Biol103 Notes

Lec 1 - Chemistry of life

- An element is a chemical substance that cannot be broken-down into any simpler substances
- About 20-25%of the 92 natural elements are essential to life
- Four elements make up 96%of the living parts of organisms;
  - Oxygen, Carbon, Hydrogen, Nitrogen

Atoms

- Atoms of the various elements differ in their number of subatomic particles
- All atoms of a particular element have the same number of protons in their nuclei
- The number of protons in an atom of an element is the atomic number
- Atomic Mass Number is the sum of protons and neutrons in the nucleus of the atom
- The contribution of electrons to the mass is negligible.
- Some atoms have more neutrons than other atoms of the same element, called Isotopes
- Although the isotopes of an element have slightly different masses, they behave identical in chemical reactions

Electrons

- Electrons in orbitals closest to the nucleus have the lowest energy levels electrons
- The outermost electrons (valence) can leave/gain electrons to form ions
- An orbital can contain no more than 2 electrons (can have several in a given energy level)

Bonding

Covalent Bonds

- Sharing of electrons creates covalent bonding
- A compound whose atoms are joined by covalent bonds is called a covalent compound

Ionic Bonds

- When atoms lose/gain electrons from their valence shell, they become charged particles - ions
- Ionic compounds are composed of anions and cations bonded together by opposite charges
- Bonds formed by the attraction of positive and negative charges are known as ionic bonding

Water is the medium of life

- Special physical and chemical properties of water provided a medium in which living organisms originated, survived and evolved. All life exists in and reacts in the presence of water

Properties - due to polar covalent bonds and hydrogen bonds

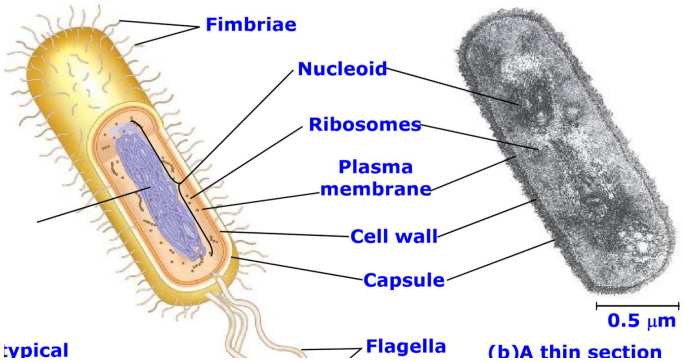
- Specific heat - Raise the temperature of 1g of substance by 1oC
- Vaporisation- Energy absorbed per gram as it changes from a liquid to a gas (water vapour)
- Floating ice- Density of solid water is less than liquid water
- Cohesion - Water molecules tend to stick to one another
- Adhesion- They also tend to stick to other molecules that have charged surface groups to which water molecules can hydrogen bond
- Surface tension- At the interface between water and air, the cohesive forces between water molecules are much stronger than between water and air molecules

Lec 2 - Cell structure I

- All living organisms are made up of cells and the materials produced by them
- A cell is the basic structural and functional unit of living organisms
- The activity of an organism depends on the individual and collective activities of the cell. Each action of an organism begins at a cellular level

Prokaryotic cells

- Only organisms of the domains Bacteria and Archaea consist of prokaryotic cells
- Prokaryotic cells are much smaller – typically about 1m in diameter
- Characterised by having; No membrane bound organelles, DNA in an unbound region called the nucleoid, Cytoplasm bound by plasma membrane



Eukaryotic Cell

- Protists, fungi, animals, and plants all consist of eukaryotic cells
- Characterised by having; DNA in a nucleus that is bounded by a membranous nuclear envelope
- Eukaryotic cells are generally much larger than prokaryotic cells
- The organelles and other subcellular components lie in the cytoplasm (aqueous solution)
- Cytoplasm consists of the cytosol and subcellular components excluding the nucleus

	Animal Cell	Plant Cell
Cell wall	No	Yes (cellulose)
Chloroplast	No	Yes
Central Vacuole	No	Yes
Plasmodesma	No	Yes
Lysosomes	Yes	No
Centrosomes with centrioles	Yes	No
Flagella	Yes	No
Plasma membrane	Yes	Yes
Nucleus	Yes	Yes
Ribosomes	Yes	Yes
Endoplasmic reticulum	Yes	Yes
Golgi apparatus	Yes	Yes
Mitochondria	Yes	Yes
Cytoskeleton	Yes	Yes

Nucleus

- The main feature of the eukaryotic cell is the nucleus
- Surrounded by a double membrane – nuclear envelope
- Contains one or several nucleoli, darkly staining regions, contain high concentrations of DNA, RNA and protein
- Perforated at intervals called nuclear pores
- Within the nucleus, the DNA is organised into discrete units called chromosomes

