

BIOL10002

- Practical = 10 marks
 - Pre-prac test (1 mark)
 - Practical (5 marks)
 - Post-prac test (4 marks)
- Labour Day (7th March) is not a holiday

Lecture 1

1ST FOUNDATION OF BIOLOGY

- **Evolution and Natural Selection**

- "Ontogeny recapitulates Phylogeny" – Development is a fast action replay of evolutionary ancestry
- **Homology** – derived from a common ancestral feature, e.g. forearm structure in various mammals and amphibians
- Biogeography also supports evolution
- Darwin's 3 observations (Survival of the fittest):
 - Individuals in a population vary (fitness)
 - Pass on traits (fitness) to offspring (heredity)
 - Never enough resources (competition for survival and reproduction)
- Evolution is a two-step process:
 - Variability
 - Ordering that variability by Natural Selection

2ND FOUNDATION OF BIOLOGY

- **Unity of biochemical processes**

- DNA – all organisms use this material to encode their blueprint
- DNA contains the history of evolution
- Proteins – hardware to carry out instructions

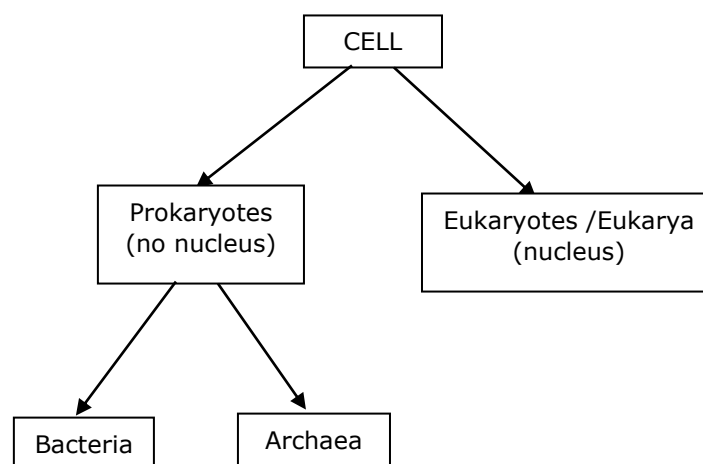
3RD FOUNDATION OF BIOLOGY

- **Cell theory**

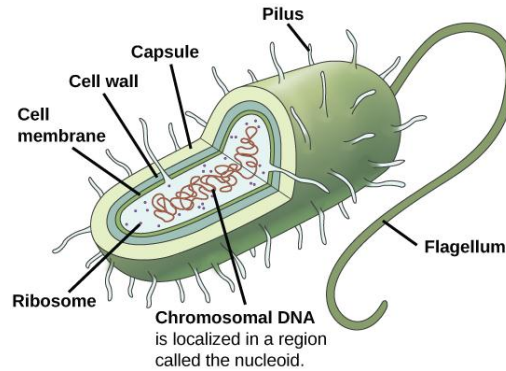
- All living things are made of cells
- Every cell arose from a pre-existing cell
- The cell is the fundamental unit
- Cells contain DNA which is passed from cell to cell

DOMAINS

- There are three domains:
 - Eukarya
 - Archaea (more related to Eukarya than Bacteria is)
 - Bacteria



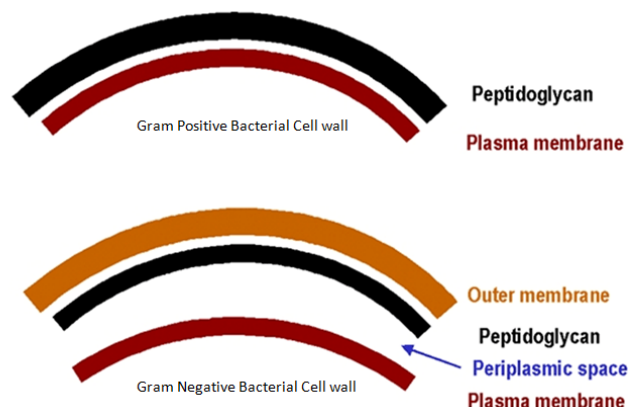
Lecture 2 – Prokaryotes



- Prokaryotes are microscopic
- They are used in food production (fermented foods)
- DNA is contained within a single, circular chromosome (nucleoid) attached to the plasma membrane
- **Typical prokaryotic cell:** DNA, cytoplasm, cell wall (peptidoglycan), plasma membrane, ribosomes, pilus (hair-like structures), capsule, bacterial flagellum (tail)
- **Ribosomes:**
 - occur in all cells
 - composed of proteins and RNAs
 - synthesise proteins
 - site of translation
 - Prokaryotic ribosomes are smaller (17-23nm)
 - Eukaryotic ribosomes are larger (25-30nm)
 - sensitive to antibiotics
- Prokaryotic flagellum: motility appendage, composed of flagellin protein, extracellular, long thin filament, spins/rotates at 200rpm
- Prokaryotes divide via binary fission and grow exponentially
- Their circular chromosome is duplicated during binary fission
- Bacteria and Archaea are two different domains due to different DNA sequences

