thebiotutor

AS Biology OCR

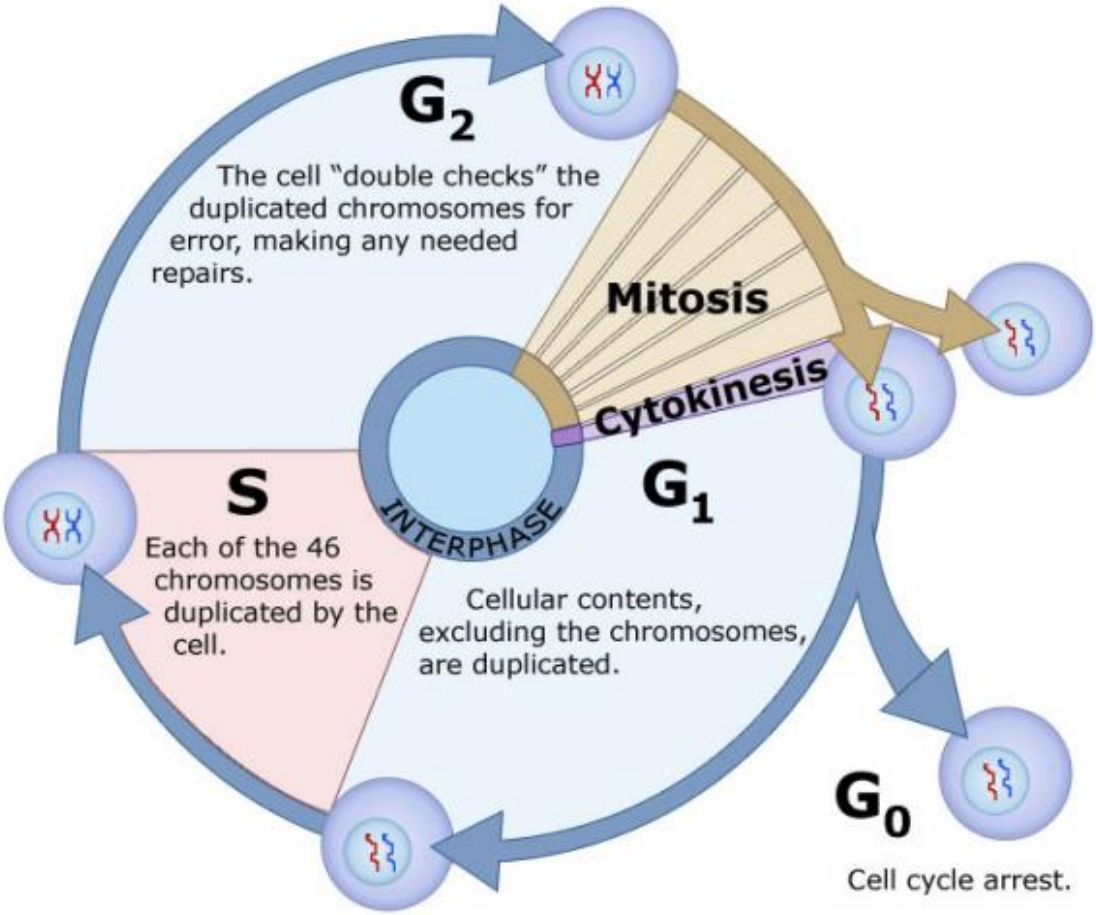
Unit F211: Cells, Exchange & Transport

Module 1.3 Cell Division, Diversity and Organisation

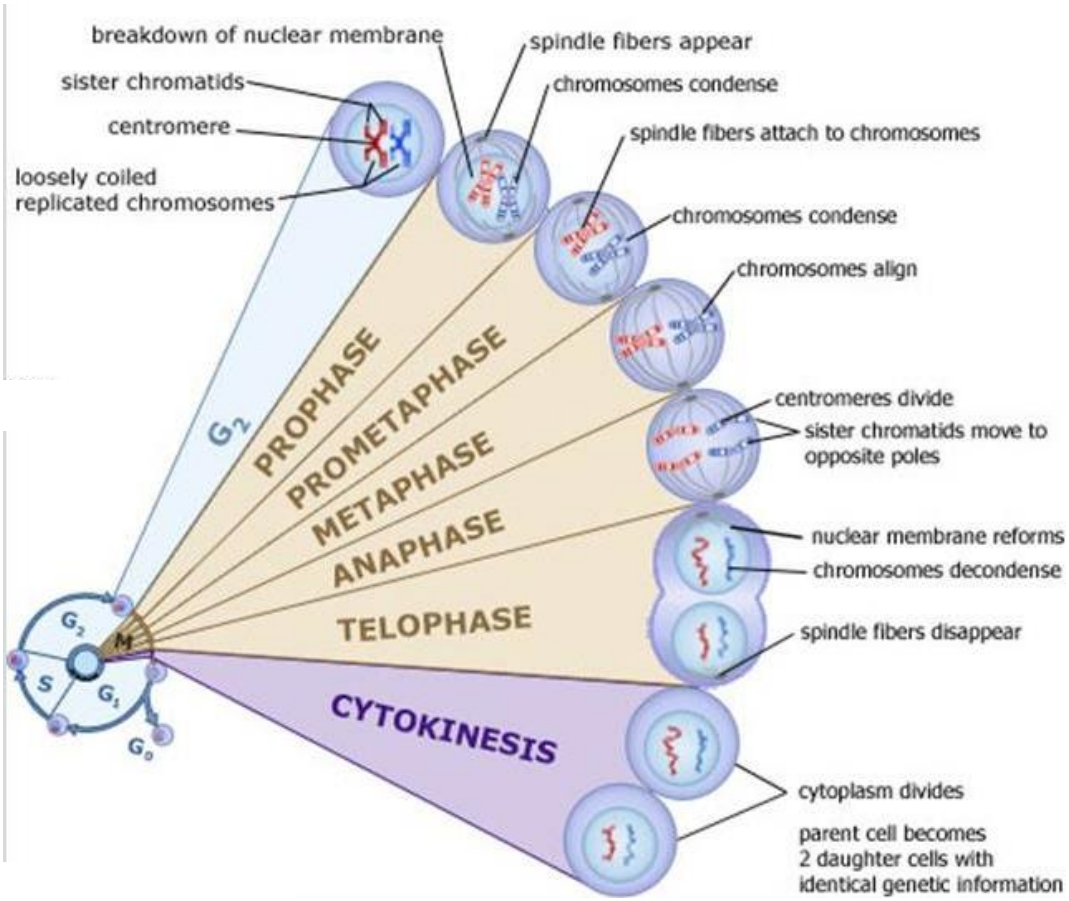
Notes & Questions

State that mitosis occupies only a small percentage of the cell cycle and that the remaining percentage includes the copying and checking of genetic information.

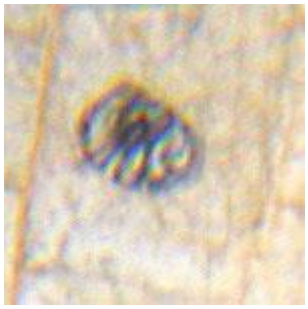
- The cell cycle is the process of cell growth and division
- Mitosis only takes up about 5 - 10% of the cell cycle.
- The majority of the cell cycle is taken up by Interphase
- During interphase the cell undertakes normal functions alongside preparing the cell to divide.
- Interphase consists of three sub-phases
    - G1
        - organelles are duplicated
        - centrioles replicate
        - Normal life processes
            - Respiraton
            - Protein synthesis
    - S
        - Chromosomes are duplicated/replication of DNA
        - Semi-conservative replication of DNA
    - G2
        - Duplicated chromosomes are checked for any errors that may have occurred when copying them.



Describe, with the aid of diagrams and photographs, the main stages of mitosis (behaviour of the chromosomes, nuclear envelope, cell membrane and centrioles).



- **Prophase** - Replicated chromosomes supercoil (shorten and thicken)
    - Chromosomes shorten and thicken (supercoil),
    - Chromosomes become visible
    - Chromosomes consist of two chromatids
    - Chromatids are joined by a centromere
    - Centrioles migrate to the poles of the cell (Not in Plant cells)
    - Spindle fibres form
    - Nuclear envelope breaksdown



- **Metaphase** - Replicated chromosomes line up along the cells equator
    - Homologous pairs of chromosomes arrange themselves in a line along the cell's equator.
    - Spindle fibres attach to the centromere which holds the homologous pair together.


- **Anaphase** - The replicas of each chromosome are separated from Each other and pulled towards the poles of the cells
    - Centromeres divide
    - Separating each pair of chromatids
    - The spindles contract and shorten
    - Pulling chromatids to opposite ends of the cell,
    - Centromere first.

