# Microbiology

## Summary

# Week 2 - The Origins of Microbial Life

- **Spontaneous generation** —> arise without parents
- **Pasteur** said fermentation was caused by microorganisms
- Early organisms were anaerobic, **lithotrops** (get energy from organic matter), oxygenic (producing oxygen)
- First 3 billion years was all microbial life
- **Micelles** (balls of polar lipids) were how membranes were formed
- **RNA** was probably first (as some viruses have RNA, and thymine is made from Uracil)
- **Endosymbiotic theory** —> chloroplast and mitochondria were engulfed by cells, now occur in eukaryotes
- Only eukaryotes and some archaea have **histone** proteins — bacteria don't
- **Algae** —> call walls made of cellulose can be both unicellular or multicellular
- **Protozoa** —> no cell walls, all heterotrophs (eat organic molecules), can reproduce **sexually** and **asexually**
- **Fungi** —> cell walls made of **chitin**, can be micro or macroscopic (mushroom)
- **Inclusion** —> a vesicle containing many proteins, ribosomal components and DNA/RNA fragments
- **Viruses** —> no cells, simple structure, need host for replication, cant use energy (needs a cell for all its function), no homeostasis —> not considered living
- **Viroids** —> only nucleic acids
- **Prions** —> only proteins

# Microscopy

- **Light microscopy** —> x1000 (200nm)
- **Magnification** —> how big can the image get
- **Resolution** —> how much detail can be seen
- **Contrast** —> how well it stands out from the background
- Staining can be positively charged —> binds with negatively charged parts of cell
- **Resolving power** —> the least distance between 2 points that can be distinguished as separate

$$d = (0.61 \times \lambda) / n \sin\theta$$

**λ** = wavelength of light

**n** = refractive index

**θ** = 1/2 the angle of cone of light entering object

**NA** = numerical aperture (n sinθ)

- The longer the wavelength, the worse the resolution
- However a higher NA would increase detail
- **Immersion oil** is used to reduce the refractive index —> so light will actually hit the lens
- **Dark field microscopy** —> object viewed against a black background
- **Fluorescence microscopy** —> light is absorbed by the specimen and reemitted at a lower energy (longer wavelength)
  - Only detects organisms with intact DNA
  - Electron absorbs energy of UV —> moves to higher orbit (gains energy) —> moves back down (loses energy) —> emits a longer wavelength —> glows
  - Used for cell counts and cell part labelling
- **Confocal microscopy** —> each layer of cells can be scanned individually and a computer can put them together to make a 3D image
  - Allows observation of live microbes in real time

- **Electron microscopy**
  - **Transmittion electron microscopy** (**TEM**) —> electron passes through specimen, revealing internal structures
  - **Scanning electron microscopy** (**SEM**) —> electrons scan the surface of specimen, getting 3D images
- Wavelength of electron microscopy is ~ 0.005 nm (x1000 of light microscope)
- Must be done in a vacuum

# Week 4 - Prokaryotes

- Single celled organisms: may not be as efficient, temperature, pH change and osmotic pressure could all be factors that put the cell at risk
- **X-ray crystallography** —> used to determine structure
- Cell wall of bacteria made or **peptidoglycan** —> a covalently linked molecule
- Cytoplasm is is like jelly (70% water)
- Cell membrane made of phospholipids and proteins —> connected via non-covalent bonds
- **Active transport** —> using energy
- **Passive transport** —> not using energy
- **Integral proteins** —> proteins that go through the membrane
- **Peripheral proteins** —> are only on one side of the membrane
- **Phosphatydilethanolamine** —> a phospholipid with an ethanol and amine group
- **Palmatic acid** —> fatty acid chains are all straight
- **Oleic acid** (**trans**) —> fatty acid has double bonds, but on opposite sites
- **Oleic acid** (**cis**) —> fatty acid has double bonds, on the same side
- **Saturated fatty acid** —> no double bonds, are a part of palmatic acids
  - Would pack closer together, resulting in a higher melting point (e.g. butter)
  - Thermophile would have saturated membranes
- **Unsaturated fatty acid** —> has 1 or more double bonds, used in oleic acids
  - Would not pack as closely, and therefore be liquid at room temperature (e.g. olive oil)
  - **Psychrophiles** will have more unsaturated membranes
- Bacteria can change the ratio of saturated : unsaturated, if temperature changes
- Small molecules like $O_2$, $CO_2$ and $H_2O$ can just diffused into cell without channels
- **Sterol** —> molecules like cholesterol, that are flat and can fit between phospholipids, giving them strength
- Bacteria have **ester bonds** between their glycerol and fatty acid —> are pretty weak