Chapter 4 –Part II

Eucaryotic Cell Structure and Function

The Nucleus and Cell Division

- *Constant feature in eukaryotic cells*
- *Place where the cell's genetic information and its control center*

Nuclear Structure

- *Nuclei are membrane-delimited spherical bodies*
- *Containing **Chromatin:** Dense fibrous material*
  - *In non-dividing cells, chromatin exists in a dispersed condition, but condenses during mitosis to become visible as **Chromosomes**.*
  - ***Euchromatin**: loosely organized and contains genes that expressly themselves actively.*
  - ***Heterochromatin**: is coiled more tightly and is not genetically active most of the time.*

Nuclear Envelope

- *Complex structure of both inner and outer membrane separated by an **perinuclear space** that bounds the nucleus.*
  - *Continuous with the ER at several points*
  - *Outer membrane is covered with ribosomes*

- ***Nuclear lamina**: a network of intermediate filaments lie against the inner surface of the envelope and supports it. **Chromatin** is usually associated with the inner membrane.*
- ***Nuclear pores**: penetrate the envelope*
  ***Functions**: serve as a transport route between the nucleus and surrounding cytoplasm*

  - *pores are formed by a fusion of the outer and inner membrane*
  - *occupy 10 – 25% of the nuclear surface*
  - ***Annulus:** complex ringlike arrangement of granular and fibrous material located at the edge of each pore.*
    *-- **Function** is not understood, it may regulate or aid the movement of material through the pores.*

The Nucleolus

Functions: *plays a major role in ribosome synthesis.*

- *The most noticeable structure within the nucleus*
- *Nucleus may contain one to many nucleoli*
- *Not membrane enclosed*
- *Complex organelle with separated granular and fibrillar regions.*
- *Present in non-dividing cells, but disappears during mitosis*
- *After mitosis, reforms around the* ***nucleolar organizer****: a particular part of a specific chromosome.*
- ***Nucleolar organizer****:*
  - *NO DNA directs the production of ribosomal RNA*
  - *rRNA then combines with the ribosomal proteins to form partially completed risosomal subunits.*
  - *Immature ribosomal subunits then leave the nucleus, by way of the envelope pores and mature in the cytoplasm*

Mitosis and Meiosis

Mitosis:

- *When the genetic material must be duplicated and then separated to ensure that each new nucleus possess a complete set of chromosomes in eukaryotic reproduction (nuclear division and chromosomes distribution).*

- *Occupies a small portion of a microorganism's life*

- *Can be seen in the* ***Cell Cycle***

Cell Cycle*: total sequence of events in the growth-division cycle between the end of one division and the end of the next.*

(1) Interphase*:*

- *Cell growth takes place , portion of the cycle between periods of mitosis.*

Composed of three parts:

1. ***G_1 Period*** *(gap 1 period)*
   - *Active synthesis of RNA, ribosomes, and other cytoplasmic constituents accompanied by considerable growth.*

2. ***S Period*** *(synthesis period)*
   - *DNA is replicated and doubles in quantity*
   - *Distributed equally to two (2) new nuclei so that each has a full set of genes.*

3. ***G_2*** *(gap 2 period)*
    - *Cell prepares for mitosis (the M Period) by the synthesis of special division protein.*
    - *Cycles different length of time differ due to the G1.*

Four Phases of Mitosis:

1. ***Prophase***
    - *Chromosomes (having two chromatids) become visible and move toward the equator of the cell.*
    - *Mitotic spindle forms*
    - *Nucleous disappears*
    - *Nuclear envelope begins disappeared*

2. ***Metaphase***
    - *Chromosomes are arranged in the center of the spindle*
    - *Nuclear envelope has disappeared.*

3. ***Anaphase***
    - *Chromatids in each chromosome separate and move toward the opposite poles of the spindle.*

4. ***Telophase***
    - *Chromatids become less visible*
    - *Nucleolus reappears*
    - *Nuclear envelope reassembles around each set of chromatids to form two new nuclei.*

In mitosis:

- *The original number of chromosomes is the same after division*
- *Diploid organism will remain or 2N (still has two copies of each chromosome)*
- *Microorganisms reduces its chromosome number by half,* ***from 2N to 1N,*** *from Diploid to* ***Haploid (a single copy of each chromosome).***

Meiosis:

- *When the number of chromosomes is reduced in half with each daughter cell receiving one complete set of chromosomes.*

Two stages of meiosis:

Stage I

- ***Prophase****:* ***synapsis*** *occurs homologous chromosomes come together and lie side by side.*

- ***Anaphase**: double stranded chromosomes from each homologous pair move to opposite poles.*

The number of chromosomes in halved in meiosis not mitosis.