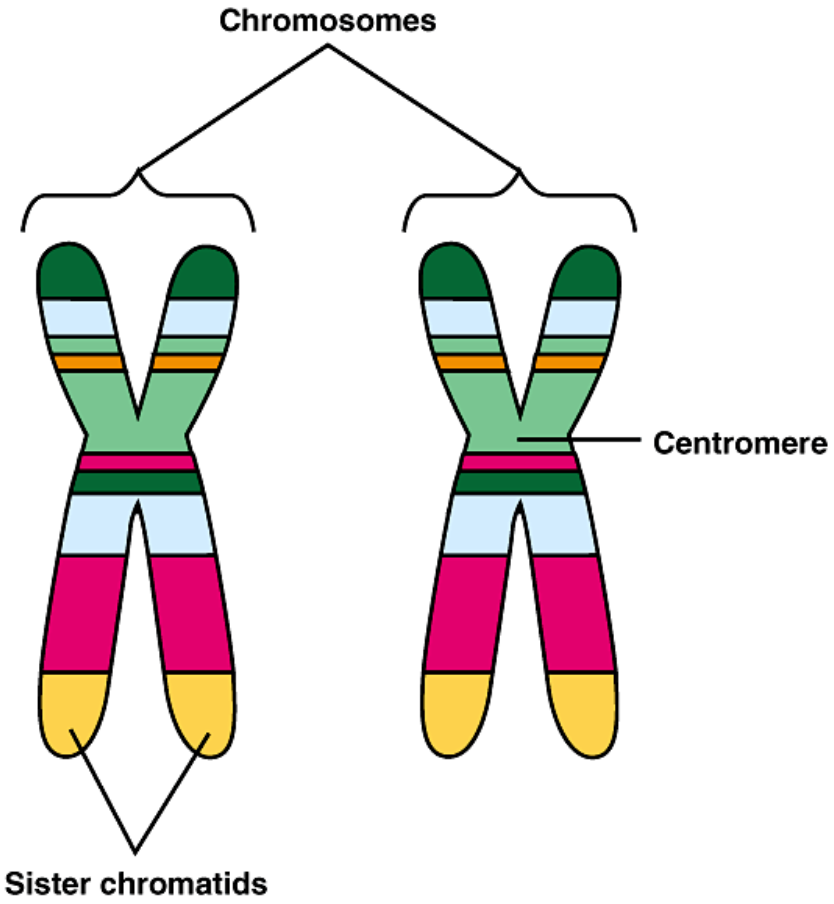

- **Telophase** - Two new nuclei are formed
    - The chromatids reach each pole of the cell.
    - The chromatids uncoil and become long and thin again
    - They are now referred to chromosomes again.
    - A new nuclear envelope forms around each group of chromosomes so they are now two nuclei.

- **Cytokinesis** – Cell division
  - This is not a part of mitosis.
  - The cytoplasm divides and the plasma membrane nips in half forming two new cells
  - In animal cells this starts from the outside 'nipping in'
  - In plants this starts with the formation of a cell plate which is laid down along the cell equator. A new membrane and wall is laid down along the plate.

- The two new daughter cells are;
  - Diploid 2n (46 chromosomes as 23 pairs)
  - Genetically identical to each other and the parent cell
  - Most animal cells are capable of undergoing mitosis and cytokinesis
  - In plants only meristem cells can divide in this way

Explain the meaning of the term *homologous pair of chromosomes*

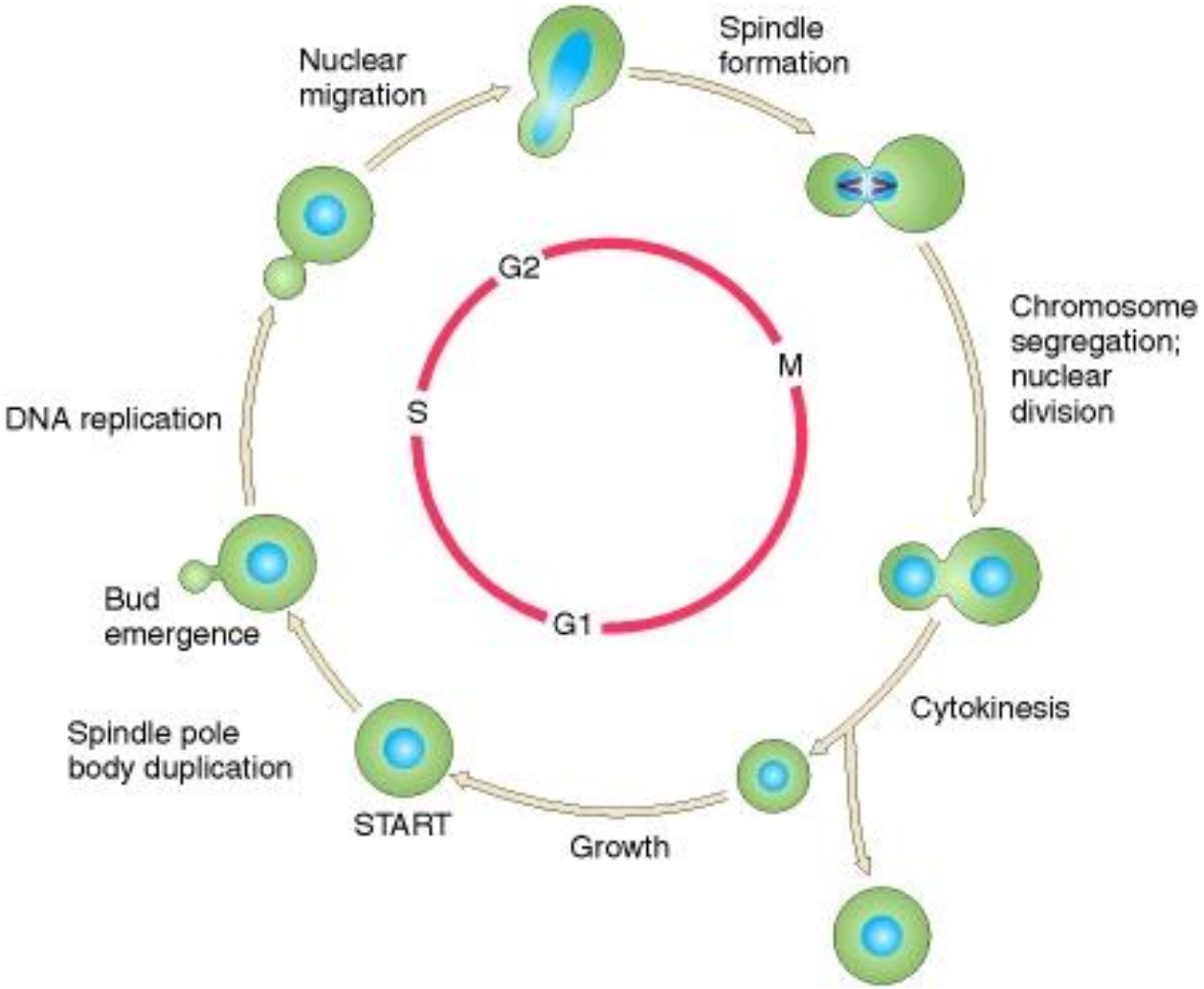
- A pair of identical chromosomes (1 from father and 1 from mother)
- Same genes but can have either the same or different alleles
- Humans have 23 homologous pairs of chromosomes