BACTERIA

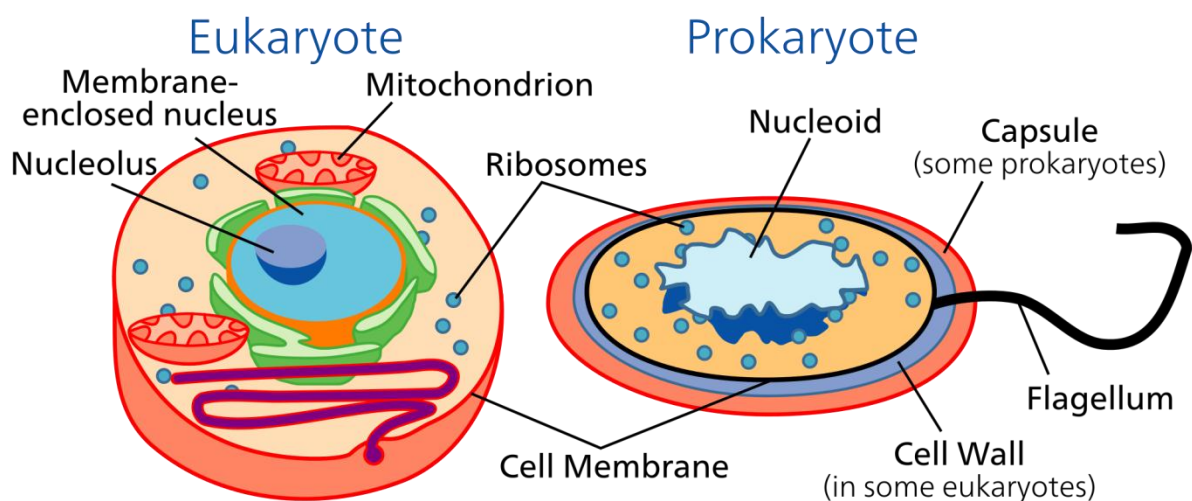
- Microbiome in gut (about 2kg)
- More than 50% of oxygen on earth is generated by photosynthetic bacteria
- Bacteria process about 70% nitrogen
- Bacteria also cause disease by colonising our bodies and using up resources
- No proteins (histones) are attached to DNA
- Wall (peptidoglycan) similar in Bacteria and Archaea
- **Gram +** bacteria contains peptidoglycan and one surrounding membrane (stains purple; thicker walls)
- **Gram –** bacteria contains peptidoglycan and two surrounding membranes (does not stain; thinner walls)



ARCHAEA

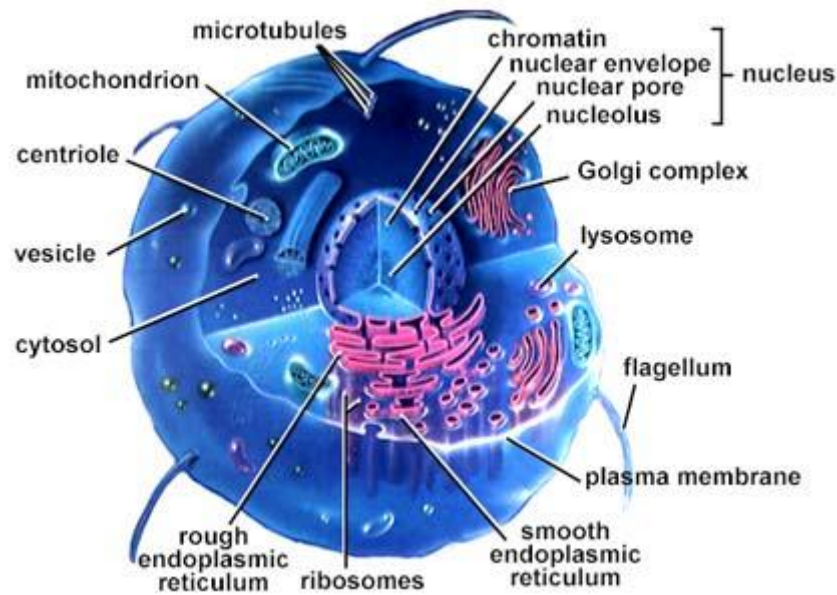
- Archaea do not cause any diseases
- Proteins (histones) are attached to DNA
- Wall (peptidoglycan) similar in Bacteria and Archaea