Ribosomes (Protein Factories)

- Complexes made up of ribosomal RNA and protein
- Cellular components that carry out protein synthesis.
- The cytoplasm of eukaryotes contain millions ribosomes (granular structures 25-30 nm in diameter
- Ribosomes are composed of 2 subunits assembled in the nucleolus from RNA and protein
- The subunits move through the nuclear pore into the cytosol, associate with a mRNA molecule, form a functional ribosome and facilitates protein synthesis

Endomembrane System

- The endomembrane system regulates protein traffic and performs metabolic functions
- Components include: Nuclear envelope, Endoplasmic reticulum, Golgi apparatus, Lysosomes, Vacuoles and Plasma membrane
- These components are either continuous or connected via transfer by vesicles

Endoplasmic Reticulum (ER)

- A network of membranous sacs (Cisternae) that extends throughout the cytoplasm of eukaryotic cells, accounting for more than half the total membrane
- ER membrane is continuous with the outer membrane of nuclear envelope

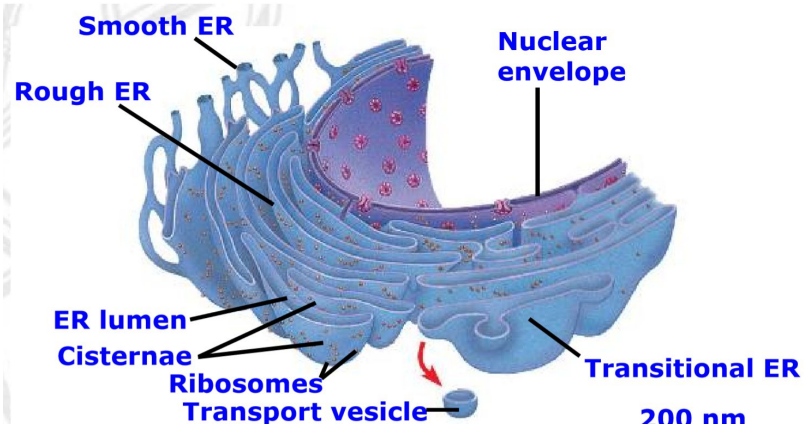
Smooth ER which lacks ribosomes

Functions;

- Lipid synthesis
- Carbohydrate metabolism
- Detoxify drugs and poisons
- Calcium storage

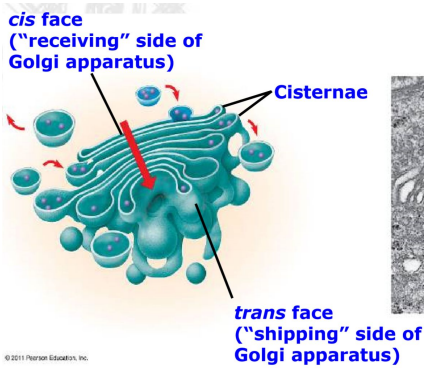
Rough ER with ribosomes studding its surface

- Has bound ribosomes giving it a rough appearance
- The ribosomes are involved in the synthesis of proteins
- Proteins are glycosylated (covalently bonded to carbohydrates) in the ER lumen
- Distributes transport vesicles, proteins surrounded by membranes
- Is a membrane factory for the cell



Lec 3 - Cell Structure II

Golgi Apparatus



- The Golgi apparatus consists of flattened membranous sacs called: Cisternae
- Golgi stack is usually surrounded by a cloud of small vesicles
- Each stack has a distinct polarity
  - *cisface* –faces the cisterna of ER
  - transface –opposite side of the Golgi stack
- Proteins and glycoproteins enter each Golgi stack at the ____face –via the transport vesicles which bud off the ER membrane
- These transport vesicles fuse with the cis cisterna
- Functions of the Golgi apparatus:
  - Modifies products of the: ER
  - Manufactures certain macromolecules (example – pectin)
  - Sorts and packages materials into transport: vesicles

Lysosomes

- Membrane bound organelles – animal cells involved in the degradation of many types of macromolecules
- A lysosome is a membranous sac of: that can digest macromolecules
- Lysosomal enzymes can hydrolyze proteins (proteases), fats (lipases), polysaccharides (glycosidases), and nucleic acids (nucleases)

Vacuoles

- Vacuoles can be found in many cell types (not just plant cells).
- They are membrane bound vesicles – functions vary in different kinds of cells
- For example, vacuoles can be the largest compartment in a plant cell:
  - Contain hydrolytic enzymes
  - Storage of nutrients, pigments or waste materials
  - Maintenance of cell turgor pressure