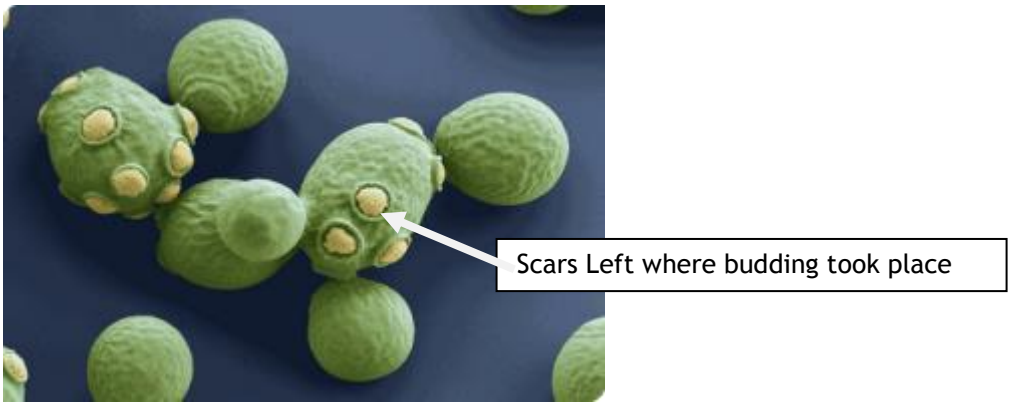
Explain the significance of mitosis for growth, repair and asexual reproduction in plants and animals.

- Mitosis is type of cell division involving somatic or normal body cells.
- It is important that the cells divide and replace old worn out cells/repair tissues and more importantly be able to replicate the duties of the cells they replace.
- Mitosis is important for growth of tissues to take place. Mitotic divisions enables a single cell to grow eg. from conception, repeated cell division has allowed us to developed into multicellular organisms.
- Its is also important for genetic stability/maintains chromosome number (ploidy). By duplicating the exact copy of our genetic material it ensures that our genetic material is stable and able to carry out its function correctly because the instructions from the previous cells would have been passed on to the new daughter cells.
- Its also important in asexual reproduction.
- Produces genetically identical cells/clones

Outline, with the aid of diagrams and photographs, the process of cell division by budding in yeast.



- *Saccharomyces cerevisiae*, commonly known as Baker's yeast, is a unicellular fungus that reproduces by budding.
    - During S phase of the cell cycle (while the replication machinery in the nucleus makes a second copy of the genome), a small bud emerges from the ovoid mother cell.
    - This bud continues to grow as the cell prepares for cell division (mitosis in M phase).
    - During mitosis, the nucleus divides and one full complement of DNA is packaged into the large bud before it is pinched off.
    - Both the mother and daughter cells go on to G_1 where they grow and subsequently embark on a new round of the cell cycle.



State that cells produced as a result of meiosis are not genetically identical.

- Meiosis
    - Haploid cells n (23 chromosomes, no pairs)
    - 4 news cells produced
    - Genetically unique to parent and each other
    - Only occurs in gonads
    - Gamete production (E.g sperm, ova, pollen grain & egg)

Define the term *stem cell.*

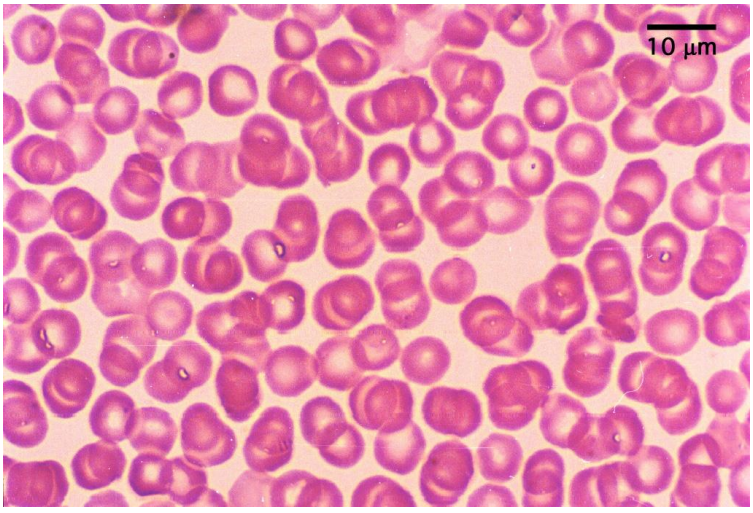
- Unspecialised (undifferentiated) cell – capable of becoming differentiated to a number of different cell types/
    - Totipotent (omnipotent)
        - Zygote (can become an entire organism)
        - Cambium in plants
    - Pluripotent
        - Embryo (can become most cell types)
    - Multipotent
        - Adult Stem Cell (can become several closely related cells)
        - Bone marrow
    - Somatic
        - Specialised body cell.