Prokaryotes	Eukaryotes
Microscopic, can only be seen with an electron microscope	Can be large and multicellular, sometime can be seen by the naked eye
Lack a nucleus	Have a nucleus, double membrane/nuclear envelope, nuclear pores, contains nucleolus where ribosomal genes are transcribed
	Division of labour in the cytoplasm
	Endomembrane system (system of membranes inside cell) – Endoplasmic Reticulum, Golgi complex
	Cytoskeleton (microtubules, microfilaments, intermediate filaments)
	Motor proteins and movement
	Histones
Single, circular chromosome	Long linear strand of DNA covered in histones (chromatin)
	Different organisms have different numbers of chromosomes
	Transcription: DNA → RNA to be translated in cytoplasm



**Suffix "-in" is a protein

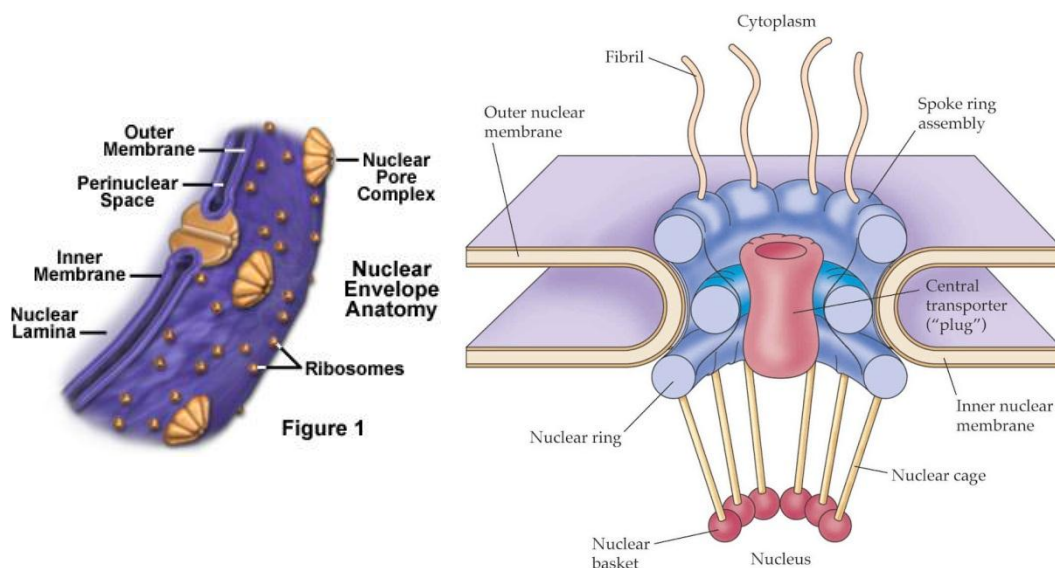
Lecture 3 - Eukaryotes



NUCLEUS

- **Nuclear envelope** surrounds the nucleus and projects all throughout the rest of the cell to form the rough **Endoplasmic Reticulum**
- The outer side of the nuclear envelope has ribosomes attached to it
- Contains nuclear **pores**
 - Lined with proteins
 - Attached to lamina (nuclear skeleton)
 - Evenly spaced over nuclear envelope
 - Used to traffic proteins and RNAs into and out of nucleus
 - Located at site where inner membrane curls around to become outer membrane

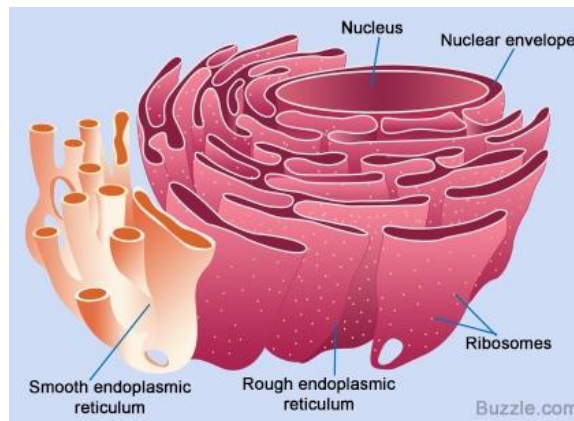
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ENDOPLASMIC RETICULUM (ER)