Mitochondria

- Are not part of the endomembrane system
- Have a double membrane
- Contain free ribosomes and circular DNA
- Grow and reproduce somewhat independently in cells
- Evolved from bacteria (prokaryotes) that were engulfed by ancestral eukaryotic cells
- Site for cellular respiration, release of energy during the oxidation of sugars and fats –also known as oxidative phosphorylation–released energy is stored as ATP
- Large organelles –1-10 m long, can be seen using light microscope
- Shape and size varies in different cells – spherical or elongated
- Surrounded by a double membrane
- Outer membrane is smooth but the inner membrane is convoluted with infoldings called: cristae
- Inner membrane is lined with numerous knob like structures –enzyme complexes responsible for ATP synthesis
- The core –matrix–mitochondrial ribosomes, mitochondrial DNA and structural proteins _____

Chloroplasts

- The chloroplast is a member of a family of organelles called plastids
- Chloroplasts contain the green pigment chlorophyll, as well as enzymes and other molecules that function in: photosynthesis
- Chloroplasts are found in leaves and other green organs of plants and in algae
- They have highly developed internal membranes

Chloroplast structure includes:

  - Thylakoid, membranous sacs, stacked to form a granum –like poker chips piled up
  - Stroma, the internal fluid
- Stroma –contains the chloroplast DNA and ribosomes, as well as many enzymes
- They are mobile –move around the cell along tracks of the cytoskeleton

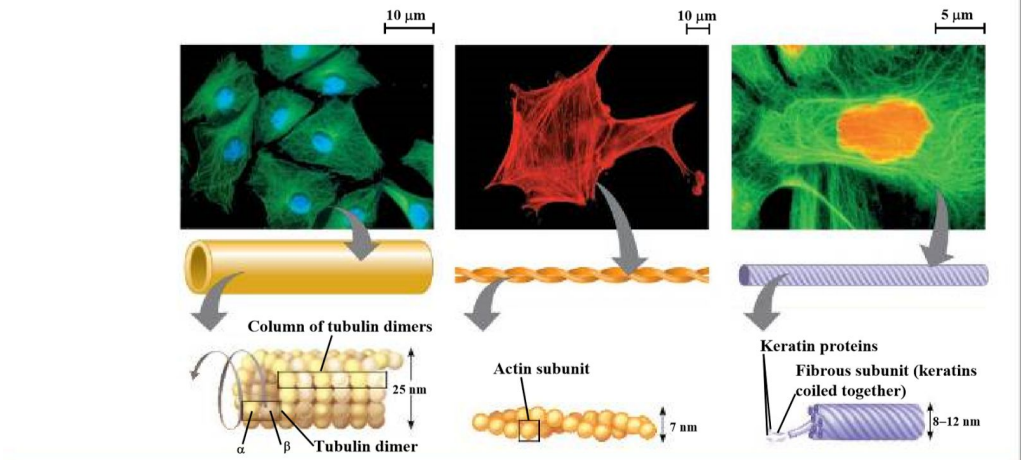
Peroxisomes: Oxidation

- Peroxisomes are specialised metabolic compartments bounded by a single membrane
- Peroxisomes produce hydrogen peroxide and convert it to water
- Peroxisomes perform reactions with many different functions

Cytoskeleton

- It is a network of fibers that organize structures and activities in the cell
- Components of cytoskeleton; Microtubules (composed of tubulin), Microfilaments (composed of actin), Intermediate filaments (several types; each composed of a distinct protein)
- Cytoskeleton also facilitates maintenance and remodeling of cell shape

Property	Microtubules (Tubulin Polymers)	Microfilaments (Actin Filaments)	Intermediate Filaments
Structure	Hollow tubes; wall consists of 13 columns of tubulin molecules	Two intertwined strands of actin, each a polymer of actin subunits	Fibrous proteins supercoiled into thicker cables
Diameter	25 nm with 15-nm lumen	7 nm	8–12 nm
Protein subunits	Tubulin, a dimer consisting of α-tubulin and β-tubulin	Actin	One of several different proteins (such as keratins), depending on cell type
Main functions	Maintenance of cell shape (compression-resisting "girders") Cell motility (as in cilia or flagella) Chromosome movements in cell division Organelle movements	Maintenance of cell shape (tension-bearing elements) Changes in cell shape Muscle contraction Cytoplasmic streaming Cell motility (as in pseudopodia) Cell division (cleavage furrow formation)	Maintenance of cell shape (tension-bearing elements) Anchorage of nucleus and certain other organelles Formation of nuclear lamina



Cell Wall

- Plant cell wall is an important feature that clearly distinguishes them from animal cells
- Prokaryotes, fungi, and some protists also have cell walls
- Plant cell walls are made of cellulose fibres embedded in other polysaccharides and protein
- The cell wall protects the plant cell, maintains its shape, prevents excessive uptake of water
- Plant cell walls are commonly perforated by channels between adjacent cells called: plasmodesmata