Define the term *differentiation*, with reference to the production of erythrocytes (red blood cells) and neutrophils derived from stem cells in bone marrow, and the production of xylem vessels and phloem sieve tubes from cambium.

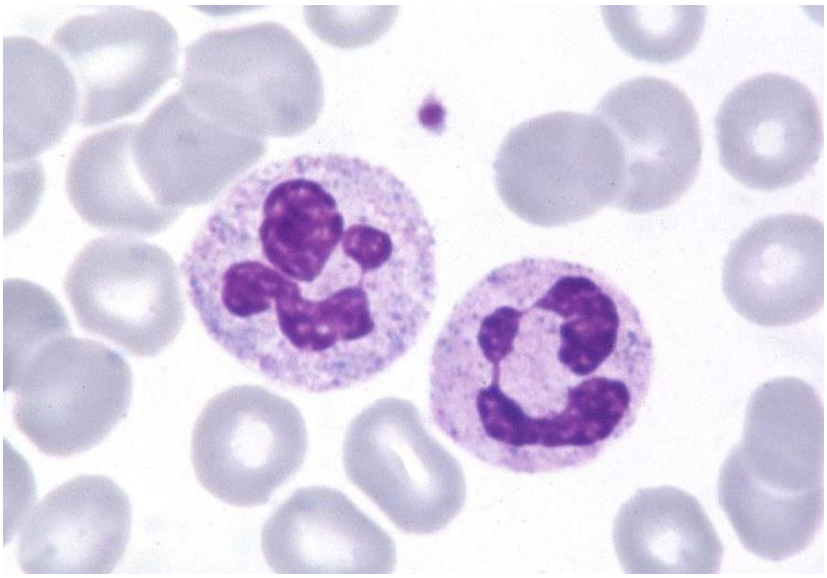
- Differentiation
  - The development and changes seen in cells of a multicellular organism as they mature to form specialized cells which perform a specific function.
  - Cells can differentiate in a number of ways, with change to:
    - The number of a particle organelle
    - The shape of the cell
    - Some of the contents of the cell

- Bone Marrow = Erythrocytes & Neutrophils
  - Bone marrow contains undifferentiated stem cells (multipotent).
  - These cells will specialize into both erythrocytes and neutrophils even though they all contain the same set of chromosome.

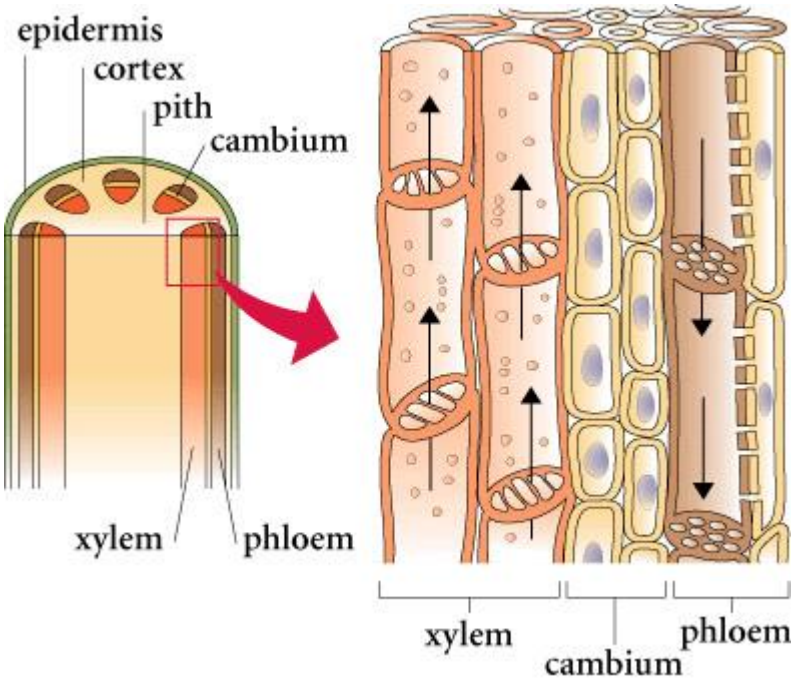
  - Erythrocytes
    - lose their nucleus, mitochondria, golgi apparatus and rough endoplasmic reticulum.
    - Make lots of the protein Haemoglobin
    - Shape changes to become bi-concave discs
    - Function to transport oxygen and carbon dioxide.



