**Mastery Matrix: Topic 1 - Cells**

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| **Topic Title** | **Topic Number** | **Sub-Topic Title** | **Sub-Topic Number** | **Paper** | **Learning Statement** | **Statement Type** |
| Cells | 1 | Viewing Cells | 1.1 | 1 | Compare the principles and limitations of optical, transmission electron and scanning electron microscopes. | K |
| Cells | 1 | Viewing Cells | 1.1 | 1 | Calculate the magnification, when given the size of an object and the size of its image. | M |
| Cells | 1 | Viewing Cells | 1.1 | 1 | Explain the role of cell fractionation and ultracentrifugation in separating cell components. | K |
| Cells | 1 | Viewing Cells | 1.1 | 1 | Explain the difference between artefacts and cell organelles. | K |
| Cells | 1 | Viewing Cells | 1.1 | 1 | Understand how to prepare and stain a root tip squash | RP |
| Cells | 1 | Viewing Cells | 1.1 | 1 | Explain how iodine in potassium iodide solution can be used to identify starch grains in plant cells | AT |
| Cells | 1 | Cell Structure | 1.2 | 1 | State the function of the following eukaryotic structures: cell-surface membrane, nucleus, mitochondria, chloroplasts, Golgi apparatus, lysosomes, ribosomes, rough/smooth endoplasmic reticulum, cell wall, cell vacuole. | K |
| Cells | 1 | Cell Structure | 1.2 | 1 | Describe the levels of organisation in complex multicellular organisms. | K |
| Cells | 1 | Cell Structure | 1.2 | 1 | Explain the adaptations of specialised eukaryotic cells. | K |
| Cells | 1 | Cell Structure | 1.2 | 1 | Compare the internal structures of eukaryotic & prokaryotic cells. | K |
| Cells | 1 | Cell Structure | 1.2 | 1 | Describe the role played by plasmids in prokaryotic cells. | K |
| Cells | 1 | Cell Structure | 1.2 | 1 | Describe the structure of virus particles. | K |
| Cells | 1 | Cell Division | 1.3 | 1 | Explain why viruses are classed as non-living entities. | K |
| Cells | 1 | Cell Division | 1.3 | 1 | State that not all cells within a multicellular organism retain the ability to divide. | K |
| Cells | 1 | Cell Division | 1.3 | 1 | Define the cell cycle as the series of steps which make up cell division. | K |
| Cells | 1 | Cell Division | 1.3 | 1 | State that DNA replication occurs during interphase. | K |
| Cells | 1 | Cell Division | 1.3 | 1 | Define mitosis | K |
| Cells | 1 | Cell Division | 1.3 | 1 | Describe the behaviour of chromosomes during interphase, prophase, metaphase, anaphase and telophase. | K |
| Cells | 1 | Cell Division | 1.3 | 1 | Explain the role of spindle fibres in the separation of chromatids | K |
| Cells | 1 | Cell Division | 1.3 | 1 | Define cytokinesis | K |
| Cells | 1 | Cell Division | 1.3 | 1 | Explain how uncontrolled cell division can lead to the formation of tumours/cancers. | K |
| Cells | 1 | Cell Division | 1.3 | 1 | Describe, in detail, binary fission in prokaryotic cells. | K |
| Cells | 1 | Cell Division | 1.3 | 1 | Explain how viruses use host cells to replicate. | K |
| Cells | 1 | Cell Division | 1.3 | 1 | Calculate mitotic index from an image | RP |
| Cells | 1 | Transport & Membranes | 1.4 | 1 | Describe the fluid mosaic model of the cell membrane. | K |
| Cells | 1 | Transport & Membranes | 1.4 | 1 | State the function of the following species in the cell membrane: phospholipids, proteins, glycoproteins, glycolipids & cholesterol. | K |
| Cells | 1 | Transport & Membranes | 1.4 | 1 | State the differences between intrinsic & extrinsic membrane proteins. | K |
