F211
Spec:

- Cells are basic units of all living things.
- Cells with similar functions = tissue. Tissue with similar functions = organ. Multiple organs = organ system. All living things are compromised of an organ system.
- Organisms can only function because of communication and co-operation between specialised cells.
- Cell division = Fundamental process for reproduction (meiosis), growth and repair (mitosis).
- Sate resolution and magnification of light microscope, transmission electron microscope and a scanning electron microscope (SEM). Maximum resolution and magnification for a light microscope is 200nm and x1500 magnification. Electron microscope is 50pm (0.05nm) and x10, 000,000. SEM is 50-100nm and x20 - x30, 000.
- State how to use light microscope and why electron microscopes are very important in biology. Electron microscopes are very important as they can show many clear and in depth images that can be used to investigate structures and functions of organelles too small to see by light microscopes.
- State that electron microscope reveals details of cell structure, ultrastructure and provides evidence for hypotheses about roles of cells and organelles.
- Explain difference between resolution and magnification. Resolution is ability of lens to distinguish between two points clearly. How sharp an image is depends on the resolution. If you can distinguish an object e.g. 0.1nm apart (1×10^{-6}mm, so 1mm = $1x10^{6}$nm) then it would have high resolution as you can distinguish very small objects meaning it's a very clear and sharp image. Magnification is the degree of how much an image has been largened by.
- Explain why you stain samples when using them in light and electron microscopy. Staining is an auxiliary (provides support) technique that enhances contrast in microscopy to highlight organelle structures clearly.
- State how to calculate linear magnification of an image. Magnification = image size/actual image size. So rearrange for Image size/magnification = actual image size. Make sure both image sizes are in the same units!
- Describe eukaryotic cells image under an electron microscope.
- Explain every visible cell structure from this microscope.
- Nucleus, nucleolus, nuclear envelope, rough and smooth endoplasmic reticulum, Golgi apparatus, ribosomes, mitochondria, lysosomes, chloroplast, plasma membrane, centrioles, flagellum and cilia,
- State the functions of all these organelles/structures. Nucleus; large organelle surrounded by nuclear envelope (double membrane), contains many pores. Nucleus contains chromatin (material of what chromosomes are made of) and nucleolus (believed to create the ribosomes). Chromatin is made of proteins and DNA. Nuclear pores allow substances such as RNA to move between nucleus and cytoplasm for proteinsynthesis. Endoplasmic reticulum's are a system of membranes enclosing a fluid filled space. The rER is covered in ribosomes and folds and processes

proteins made by these ribosomes. The sER synthesizes and processes lipids. The ribosome is a very small free floating organelle in the cytoplasm or attached to rER and consists of 2 sub units. The ribosome consists of a small and large sub unit (made by nucleolus btw) and is the site where proteins are made during proteinsynthesis. The Golgi apparatus is a group of fluid filled flattened sacs with vesicles at the edges of the sacs. The Golgi apparatus processes and packages new lipids and proteins and also produces lysosomes. Lysosomes are a round organelle surrounded by a membrane with no clear internal structure but contain digestive enzymes to digest invading cells or break down worn out components of cells. The mitochondrion (singular) is oval shaped with a double membrane. The inner membranes fold to form a structure known as the cristae. The inside of the mitochondria contains the matrix (basically cytoplasm of mitochondria), which contains enzymes for respiration. The mitochondrion is the site of aerobic respiration where ATP is produced. Cells that require a lot of energy from being active (such as sperm cells) will have a large number of mitochondria to meet this demand of energy. Centrioles are organelles that contain a ring of microtubules. They are essentially hollow cylinders and are involved in the separation of chromosomes during mitosis. Chloroplasts are small, flattened organelles in plant cells. They have a double membrane (chloroplast envelope) with thylakoids (fluid filled sacs) stacked up inside to form a granum (plural is grana). The grana are all linked by pieces of the thylakoid membrane called lamellae (singular is lamella). The thylakoids contain the photosynthetic pigments (chlorophyll a and b etc.), these pigments are attached to proteins to form a photosystem. The chloroplast also contains starch grains, oil droplets and is located in the stroma (basically cytoplasm of chloroplast). Starch grain could be used as store for energy. The plasma membrane (cell membrane) is a double membrane (oh god what isn't, might as well call it the cell envelope) that separates the cells internal components from the outside. The cell membrane is a phospholipid bilayer, compromising of phospholipids, glycoproteins, carbohydrates and protein channels etc. and is a partiable permeable membrane. The flagellum is a structure in bacteria and sperm cells that allow locomotion (movement) and is also a sensory organelle. Cilia are organelles that move liquid past the surface of a cell like sperm and also are a sensory organelle. Cilia are located in anchored cells (cannot move), such as epithelial cells (in trachea) and help liquid flow past.

