

## **BIOL103 – Exam Lecture Notes**

### **Chemistry of Life**

- Element = substance that cannot be broken down into smaller substances by chemical reaction.
  - 4 elements make up 96% of the living parts of organisms
    - Hydrogen
    - Carbon
    - Oxygen
    - Nitrogen
- Atom = the smallest part of an element, consisting of 3 subatomic particles: protons, neutrons, electrons.
- Properties of water = consequence of polar covalent bonds and hydrogen bonds.
  - High Specific heat
  - Solvent properties
  - Heats of fusion & vaporization
  - Cohesion & adhesion
    - Cohesion = hold together due to hydrogen bonds
    - Adhesion = clinging of one substance to another
  - Surface tension.

### **Cell Structure**

- Microscopy
  - Light Microscope (limit 250 microm)
    - Uses glass lenses to focus visible light onto an object & collect the light that passes through it.
    - The lens refracts the light so that the image is magnified as it is projected into the eye.
  - Electron Microscope (limit 2microm)
    - Uses magnets to focus a beam of electrons onto preserved tissue.
    - Transmission electron microscope
      - Electron passes through thin sections of preserved tissue & projected onto a phosphorus screen.
      - Specimen is usually stained with atoms of heavy metals, which attach to certain cellular structures, enhancing the electron density of that area.
    - Scanning electron microscope
      - Electron beam scans the surface of the sample, which is usually coated with a thin film of gold.
      - The beam excites electrons on the surface, which are detected by a device that translates the pattern of electrons into an electronic signal to a video screen – 3D image.
- Prokaryotic cells
  - Unicellular = contains everything in it needed to sustain life
  - Characterised by:
    - No membrane-bound nucleus – floats in the cytosol.

- DNA in an unbound region called the nucleoid.
  - No membrane-bound organelles.
  - Cytoplasm bound by the plasma membrane.
- Eukaryotic cells
  - Characterised by having:
    - DNA in a membrane-bound nucleus
    - Membrane-bound organelles
    - Cytoplasm
      - Consists of the cytosol and subcellular components
      - Cytosol = aqueous solution with gel-like consistency
      - Protoplasm = cytoplasm + nucleus.
  - Plasma Membrane
    - Selectively permeable barrier that allows sufficient passage of oxygen, nutrients and waste.
  - Nucleus – Information Centre
    - Nuclear envelope = double-membrane surrounds nucleus
      - Nuclear pores = channel for movement of molecules
    - Contains one/several nucleoli with high concentrations of RNA, proteins, and DNA.
  - Ribosome = RNA/protein complex carry out protein synthesis
    - Free ribosomes – located within the cytoplasm
    - Bound ribosomes – form rough endoplasmic reticulum.
- Endomembrane system – continuous or interconnected by vesicles
  - Nuclear Envelope
  - Endoplasmic reticulum = biosynthetic factory
    - Networks of cisternae (membranous sacs) that extend throughout the cytoplasm.
    - **Rough ER continuous with outer nuclear envelope**
    - Regions:
      - Smooth ER = lacks ribosomes
        - Synthesise lipids
        - Metabolises carbohydrates
        - Detoxifies drugs and poisons
        - Stores calcium ions.
      - Rough ER = ribosomes stud its surface
        - Proteins are glycosylated (bonded to CHO) in the ER lumen.
        - Distributes transport vesicles
  - Golgi apparatus = shipping and receiving centre
    - Each Golgi stack has a distinct polarity, and is surrounded by a cloud of vesicles.
      - Cis face = receiving side
        - Faces cisternae of ER
      - Trans face = shipping side
    - Functions:
      - Modifies products of the ER
      - Manufactures certain macromolecules
      - Sorts & packages materials into transport vesicles.
  - Lysosomes = digestive compartments

- Membrane bound organelles involved in the degradation of macromolecules (in animal cells) = hydrolytic enzymes
  - Vacuoles
    - Membrane-bound vesicles that carry out a variety of different functions in different cells.
      - Contain hydrolytic enzymes
      - Storage of nutrients, pigments, or waste materials.
      - Maintenance of turgor pressure
        - Pressure exerted on a plant cell wall by water passing into the cell by osmosis.
  - Plasma membrane
- Mitochondria = chemical energy conversion
  - Structure:
    - Double membrane
      - Outer membrane = smooth
      - Inner membrane = convoluted with cristae
    - Matrix (core)
      - Contain free ribosomes
      - Mitochondria DNA = grow/reproduce independently
      - Structural proteins
  - Site for cellular respiration – release of energy during the oxidation of sugars and fats = oxidative phosphorylation.
- Chloroplasts = capture light energy
  - Type of plastid (organelle of plants & algae)
  - Structure:
    - Thylakoids = membranous sacs, stacked up into a granum
    - Stroma = internal fluid.
      - Contains chloroplast DNA & ribosomes, many enzymes = self-replicate, allow as much as needed.
    - Highly developed internal membranes.
  - Mobile – move around the cell along tracks of the cytoskeleton.
- Peroxisomes: Oxidation
  - Specialised metabolic compartments
  - Produce hydrogen peroxide ( $H_2O_2$ ) and convert it to water
- Cytoskeleton
  - Network of fibres that organize the structure and activities in the cell = facilitates maintenance and remodelling of cell shape.
  - Structure:
    - Microtubules (composed of tubulin polymers)
      - Maintain cell shape, motility, division & organelle/chromosome movement.
    - Microfilaments (composed of actin filaments)
      - Maintain cell shape, motility & division
      - Cytoplasmic streaming
    - Intermediate filaments (several types – composed of a distinct fibrous protein).
      - Maintains cell shape
      - Anchors nucleus & organelles

- Formation of nuclear lamina.
- Cell Wall
  - Protects plant cell, maintains its shape & prevents excessive uptake of water.
  - Made of cellulose fibres embedded in polysaccharides & proteins.
  - Perforated by Plasmodesmata = channels between adjacent cells