Stage II

- *Similar to mitosis in mechanics*
- *Single stranded chromosomes are separated*
- *After Meiosis I and II, the 2N has been transformed into four (4) 1N cells.*

External Cell Coverings

Procaryotic and Eucaryotic cells differ with regards to the supporting and protective structure outside of the plasma membrane.

Bacteria have cell walls which provide the shape and protection

In contrast MANY EUCARYOTES LACK A CELL WALL.

- *Cell membrane of Eucaryotic contains sterols (cholesterol) in their lipid bilayer making them mechanically strong, reducing the need for external support.*
  - *Some bacterial contain hopanoids which help to strengthened their cell membrane.*

NOW ---Many EUCARYOTIC CELLS DO HAVE a rigid external cell wall.

- ***Algae:** photosynthetic have cell walls that contain polysaccharides such as cellulose and pectin.*
- ***Fungal:** nonphotsynthetic, cell wall composition varies, usually cellulose, chitin, or glucan*
- ***The EC cell walls are much simpler then those of the peptidoglycan cell wall of the PC.***

- ***Protozoa and some algae mostly nonphotosynthetic** have a different external structure*

  ***Pellicle:** a rigid layer of components just beneath the plasma membrane*
  - *fairly simple in structure*
  - *not as strong and rigid as the cell wall**, it gives the organism a characteristic shape.***

  Example: Euglena

Cilia and Flagella:

- *Most prominent organelles associated with motility.*
- *Both are whiplike and beat to move the mo along, they are different.*

Two Ways they Differ:

1. Size (cilia are smaller length to the flagella)
Cilia: 2 to 20 um
Flagella: 100 to 200 um

2. Pattern of movement

Flagella

- *Flagellum movement often takes the form of waves that move through either from the base of the flagellum to its tips or in the opposite direction.*
- *The motion of the waves propels the organism along.*

Cilium

- *Beat takes place in two different phases:*
  (1) a stroke represents when the cilium remains fairly stiff as it swings through the water

  (2) Followed by a recovery stroke in which the cilium bends and returns to its initial position.

Comparison of the Procaryotic and Eucaryotic Cells

Eucaryotes *have a membrane-enclosed nucleus*

- *Algae, fungi, protozoa, higher plants, and animals*
- *Phagocytosis, pintocytosis, intracellular digestion, etc.*

Procaryotes *do not. Lack a true nucleus.*

- *Bacteria and Archea are*
- *Normally smaller than EC, often about the size of mitochondria and chloroplasts*
- *PC has a much more simpler structure than EC (no membrane-organelle)*
- *Functionally, PC are much simpler than EC*
  No Mitosis and Meiosis occurring, have asexual reproduction

Chapter 5
Microbial Nutrition

Nutrients:

- *A supply of raw materials needed by organisms to obtain energy and construct cellular components.*
- *Substances used in biosynthesis and energy production, a requirement for microbial growth.*

Common Nutrient Rrequirement:

- *Over 95% of the microbial cell dry weight composition is composed of the following major elements:*
  - ***Carbon***
  - ***Oxygen***
  - ***Hydrogen***
  - ***Nitrogen***
  - ***Sulfur***
  - ***Phosphorus***
  - ***Potassium***
  - ***Calcium***
  - ***Magnesium***
  - ***Iron***

Macronutrients

These are referred to as *Macroelements or Macronutrients:* ***required by MO in relatively large amounts.***

- ***C, O, H, N, S, and P*** are components of Carbohydrates, lipids, proteins, and nucleic acids.
- ***K, Ca, Mg, and Fe*** *are cations and play a variety of roles.*
  - **K** required for activity by a number of enzymes, some involved in protein synthesis
  - ***Ca*** *contributes to the heat resistant endospore*
  - ***Mg*** *serves as a cofactor for many enzymes*
    Complexes with ATP
    Stabilizes ribosomes and cell membranes
  - ***Fe*** *is part of the cythchromes*
    A cofactor for enzymes and electron-carrying proteins

Micronutrients (trace elements)

Required by all organisms and the following are needed by the most cells.

- ***Manganese***
- ***Zinc***
- ***Cobalt***
- ***Molybdenum***
- ***Nickel***
- ***Copper***