- Explain interrelationship between organelles involved in production and secretion of proteins. Exocytosis; protein made at rER, transported to Golgi apparatus, trimmed and packaged into vesicle, excreted via exocytosis from there to membrane.
- Explain importance of cytoskeleton in providing mechanical strength to cells, aiding transport within cells and allowing cell movement. The cytoskeleton is a frame that gives shape to the cell and holds the organelles in place providing mechanical strength. The cytoskeleton aids transport by controlling the cells interior workings to help it move in its environment. The cytoskeleton is a network of protein fibres (sound

familiar?). By moving cell organelles the cell aids the movement of the actual cell.

- Be able to draw and compare structure and ultrastructure of plant and animal cells/prokaryotic and eukaryotic cells using electron micrographs.
- Know that the structure of the cell surface membrane allows cells to communicate with each other. This is important as you can make use of membrane bound receptors as sites for action of medicinal drugs.
- Know how different substances' entering the cell is also important for the development of mechanism to administer drug.
- As stated before the cell membrane controls what enters and leaves the cell. It regulates what goes in and out. However, it is a partially permeable membrane meaning things like ions can get in through diffusion. The call membrane separated the cells internals with the outside environment and the components on the surface are used for cell signaling and recognition. The cell membrane has a continuous fluid bilayer.
- The cell (plasma) membrane's structure can be shown by the fluid mosaic model to show a phospholipid bilayer. You must know and be able to draw the diagram.
- State roles of components in cell membrane. Phospholipids have hydrophobic tails (not water orientated and hydrophilic heads (water orientated). This causes the head to be oriented towards water and face the water while the tail doesn't. However water is on both sides of the membrane so this causes a double layer to form. Cholesterol molecules in the phospholipid bilayer help maintain the structure by keeping the membrane fluid consistent. The glycolipids (lipids with carbohydrate attached) function as recognition sites for cell-to-cell interactions for cellular recognition. They will bind to a complementary carbohydrate on a neighboring cell. Glycoproteins (protein with carbohydrate) along with glycolipids form hydrogen bonds with water molecules surrounding the cell and help stabilise the membrane structure. Proteins can be found on either side of the bilayer and membrane proteins can have many different functions. They can function as enzymes to speed up chemical reactions, at as receptors or help transport materials across the cell membrane (endocytosis). Carrier proteins actively move substances across membrane using ATP. Whereas channel proteins allow movement of molecules that are too large and hydrophilic to cross the membrane.
- State the effect of changing temperature on the membrane structure and permeability. As temperature increases, the permeability increases as increase in temperature gives molecules more kinetic energy. Increased movement of phospholipid bilayer (due to extra KE) makes the membrane more permeable. After a certain temperature the membrane structure falls apart. This is because at higher temperatures the cell membrane denatures which causes permeability to substantially increase. This can be shown in the beetroot experiment if you need to know it.
- Define cell signaling. The way cells interact with other cells around them and their environment. One cell releases a messenger molecule, which travels to another cell, where it binds to a receptor on another cell membrane. As they have complementary shapes this will cause the target cell to respond.

- Explain role of membrane-bound receptors as sites where hormones and drugs can bind. Hormones bind to sites where the shape is complementary to the receptor. E.g. glucagon to liver cells. Drugs also bind to a complementary receptor and either triggers a response or blocks the receptor to prevent signaling.
- Explain passive transport, active transport, endocytosis and exocytosis. Passive transport is the cellular process of moving molecules and substances across a membrane using no energy. This consists of diffusion, facilitated diffusion and osmosis. Diffusion is the movement of molecules from a region of high concentration to a region of low concentration down a concentration gradient. Facilitated diffusion is when a protein is a specific shape so only a specific molecule can fit in the membrane surface. Once the molecule is in the protein changes shape to let the molecule through the cell membrane. Active transport is the movement of molecules across a membrane against the concentration gradient using ATP to power protein pumps. Endocytosis is the movement of a large molecule into the cell. Exocytosis is the movement of a large molecule out the cell.
- Explain what osmosis means in term of water potential. Osmosis is the movement of water molecules from a region of high water potential to a region of low water potential across a partiable permeable membrane. Water potential is the measure of tendency for water molecules to diffuse from one place to another.
- Explain effects that solutions of different water potentials can have on a plant and animal cell. If animal cell is places in pure water (low water potential) then water enters cell via osmosis and causes it to swell and eventually burst (haemolysed). Whereas if a plant cell is placed in pure water, water enters the cell via osmosis causing it to swell which causes the cell membrane to push on the cell wall but not burst, as the cell wall is turgid. If an animal cell is placed in sugar water (high water potential) then water molecules move in and out via osmosis. Overall there will be more net movement out the cell, which causes the cell to shrink and the membrane to wrinkle (crenated). If a plant cell is placed in water with high water potential, then more net movement of water out the cell via osmosis causing the cell and vacuole to shrink. The cell surface membrane will then pull away from the cell way (plasmolysed).
- During the cell cycle, genetic information is copied (DNA) and is passed to daughter cells. Microscopes can be used to view different stages if the cycle (PMAT).
- In multicellular organisms, stem cells are modified to produce much different type of specialised cells. Knowing how to modify stem cells has many uses in practical medicine.
- State that mitosis occupies a small percentage of the cell cycle and the remaining percentage includes copying and checking genetic information.
- Describe (and know how to draw) the main stages of mitosis (PMATC). Prophase is the first stage after preparation (interphase) where the replicated chromosomes supercoil (become short and thick… like Cartman), the nuclear envelope then breaks down and disappears leaving the chromosomes free in the cytoplasm. The centriole divides into 2 and