  - Neutrophils
    - Keep their nucleus
    - They produce granular looking cytoplasm due to many lysosomes produced.
    - Role is to ingest invading microorganisms



- Cambium = Xylem & Phloem
    - Cambium contains meristem cells (totipotent)



    - Xylem
        - Meristem cells elongate and line up end to end
        - Walls become reinforced and waterproofed by deposits of lignin
        - Cell contents and end walls are destroyed forming a continuous long tube.
        - Xylem tissue is suited to transporting water and dissolved minerals up the plant.

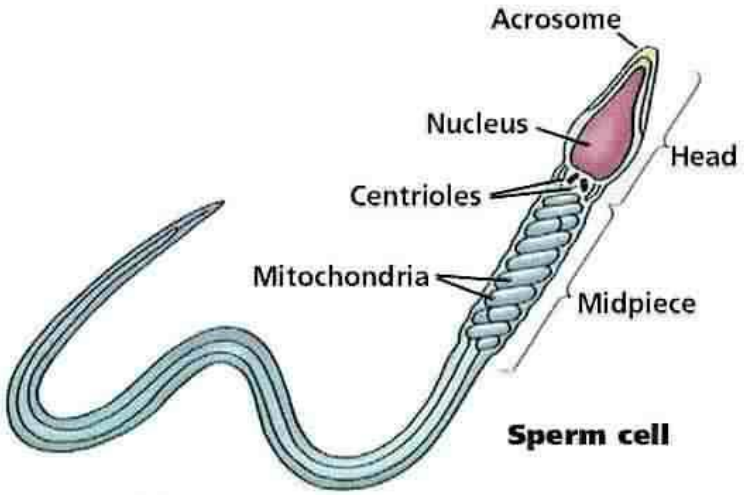
- Phloem
  - Meristem cells elongate and line up end to end
  - Consists of two cell types sieve tube elements and companion cells
  - Sieve tube elements
    - Cell end walls do not breakdown completely and form sieve plates
    - Sieve plates allow assimilates to move up and down the plant
  - Companion cells
    - Very metabolically active
    - Lots of mitochondria, membrane proteins

Describe and explain, with the aid of diagrams and photographs, how cells of multicellular organisms are specialised for particular functions, with reference to erythrocytes (red blood cells), neutrophils, epithelial cells, sperm cells, palisade cells, root hair cells and guard cells.

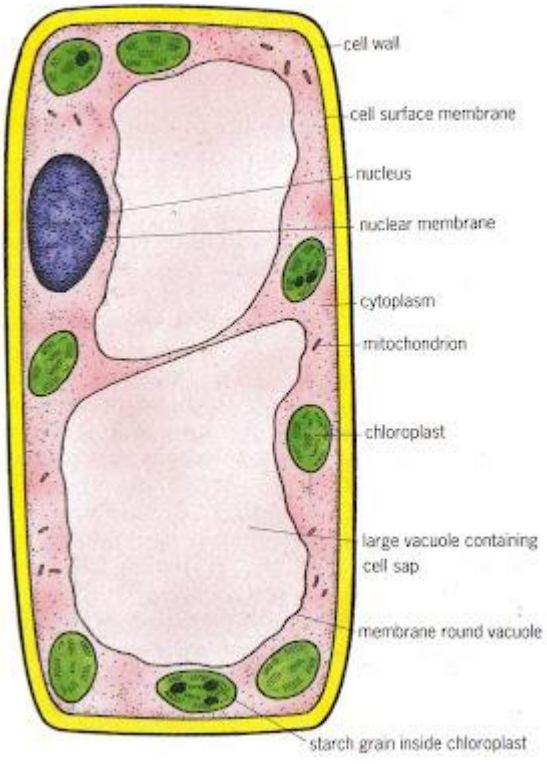
- Epithelial cells
  - Epithelial Tissue is made up of Epithelial Cells cover external and internal surfaces in an animal.
    - Different Types of Epithelial Cells exist, for example, Squamous Epithelial Cells and Ciliated Epithelial Cells.
  - Squamous Epithelial Cells make up Squamous Epithelial Tissue.
    - They are flat cells that form a single thin, smooth layer that lines tubes where diffusion occurs.
    - They occur, for example, in Alveoli and some blood vessels. They are held in place by a Basement Membrane. This is composed of Collagen and Glycoproteins, secreted by Epithelial Cells, that binds them to Connective Tissue.
  - Ciliated Epithelial Cells are column shaped cells, that cover many surfaces.
    - They have tiny projections on their exposed surface, called Cilia, which beat in a synchronised pattern to move Mucus, produced by Goblet Cells, along the surface.
    - They can be found, for example, in the Trachea, the Uterus and the Bronchi.

- Sperm Cells
  - Spermatozoon are motile Sperm Cells..
  - They travel toward the female's Egg and attempt to fertilize it to produce a Totipotent Zygote.
  - Sperm Cells are specialised in a number of ways.
    - They have an Undulipodium (tail)
    - Which moves by energy generated by many mitochondria and propels the cell.

