

# BIOL103 study notes – Entire semester

## Chemistry of life

### Elements

- *Element* = a substance that cannot be broken down into simpler substances by chemical reactions
- About 20-25% of the 92 natural elements are essential to life
- 4 elements that make up to 96% of living organisms:
  1. Hydrogen
  2. Oxygen
  3. Carbon
  4. Nitrogen

### Atoms

- *Atom* = smallest part of an element
- 3 subatomic particles of atom = protons, neutrons, electrons
  - Nucleus = neutrons + protons (normal = same number of each)
  - Orbiting rings/shells = electrons
- Atoms of the different elements have different numbers of subatomic particles
- All atoms of a certain element = same number of protons
  - Number of protons = *atomic number* (in subscript)  ${}_8\text{O}$
  - Number of protons + neutrons = *atomic mass* (in superscript)  $^{16}_8\text{O}$
- Electrons don't affect atomic mass

### Isotopes

- *Isotopes* = atom that has different number of neutrons than others of the same element (different atomic mass)
  - Still behave the same in chemical reactions

### Electrons

- Electrons closest to nucleus = lowest energy levels
- *Valence* = outermost shell (electrons here can leave/be shared) > form ions (has charge)
  - Ion = net pos or neg charge (eg H > lose electron > H<sup>+</sup>)
- Different numbers of orbitals per shell
- Each orbital = can have no more than 2 electrons
  - 1<sup>st</sup> shell = 2 electrons
  - 2<sup>nd</sup> shell = 8 electrons in 4 orbitals
  - 3<sup>rd</sup> shell = 18 electrons
  - 4<sup>th</sup> shell = 32 electrons

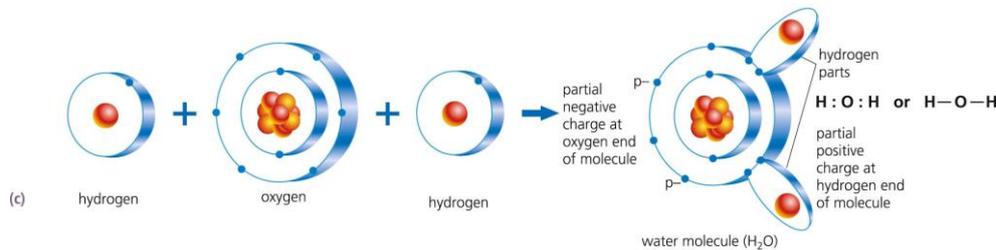
### Chemical bonds

- Atoms with incomplete valences want to complete it = interact with other atoms
- Can gain or share electrons
- Types of bonds:
  - *Covalent bonds* = sharing of electrons > forms a molecule

- *Ionic bonds* = one donates electrons (opposite charges attracting one another)

### Polar vs non-polar covalent bonds

- Non-polar = single/double bonds (O=O, H-H)
- Polar = uneven sharing of electrons from one atom (H<sub>2</sub>O)



### Ionic bonds

- Ionic bond = formed by attractions of pos and neg charges
- Na atom gives electron to Cl > Na<sup>+</sup> ion and Cl<sup>-</sup> ion with ionic bond
- *Cation* = lose electron = positively charged ion
- *Anion* = gain electron = negatively charged ion

### Hydrogen bonds (H<sub>2</sub>O is polar)

- Water = electrons shared unequally between hydrogen/oxygen atoms
- Hydrogen atom = slightly more positive
- Hydrogen bonds tend to form with oxygen or other electronegative atoms
- Hydrogen bonds = weak (readily formed/broken)

## Cell structure

### Cells

- Cells are the basic units of life
- Activity of organism = depends on activity of its cells
- Humans eyes limit of resolution = 200 μm
- Most cells = between 1 & 100 μm (need microscope)
- Basic features of all cells:
  - Plasma membrane
  - Semifluid substance called cytosol
  - Chromosomes (carry genes)
  - Ribosomes (make proteins)

