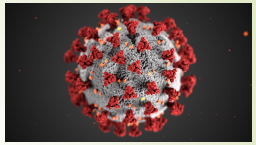
16

Features of eukaryotic cells not found in prokaryotes:

- Complex flagella and cilia
- Ability to ingest fluid and particulate material by enclosure within plasma membrane vesicles (endocytosis and phagocytosis)
- Cellulose-containing cell walls (in plants)
- Cell division using a microtubule-containing mitotic spindle that separates chromosomes
- Presence of two copies of genes per cell (diploidy), one from each parent
- Presence of three different RNA synthesizing enzymes (RNA polymerases)
- Sexual reproduction requiring meiosis and fertilization

17

Virus



- **Virus**, infectious agent of small size and simple composition that can multiply only in living cells of animals, plants, or bacteria. The name is from a Latin word meaning "slimy liquid" or "poison."
- The earliest indications of the biological nature of viruses came from studies in 1892 by the Russian scientist Dmitry I. Ivanovsky and in 1898 by the Dutch scientist Martinus W. Beijerinck.
- Both of these investigators found that a disease of tobacco plants could be transmitted by an agent, later called tobacco mosaic virus

18

General features

- Viruses occupy a special taxonomic position: they are not plants, animals, or prokaryotic bacteria and they are generally placed in their own kingdom. In fact, viruses should not even be considered organisms, in the strictest sense, because they are not free-living—i.e., they cannot reproduce and carry on metabolic processes without a host cell.
- Viruses are inert outside the host cell. Small viruses, e.g., polio and tobacco mosaic virus, can even be crystallized.
- All true viruses contain nucleic acid—either DNA (deoxyribonucleic acid) or RNA (ribonucleic acid)—and protein. The nucleic acid encodes the genetic information unique for each virus.

19

General features

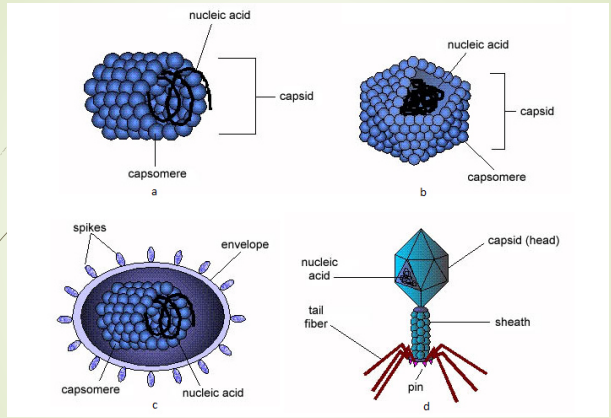
- Viruses depend on the host cell for almost all of their life-sustaining functions. Unlike true organisms, viruses cannot synthesize proteins, because they lack ribosomes and must use the ribosomes of their host cells to translate viral mRNA into viral proteins.
- Viruses are also energy parasites; unlike cells, they cannot generate or store energy in the form of adenosine triphosphate (ATP). The virus derives energy, as well as all other metabolic functions, from the host cell.

20

Size and shape

- Most viruses vary in diameter from 20 nanometres to 250–400 nm; the largest (Megavirus), however, measure about 500 nm in diameter and are about 700–1,000 nm in length.
- There are five main morphological virus types
  - Helical – These viruses are composed of a single type of capsomer stacked around a central axis to form a helical structure, which may have a central cavity, or hollow tube.
  - Icosahedral – Most animal viruses are icosahedral or near-spherical with icosahedral symmetry.
  - Prolate – This is an isosahedron elongated along one axis and is a common arrangement of the heads of bacteriophages.
  - Envelope – Some species of virus envelop themselves in a modified form of one of the cell membranes, either the outer membrane surrounding an infected host cell or internal membranes such as nuclear membrane or endoplasmic reticulum, thus gaining an outer lipid bilayer known as a viral envelope.
  - Complex – These viruses possess a capsid that is neither purely helical nor purely icosahedral, and that may possess extra structures such as protein tails or a complex outer wall.