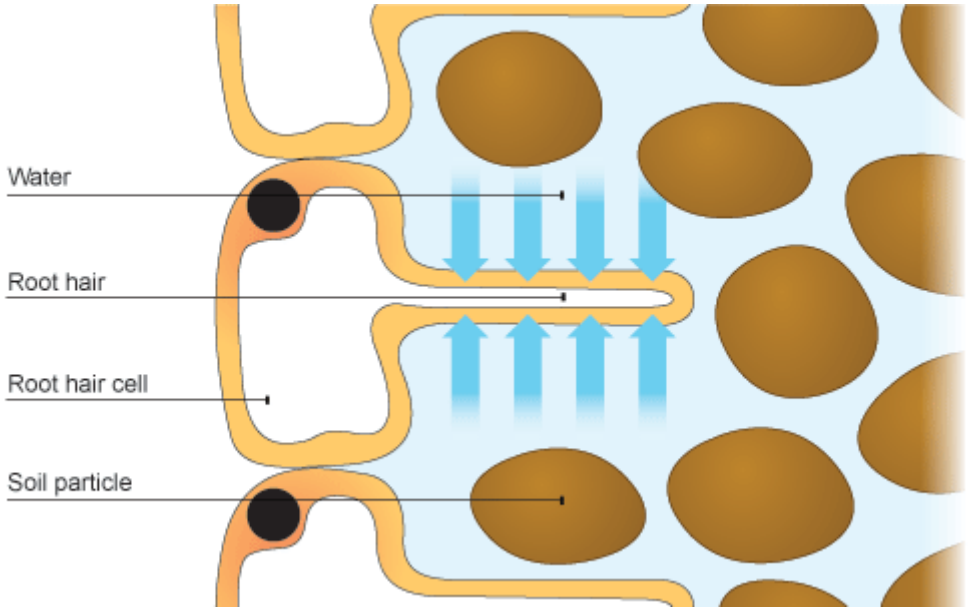
- The head of the cell contains an Acrosome, which is a specialised Lysosome that releases enzymes so that the Sperm Cell can penetrate the Ovum Coat of the Egg.
- Haploid cell – contains 23 chromosomes (half the amount to form a zygote)
- Sperm Cells are also very small and thin, which aids their movement.



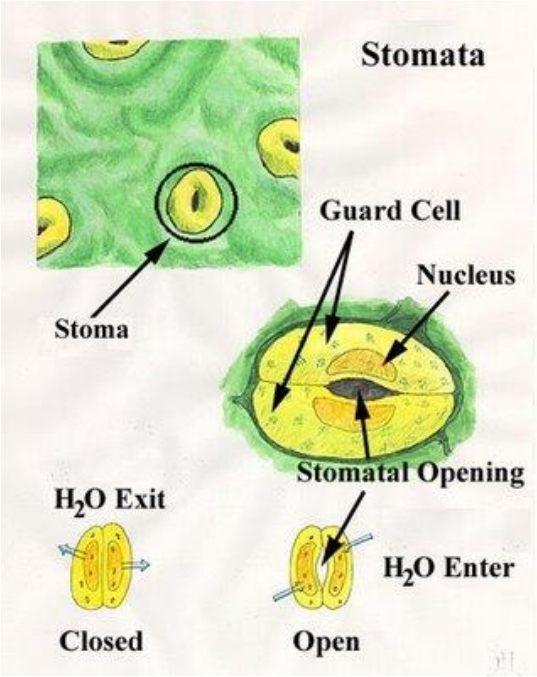
- Palisade cells
  - Long, thin cells that are tightly packed together
  - They contain a lot of chloroplasts which are densely packed with chlorophyll
  - They are the main photosynthetic units of the plant.



- Root Hair cells
  - Root Hair Cells are found in the roots of plants.
  - Their role is to absorb water and minerals in the soil.
  - They have a large surface area, due to their hair-like projections, which eases uptake.
  - They also have a large amount of Mitochondria, which provide more energy for Active Transport.
  - They have thin cell walls
  - Lots of protein carriers



- Guard Cells
  - They appear in pairs around stomata
  - They appear mainly on the lower epidermis of leaves
  - They contain chloroplasts
  - Their cell walls on one side contain spiral thickenings of cellulose
  - When they take in water their inner walls expand less due to these thickenings and so causes the stomata (pores) to open.