| Cells | 1 | Transport & Membranes | 1.4 | 1 | Describe the movement of substances across the phospholipid bilayer via: simple diffusion, facilitated diffusion, osmosis, active transport and co-transport. | K |
| Cells | 1 | Transport & Membranes | 1.4 | 1 | Understand the role of ATP hydrolysis in active transport. | K |
| Cells | 1 | Transport & Membranes | 1.4 | 1 | Understand that specialised cells may be adapted for rapid transport across the membrane. | K |
| Cells | 1 | Transport & Membranes | 1.4 | 1 | Explain how surface area, no. of carrier proteins & steepness of conc gradient can affect the rate of movement across the membrane. | K |
| Cells | 1 | Transport & Membranes | 1.4 | 1 | Understand how to produce a dilution series of a solute. | RP |
| Cells | 1 | Transport & Membranes | 1.4 | 1 | Explain how to use a calibration curve to identify the water potential of plant tissue. | RP |
| Cells | 1 | Transport & Membranes | 1.4 | 1 | Describe the effect of temperature on membrane permeability. | RP |
| Cells | 1 | Transport & Membranes | 1.4 | 1 | Select an appropriate format for plotting experimental data. | M |
| Cells | 1 | Transport & Membranes | 1.4 | 1 | Use the intercept of a graph to determine the water potential of a plant tissue. | M |
| Cells | 1 | Immune Response | 1.5 | 1 | State that each type of cell has specific antigens on its surface. | K |
| Cells | 1 | Immune Response | 1.5 | 1 | Define an antigen and explain their role in disease prevention. | K |
| Cells | 1 | Immune Response | 1.5 | 1 | Define phagocytosis & explain the role of lysozymes. | K |
| Cells | 1 | Immune Response | 1.5 | 1 | Describe the responses of T lymphocytes, helper T cells, cytotoxic T cells, B cells and phagocytes to a foreign antigen. | K |
| Cells | 1 | Immune Response | 1.5 | 1 | Describe the role of B lymphocytes in clonal selection and the release of monoclonal antibodies | K |
| Cells | 1 | Immune Response | 1.5 | 1 | Define the humoral response | K |
| Cells | 1 | Immune Response | 1.5 | 1 | Define an antibody and describe its structure. | K |
| Cells | 1 | Immune Response | 1.5 | 1 | Describe the formation of an antigen-antibody complex, leading to agglutination and phagocytosis. | K |
| Cells | 1 | Immune Response | 1.5 | 1 | Explain the roles of plasma cells and memory cells in the primary and secondary immune responses. | K |
| Cells | 1 | Immune Response | 1.5 | 1 | Understand how vaccines can provide protection against disease. | K |
| Cells | 1 | Immune Response | 1.5 | 1 | Define herd immunity and explain the difference between active and passive immunity | K |
| Cells | 1 | Immune Response | 1.5 | 1 | Describe the structure of the HIV virus and explain how it causes the symptoms of AIDS | K |
| Cells | 1 | Immune Response | 1.5 | 1 | Explain why antibiotics are ineffective against viruses. | K |
| Cells | 1 | Immune Response | 1.5 | 1 | Explain the use of antibodies in targeting medication to specific cell types. | K |
| Cells | 1 | Immune Response | 1.5 | 1 | Outline the ethical issues associated with vaccination and use of monoclonal antibodies. | K |
| Cells | 1 | Immune Response | 1.5 | 1 | Understand the use of antibodies in the ELISA test. | K |
| Cells | 1 | Immune Response | 1.5 | 1 | Evaluate methodology, evidence and data relating to the use of vaccines/monoclonal antibodies. | K |