21



a. Helical b. icosahedral c. envelope d. prolate

22

Structure

- A fully assembled infectious virus is called a virion.
- The simplest virions consist of two basic components:
  - Nucleic acid- single- or double-stranded RNA or DNA, and
  - Capsid- a protein coat which functions as a shell to protect the viral genome

23

Nucleic acid

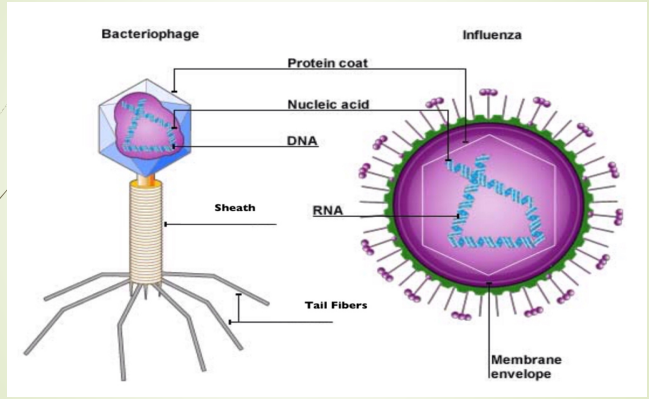
- The virus core contains the genome or total genetic content of the virus.
- Viral genomes tend to be small, containing only those genes that encode proteins that the virus cannot obtain from the host cell.
- This genetic material may be single- or double-stranded.
- It may also be linear or circular.
- While most viruses contain a single nucleic acid, others have genomes that have several, called segments.

24

Capsid

- Capsid proteins are coded for by the virus genome.
- Capsids are formed as single or double protein shells and consist of only one or a few structural protein species.
- These individual structural protein subunits are called capsomeres.
- Some virus families have an additional covering, called the envelope consisting of a lipid bilayer

25



26

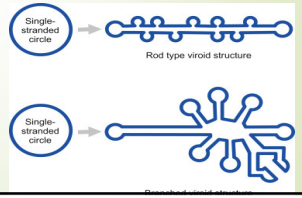
Viroids

- In 1971, Theodor **Diener**, a pathologist working at the Agriculture Research Service, discovered an acellular particle that he named a viroid, meaning "virus-like."
- The first viroid discovered was found to cause **potato tuber spindle disease**, which causes slower sprouting and various deformities in potato plants.
- Viroids only infect plants and can result in devastating losses of commercially important agricultural food crops grown in fields and orchards.
- There are 30 known viroids that have been classified in two families- *Pospiviroidae and Avsunviroidae*

27

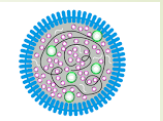
Viroids

- Viroids, the smallest known pathogens, are naked, circular, single-stranded RNA molecules that do not encode protein yet replicate autonomously when introduced into host plants.
- Unlike viruses, viroids do not have a protein coat to protect their genetic information.
- Circular RNA is modified to rod-like or branched structure in some.



28

Mycoplasma



- A large group of bacteria, with more than 100 types identified.
- **Mycoplasma** are very simple one-celled organisms without outer membranes.
- **Mycoplasmas** are **distinguished** phenotypically from **other bacteria** by their minute size and total lack of a cell wall.
- Mycoplasmas are the smallest among the known aerobic prokaryotes. They were first discovered by Pasteur in 1843, during his work on the possible causal agent of pleuropneu-monia of cattle. Thus they were called pleuro- pneumonia-like organism (PPLO).
- Mycoplasmas are commonly found in soil, hot spring, sewage water and also in plants and animals including man.

29

Important characteristics of mycoplasmal bacteria

- Cell wall is absent and plasma membrane forms the outer boundary of the cell.
- Due to the absence of cell wall these organisms can change their shape and are pleomorphic.
- Lack of nucleus and other membrane-bound organelles.
- Genetic material is a single DNA duplex and is naked.
- Possess a replicating disc at one end which assist replication process
- Heterotrophic nutrition. Some live as saprophytes but the majority are parasites of plants and animals. The parasitic nature is due to the inability of mycoplasmal bacteria to synthesise the required growth factor.

30

Classification of Mycoplasmas:

- **Based on nutritional requirement, mycoplasmas are divided into the following three genera:**

1. Mycoplasma:

They require cholesterol for their growth. They parasitise on animals including man by causing damage to the mucous membranes and different joints of the body.

2. Acholeplasma:

They do not require cholesterol for their growth. They are available in sewage water and soil as saprophytes and in vertebrates and also in plants as parasites.

3. Thermoplasma:

They also do not require cholesterol for their growth. They are aerobic microorganisms showing good growth in acidic pH between 0.96-3.0, with an optimum temperature of 59°C.

31

Prion

- **Prion**, an abnormal form of a normally harmless protein found in the brain that is responsible for a variety of fatal neurodegenerative diseases of animals, including humans, called transmissible spongiform encephalopathies.
- In the early 1980s American neurologist Stanley B. Prusiner and colleagues identified the "proteinaceous infectious particle," a name that was shortened to "prion"

32

- Prions can enter the brain through infection, or they can arise from mutations in the gene that encodes the protein. Once present in the brain prions multiply by inducing benign proteins to refold into the abnormal shape.
- They are not broken down by proteases and instead accumulate within neurons, destroying them. Progressive neuron destruction eventually causes brain tissue to become filled with holes in a spongelike, or spongiform, pattern.