each daughter centriole goes to opposite poles of the cell, forming a network of protein fibres called the spindle. The next stage is metaphase, this is where the replicated chromosomes move to the equator of the cell (central region of spindle) and become attached to the spindle by their centromere. Next is anaphase. This is where the centromeres divide separating each pair of sister chromatids and the spindle contract and shorten pulling the chromatids towards opposite ends of the cell. The final stage is telophase. Sister chromatids are now at opposite poles and a nuclear envelope forms around each group of chromosomes, resulting in 2 nuclei. The spindle breaks down and disappears; the chromatids uncoil becoming long and thin chromosomes. The cytoplasm splits with each nuclei and this is known as cytokinesis. The two daughter cells are now genetically identical to the original cell and each other.

- Explain the term homologous pair of chromosomes. A homologous pair of chromosomes is a paternal and maternal chromosome joined by the centromere (this is the chromosome pair) that same the exact same gene (homologous) but may have a different allele, location and size of the gene. Homologous pairs, pair up during meiosis.
- Explain the significance of mitosis for growth repair and asexual reproduction. Multicellular organisms grow by producing extra genetically identical cells, which can only be done by mitosis. Damaged cell needs to be replaced by new ones, which are genetically identical. This repair can be done by mitosis. It's important for asexual reproduction as the organism has no gametes so to obtain the full amount of chromosomes a haploid cell is used created by mitosis to form an offspring genetically identical to the parent plant (not sure on this last answer).
- Outline the process of cell division by budding in yeast (may require diagrams). Cells of yeast undergo cytokinesis by producing a small bud that nips off the cell in a process called cell budding (best answer I could find). The yeast cell that buds off the daughter cell is smaller than the parent cell.
- State that cells produced, as results of meiosis are not genetically identical. Meiosis produces cells with half the amount of genetic content and produced cells genetically identical from each other and the parent cell. This can be done by crossing over of chromatids and independent assortment of chromosomes.
- Define stem cell. A cell with the potential to become any one of the different cell types found in a fully-grown organism. Are either omnipotent or totipotent.
- Define differentiation in production of erythrocytes, neutrophils derived from stem cells in bone marrow, production of xylem vessels and phloem sieve tubes from cambium. Differentiation is the change occurring in cells of a multicellular organism so that each different type of cell becomes specialised to form a specific function. Differentiation in production of erythrocytes begins as stem cells in the bone marrow. The cell loses its nucleus, mitochondria, Golgi apparatus, and rER. This is done to hold as much hemoglobin (protein) as possible to carry as much oxygen as possible. The shape of the cell changes to adapt carrying oxygen to a

biconcave disk. For neutrophils, the cell also starts off as bone marrow stem cell. The cell keeps its nucleus. The cytoplasm appears grainy (granular) due to the large amounts of lysosomes being produced. The potent enzymes in the lysosomes allow the neutrophil to become specialised in digesting invading microorganisms. Xylem vessels start off as meristem cells such as cambium. Meristem cells produce small cells that elongate. Walls become waterproofed by lignin, which kills cell content. Ends of cell breaks down to form long tubes with wide lumen, this is good for transporting water and minerals up the plant as well as supporting it. This consists of the xylem vessel with parenchyma cells and fibres. Phloem sieve tubes also start off as meristem cells (cambium) and the meristem tissue produces cells that elongate and line up end to end, forming long tubes. These ends form sieve plates and these plates allow movement of materials up or down the tubes. Next to the sieve tube is a companion cell, which has a high metabolic rate and is important in moving products up and down the plant.

- Describe and explain how cells of multicellular organisms are specialised for particular functions (may require diagrams). The ones above have already been explained so I'll skip them. Squamous epithelial tissue is a thin flattened cell, which makes them ideal for fluids to pass over, and giver them a short diffusion pathway and they're flat and thin. They're held in place by basement membrane, secreted by epithelial made of collagen and glycoproteins. Sperm cells have man y mitochondria to produce ATP, which provides energy for movement. They also contain enzymes that digest the membrane around the egg cell and have a flagellum for movement. Root hair cells have a large surface area to maximise uptake of minerals and water. Palisade vertically elongated cells that are located in the palisade mesophyll, which is where most photosynthesis occurs. Guard cells are cells surrounding each stoma to regulate the rate of transpiration by controlling the opening and closing of the stomata.
- Define tissue, organ and organ system. Tissue is a collection of cells; similar to each other that performs a common function. An organ is a collection of tissues working together to perform a particular function. An organ system is a number of organs working together to perform an overall life function such as respiration.
- Discuss importance of cooperation between cells, tissues, organs and organ systems.