**Topic 1.1 – Viewing Cells: Key Knowledge**

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| State the equation for calculating magnification. | magnification = size of image/size of object |
| Convert 1mm to a)µm b)nm | a)1,000 µm b)1,000,000 nm |
| State and explain the conditions for cell fractionation | 1) cold = reduce enzyme activity 2) isotonic = prevent bursting or shrinking 3) buffered = maintain pH |
| Name and describe the 2 stages of cell fractionation | 1) Homogenation = cells broken up by homogeniser 2) Ultracentrifugation = homogenate spun at high speed to separate organelles |
| State the relative speeds where organelles are separated; | 1) nuclei (heaviest)= slowest 2) mitochondria (medium) = medium 3) lysosomes (lightest)= fastest |
| Explain how a transmission electron microscope works | Beam of electrons passed through thin specimen --> parts absorb electrons and appear dark--> parts allow electrons to pass through and appear light |
| Explain how a scanning electron microscope works | Beam of electrons directed onto surface of specimen and passed back and forth --> Electrons scatter and produce 3D image |
| Explain why an electron microscope has a higher resolution: | Electron beams have a shorter wavelength than light |
| State the limitations of electron microscopes | 1) must use a vacuum (can't study live specimens) 2) specimen must be thin (except SEM) 3) image not in colour 4) image may contain artefacts |
| Name the apparatus used to measure the size of an object under a microscope | Eyepiece graticule calibrated with a stage micrometer |
| State the substance used to 'fix' a sample of the tissue, before viewing | Hydrochloric acid |
| Name the chemical used to stain the sample, when carrying out a root tip squash | Toluidine blue |
| Describe what is meant by 'macerating' a sample | Soften/break down into smaller pieces, for easier viewing |
| State the equation used to calculate mitotic index | mitotic index = no. of dividing cells/total no. of cells |
| Name the part of a plant which typically possesses the highest mitotic index | Meristem |

**Topic 1.2 – Cell Structure: Key Knowledge**

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| State the name and function of the folds in the inner mitochondrial membrane | Cristae - Increase surface area for attachment of proteins/enzymes |
| State three adaptations of chloroplasts | Grana membranes increase surface area, stroma contains all required enzymes, chloroplasts contain DNA & ribosomes for rapid protein manufacture |
| Name the flattened sacs enclosed within the endoplasmic reticulum | Cisternae |
| Identify two types of molecule generated by RER | Proteins, glycoproteins |
| Identify two types of molecule generated by SER | Lipids, carbohydrates |
| Name the organelle responsible for modifying, 'labelling' and transporting products of the ER | Golgi apparatus |
| Describe the general structure of a lysosome | Vesicle containing a digestive enzyme (e.g. lysozyme) |
| State the type of ribosome found in prokaryotic cells | 70S |
| State the type of ribosome found in eukaryotic cells | 80S |
| Identify the substance which comprises the cell walls of: i) Plant cells, ii) Fungi, iii) Prokaryotes | i) Cellulose, ii) Chitin, iii) Murein |
| State the levels of organisation in the body, from smallest to largest | Cell, tissue, organ, organ system, organism |
| Define a tissue | A collection of similar cells, which work together to carry out a specific function |
| State the functions of the capsule in prokaryotes | Allows cells to stick together, prevents drying out |
| Describe the DNA in a prokaryotic cell | Free-floating loop of DNA + smaller plasmids, no histones |
| State the two names given to the outer coating of a virus | Capsid, protein coat |

**Topic 1.3 – Cell Division: Key Knowledge**

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| Compare the products of mitosis and meiosis | Mitosis = two, identical daughter cells ; Meiosis = four, non-identical daughter cells |
| State the functions of mitosis & meiosis | Mitosis = growth/repair of somatic tissues ; Meiosis = Gamete production |
| Identify the stage of the cell cycle when DNA replication occurs | Interphase |
| State the stages of the cell cycle, in order | Interphase, prophase, metaphase, anaphase, telophase/cytokinesis |
| Describe the function of the centrioles in animal cells | Move to opposite poles & develop spindle fibres |
| Describe the behaviour of the chromosomes during prophase | Chromosomes shorten/condense, becoming visible & turning from chromatin to chromatids |
| Name the point on each chromosome where the spindle fibres attach | Centromere |
| Name the stage of the cell cycle when the chromosomes begin to move towards the poles of the dividing cell. | Anaphase |
| Describe the processes which occur during telophase | Chromosomes uncoil, spindle fibres disintegrate, nuclear envelope + nucleolus reform. |
| State the name given to the process of the cytoplasm dividing into two equal sections | Cytokinesis |
| Name the process of cell division in prokaryotic cells | Binary fission |
| Describe what happens during binary fission | Circular DNA + plasmids replicate, cell membrane grows and 'pinches' cell in two, new call wall develops between daughter cells |
| Describe how viruses replicate | Attach to a host, insert nucleic acid into host's DNA, in order to synthesise viral components |
| State the percentage of the cell cycle spent in interphase | 90% |
| Name the disease caused by uncontrolled cell division in the body | Cancer |

