Module 1 - Information transfer

Lecture 2 - The Chemistry of Life

Learning outcomes:

- *Explore the properties of living organisms and appreciate the common origins and makeup of the molecules of life.*
- *Identify the elements particularly important for life, and define the properties used to describe how they interact.*
- *Describe the basic structures, chemical properties, and biological functions of the building blocks of life (macromolecules):*
    - *Water, carbohydrates (sugars), lipids, nucleic acids, amino acids*

- All biological processes are controlled at a molecular level
- The genetic material that is shared through generation encodes these molecules
- All species share common genes and cellular functionalities reflecting a common origin

Properties of Life:

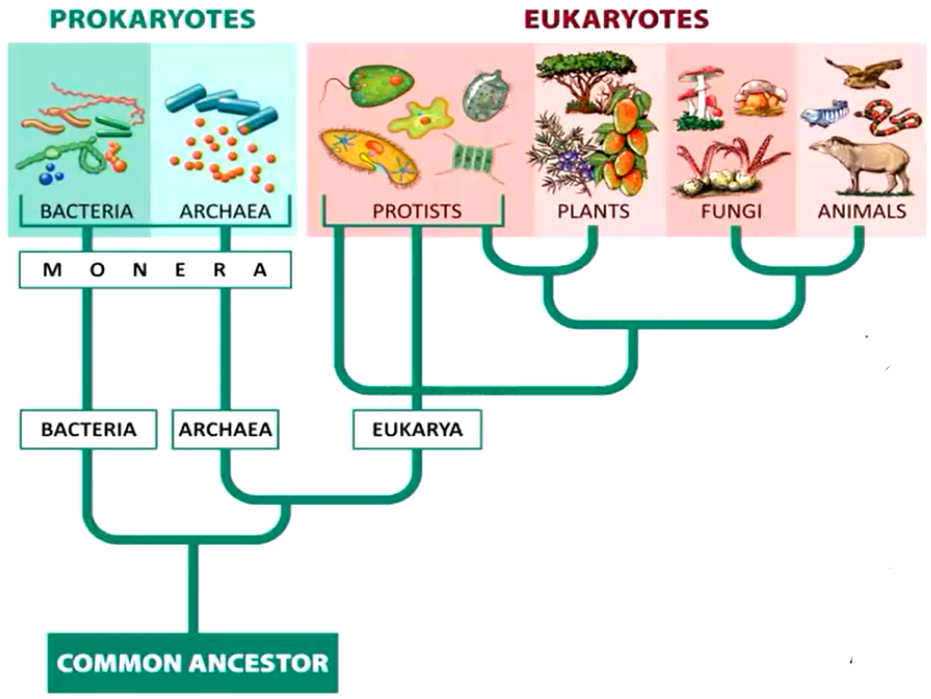
- Order
- Energy processing
- Sensitivity or response to stimuli
- Reproduction
- Growth and development
- regulation/homeostasis
- Adaptation
- Evolution

Order	Life is cell based, complex and organised - Living things are highly organized parts of a hierarchy that includes atoms, molecules, organelles, cells, tissues, organs, and organ systems. The development of cells, tissues and organs forming an entire organism. The organisms communicate and function with others and form ecosystems
Energy Processing	Autotrophs and heterotrophs Plants capture energy from the sun, and they convert chemical energy into food to provide them with nourishment. Humans and heterotrophic organisms obtain chemical energy from food and consuming other organisms
Sensitivity or response to stimuli	Responding to physical touch, sunlight, chemicals, heat. These can be internal and external
Reproduction	Sexual and asexual → asexual includes binary fission (clones)

Growth and development	Cells grow in number and also quality, leading to adaptation and evolution
Regulation/homeostasis	Homeostasis is a set of internal conditions maintained by living things despite a changing environment. The ability to regulate internal functions using specialised molecules and hormones.
Adaptation	A physical or behavioural feature that helps an organism survive better in their environment Physical and behavioural adaptations
Evolution	Key traits which lead us to life. Survival of the fittest and the survival of favourable traits to become characteristic of the species.

Classifying living things

- 6-8 kingdoms
- 3 domains



Kingdoms: Bacteria, archaea, protists, plants, fungi animals
Domains: bacteria, archaea, eukarya

Prokaryotes	**Eukaryotes**
- No nucleus - No membrane bound organelles - DNA floats around in the cytoplasm	- Nucleus - Membrane bound organelles - DNA inside the nucleus

Essential elements for life:

➔ Carbon, hydrogen, nitrogen and oxygen make up the majority of life - in the human body, these elements take up 96.3% of our entire body mass

➔ Ions such as sodium, potassium, magnesium, calcium, chlorine, sulphur and phosphorus are also present in the body for sending messages throughout the body

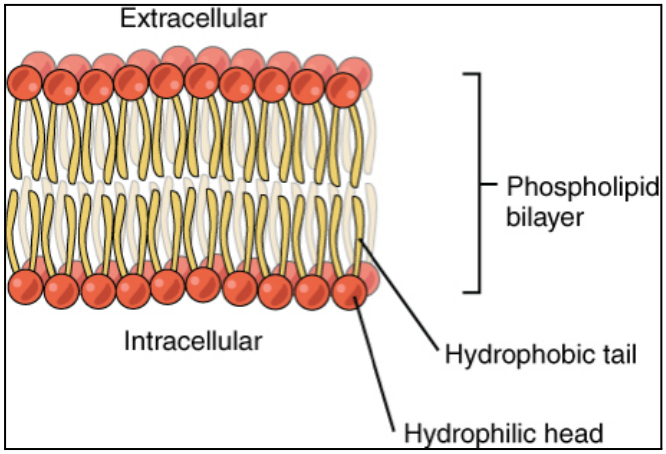
➢ Any two or more atoms bound by a chemical bond is called a molecule
➢ 2 or more different atoms bound together are known as compound

Life is carbon based → carbon is the backbone which exist in all living organisms

- This is because carbon is **versatile** (can bond with itself and other elements), **diverse** (exists in all major biopolymers → repeating units of molecules found in organisms) and is **stable** for forming covalent bonds

Molecule interactions with water:

- A molecule can be:
  - Hydrophobic (aka non-polar): does not mix well with water (eg, methane)
  - Hydrophilic (aka polar): does mix well with water
  - Amphipathic: a mixture of both → usually we see a long chain of hydrophobic with a polar head group, known as lipids which exist in aqueous environments



An example of this is the membrane which surrounds cells, allowing for certain things to pass in and out of the cell, keeping it alive.

This is known as a phospholipid bilayer

- Carbon is neutral (uncharged) and non-polar/hydrophobic
- Oxygen, Nitrogen, Phosphorus and sometimes sulfur make polar/hydrophilic compounds which are dipole or fully charged
- Hydrogen can be neutral or contribute to polarity depending on the atoms which it is bonded to or are neighbouring. For example, hydrogen with carbon is neutral, but with oxygen it is polar

The building blocks of life:

- Water
- Carbohydrates
- Lipids
- Nucleic acids
- Amino acids