### Prokaryotic vs eukaryotic cells

- *Prokaryotic* = lack a membrane-bound nucleus
  - Only bacteria/archaea
  - Smaller
  - No membrane-bound nucleus
  - No membrane-bound organelles

- DNA in unbound region called the nucleoid
- Cytoplasm bound by the plasma membrane
- *Eukaryotic* = have a membrane-bound nucleus
  - Protists/fungi/animals/plants
  - Larger
  - DNA in a nucleus that is bounded by a membranous nuclear envelope
  - Membrane-bound organelles
  - Cytoplasm between plasma membrane/nucleus

#### Inside Eukaryotic cell

- *Cytosol* = aqueous solution of molecules with a gel like consistency
- *Cytoplasm* = cytosol and subcellular components (excluding the nucleus)
- *Protoplasm* = cytoplasm + nucleus

#### Plasma membrane

- *Plasma membrane* = selective barrier that allows passage of oxygen, nutrients, and waste to service the volume of every cell
- Made of double layer of phospholipids

#### Nucleus (information central)

- *Nuclear envelope* = double-membrane that surrounds the nucleus
- *Nucleoli* = darkly staining regions (contain high concentrations of DNA, RNA, and protein)
- *Nuclear pores* = channels that allow movement of certain molecules

#### Ribosomes (protein factories)

- *Ribosomes* = made of RNA and proteins that carry out protein synthesis. Produce proteins from the DNA in the nucleus
- Composed of 2 subunits assembled in the nucleolus

#### The Endomembrane System

- *Endomembrane system* = regulates protein traffic and performs metabolic functions in the cell (has various components):
  - Nuclear envelope
  - Endoplasmic reticulum
  - Golgi apparatus
  - Lysosomes
  - Vacuoles
  - Plasma membrane

#### Endoplasmic reticulum (biosynthetic factory)

- Smooth ER = network of membranous sacs (cisternae)
  - Creates lipids
  - Metabolizes carbohydrates
  - Detoxifies drugs/poisons
  - Stores calcium ions

- Rough ER = has ribosomes attached
  - Has bound ribosomes which are involved with protein synthesis (proteins are glycosylated/bonded to carbs)
  - Distributed transport vesicles
  - Membrane factory for the cell
- Continuous with the nuclear envelope

#### Golgi apparatus (shipping/receiving centre)

- *Golgi apparatus* = shipping and receiving centre (packages proteins) consisting of cisternae. Golgi cisternae stacks have:
  - *Cis entry face* = Receives proteins from the ER. Faces the cisterna of the endoplasmic reticulum (has enzymes catalysing early protein modification)
  - *Trans exit face* = Modified proteins shipped out. Opposite side of the Golgi stack (has enzymes catalysing later modifications)
- Functions:
  - Modifies products of the ER
  - Manufactures macromolecules
  - Sorts/packages materials into transport vesicles

#### Lysosomes (digestive organelles)

- *Lysosomes* = Sac of hydrolytic enzymes that can digest macromolecules
- Have specific enzymes for what they're breaking down

#### Vacuoles

- Plant cells have really large one (contain nutrients/maintain cell turgor)
- Membrane bound vesicles – functions vary in different kinds of cells

#### Mitochondria (chemical energy conversion)

- *Mitochondria* = involved in chemical energy conversion. Contain free ribosomes and circular DNA. Thought to have evolved from prokaryotes. Site for cellular respiration. Released energy stored as the molecule ATP.
  - Cellular respiration = release of energy during the oxidation of sugars and fats
- Has double membrane and large
- Has convoluted inner-membrane = *cristae* (convoluted because it increases surface area for ATP production)
- *Matrix* = core with DNA/ribosomes/structural protein

#### Chloroplasts (plastids)

- Chloroplasts = contain chlorophyll/involved in photosynthesis (capture of light energy)
- Have thylakoids (sacs) and stroma (fluid with DNA/other enzymes)

#### Peroxisomes (oxidation)

- *Peroxisomes* = involved with the oxidation of molecules. Involved with the metabolism/break-down of other molecules. Convert hydrogen peroxide to water
- How related to other organelles still unknown