**Topic 1.4 – Transport & Membranes: Key Knowledge**

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| State the name given to the model for the structure of the plasma membrane | Fluid mosaic model |
| Describe the general structure of a phospholipid | A hydrophilic head, attached to two hydrophobic tails |
| Explain why the phospholipids arrange themselves into a 'bilayer' | Allows the hydrophilic heads to interact with water molecules, while protecting the hydrophobic tails from these interactions |
| State the name given to proteins which i) fully span the membrane ii) are embedded in, but do not span the membrane | i) Intrinsic ii) Extrinsic |
| State the two possible functions of extrinsic (glyco)proteins | Structural support, cell signalling |
| State the main function of intrinsic membrane proteins | Transport of substances across the membrane |
| Describe the effect of increasing the concentration of cholesterol in the cell membrane | Membrane becomes more rigid (components are more tightly-packed together) |
| Describe the type of molecules which are able to pass freely through the membrane | Small, non-polar (e.g. oxygen & carbon dioxide) |
| State what is meant by a process being 'passive' | Occurs without the need for an external source of energy |
| State the source of energy in facilitated diffusion | The kinetic energy of the particles being transported |
| Name the two types of intrinsic protein involved in facilitated diffusion | Protein channels, carrier proteins |
| Describe the steps involved in identifying the water potential of cells | Place the samples in a series of solutions of different concentrations, record the change in mass of the samples, identify the concentration at which there is no change in mass (no net movement of substances) |
| Describe what happens to an animal cell when placed in: i) a more dilute solution ii) a more concentrated solution | i) Water moves in, causing the cell to burst ii) Water moves out, causing the cell to shrivel |
| Identify the structure in plant cells which allows them to become turgid/plasmolysed in different solutions | Cell wall |
| State the reaction used to provide energy for active transport across the membrane | ATP --> ADP + Pi |

**Topic 1.5 – Immune Response: Key Knowledge**

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| State the role of phagocytes in the immune response | Ingesting & destroying pathogens |
| Name the two main classes of white blood cell and state which is specific and which is non-specific | Lymphocytes (specific) & phagocytes (non-specific) |
| State the contents of a lysosome | A lysosome contains the digestive enzyme, lysozyme |
| Identify the bodily locations where B-lymphocytes & T-lymphocytes mature | B-lymphocytes = Bone marrow, T-lymphocyte = Thymus |
| Define an antigen | "An antigen is a protein, found on the surface of invasive cells, which is recognised as foreign or non-self.” |
| Identify four types of antigen-presenting cells | Phagocytes, infected somatic cells, transplanted cells & cancer cells |
| Explain the difference between the cell-mediated & humoral responses | Cell-Mediated = T-lymphocytes + bodily cells ; Humoral = B-lymphocytes + extracellular fluid |
| Describe the role of T-Helper cells | Bind to presented antigens & promote copying of a specific B-cell through clonal selection |
| Name & describe the two types of cell produced by clonally-selected B-cells | Plasma cells = produce antibodies & antitoxins, Memory cells = provide long-term immunity |
| Describe the structure of an antibody | Y-shaped protein, made up of two 'heavy' chains and two 'light' chains. Contain a variable region & constant region |
| Define agglutination & explain how the structure of antibodies assist this process | Agglutination = 'clumping together' of pathogens ; antibodies have two identical binding sites |
| Explain what is meant by a monoclonal antibody | A single type of isolated & cloned antibody ; used in drug delivery & pregnancy tests |
| Describe the role of cytotoxic T-cells in the immune response | Produce perforin = 'punches' holes in the pathogen's plasma membrane |
| Explain the differences between active and passive immunity | Active = long-term + memory cells retained ; Passive = short-lived, no memory cells produced |
| Explain what is meant by ‘herd immunity’ | Once a threshold vaccination % is reached , a disease is unable to infect any individuals |