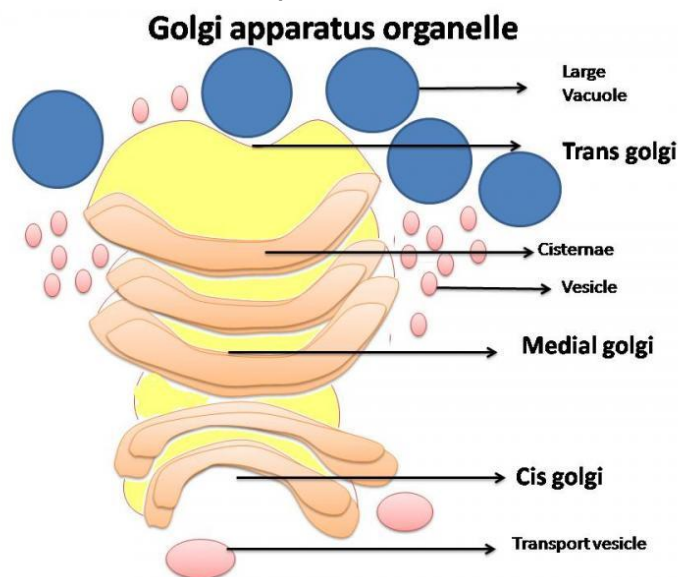
- The ER is the heart of the endomembrane system
- Contains internal compartments and channels, as a result of cisternae (bubbles)
- If ribosomes attached then called 'rough', or else 'smooth'
- Used for the manufacture and transport of proteins to the surface of the cell (rough ER)
- Used to make more membrane for the cell (smooth ER)
- Major functions of intracellular membranes:

- Provide a surface for biochemical reactions
- To establish a number of compartments to prevent mixing
- To provide a means of transport of materials within the cell, from one cell to its exterior, or from the cell to an adjacent cell



GOLGI COMPLEX

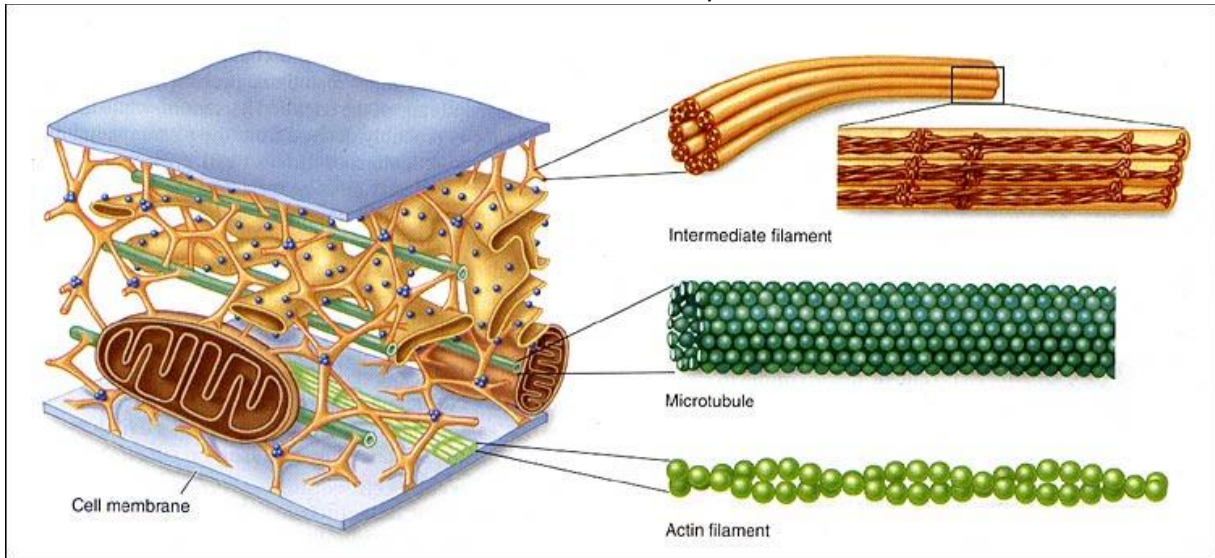
- Consists of flattened stacks of membrane (cisternae) called Golgi bodies
- Golgi complex is a collective term for all the Golgi bodies
- Functional extensions of ER
- Used to collect, modify, package and distribute molecules synthesised in the cell
- Manufactures polysaccharides for cells, by attaching them to either protein or lipid molecules (become 'identity'/recognition molecules on the surface of the cell)
- Has three zones – cis, medial and trans (where cis is closest to ER and trans furthest)



CYTOSKELETON

- Not composed of membrane
- Allows cells to change shape and shift organelles around
- Structural elements within the cell
- Three major kinds:
 - Actin filaments made of actin protein and gelsolin (7nm)
 - Microtubules made of tubulin protein; cylindrical (25nm diameter)
 - Intermediate filaments made of vimentin protein (10nm diameter)
- Interact with motor element for movement
 - Actin filaments interact with myosin motors (muscle contraction, cytoplasmic streaming, microvilli)

- Microtubules interact with kinesin (moves one microtubule against another – drives flagella beating) or dynein (moves vesicles along the microtubule) motors
- Intermediate filaments don't interact with any motors



- **Flagellum**
 - Eukaryotic flagella beat instead of rotating
 - Consists of microtubules and dynein motors
 - Whip-like movement occurs when adjacent microtubules slide against one another, anchored by dynein motors
- Cytoskeletal parts are being used to build nanomachines