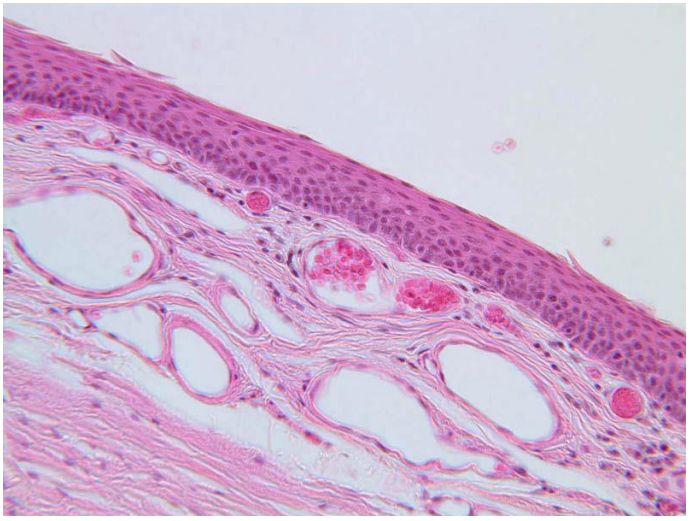
Explain the meaning of the terms *tissue*, *organ* and *organ system.*

- Tissue
  - group of cells;
  - made up of, more than one / two / a few, types of cell;
    A named cell types (vessel / fibre / parenchyma)
  - which work together
  - (specialised) to perform particular function(s); **R** *job*
  - E.g. Epithelial and nervous tissue in animals
  - *E.*g. Xylem and phloem tissue in plants.
- Organ
  - group of tissues;
  - made up of, more than one / two / a few, types of tissues;
    A named cell types (vessel / fibre / parenchyma)
  - which work together
  - (specialised) to perform particular function(s); **R** *job*
  - E.g. Liver in animals
  - E.g. Leaves in plants

- Organ System
  - group of organs;
  - made up of, more than one / two / a few, types of organ;
    A named cell types (vessel / fibre / parenchyma)
  - which work together
  - (specialised) to perform particular function(s); **R** *job*
  - E.g. Reproductive system in both animals and plants**.**

Explain, with the aid of diagrams and photographs, how cells are organised into tissues, using squamous and ciliated epithelia, xylem and phloem as examples.

- Squamous Epithelial Cells
  - They make up Squamous Epithelial Tissue.
  - They are very flat cells that form a single thin, smooth layer that lines tubes where diffusion occurs.
  - They occur, for example, in Alveoli and some blood vessels.
  - They are held in place by a Basement Membrane. This is composed of Collagen and Glycoproteins, secreted by Epithelial Cells, that binds them to Connective Tissue.



- Ciliated Epithelial Cells
  - They are column shaped cells, that cover many surfaces.
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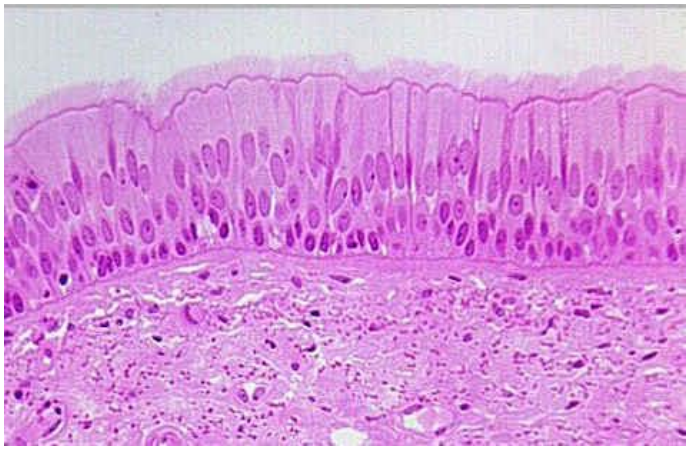
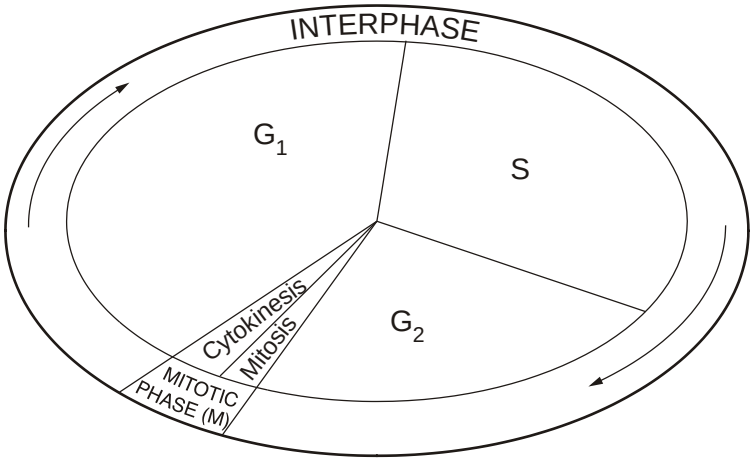


Discuss the importance of cooperation between cells, tissues, organs and organ systems.

- Cells, tissues, organs and organ systems must all cooperate with each other to enable organisms to function
- Locomotion
    - Involves the nervous, muscle and skeletal organ systems
    - This requires the action of muscle, blood and nerve tissue
    - This requires a supply of nutrients and oxygen transported using the circulatory system
    - These materials are received from the digestive and ventilation system

1. Mitosis is part of the cell cycle.

The figure below shows a diagram of the cell cycle.



(i) Name **one** process that occurs during stages G_1 and G_2.

.....

[1]

(ii) During stage **S**, the genetic information is copied and checked.

Suggest what might happen if the genetic information is not checked.

.....

.....

.....

.....

[2]

[Total 3 marks]

2. State **three** reasons why mitosis is important to organisms.

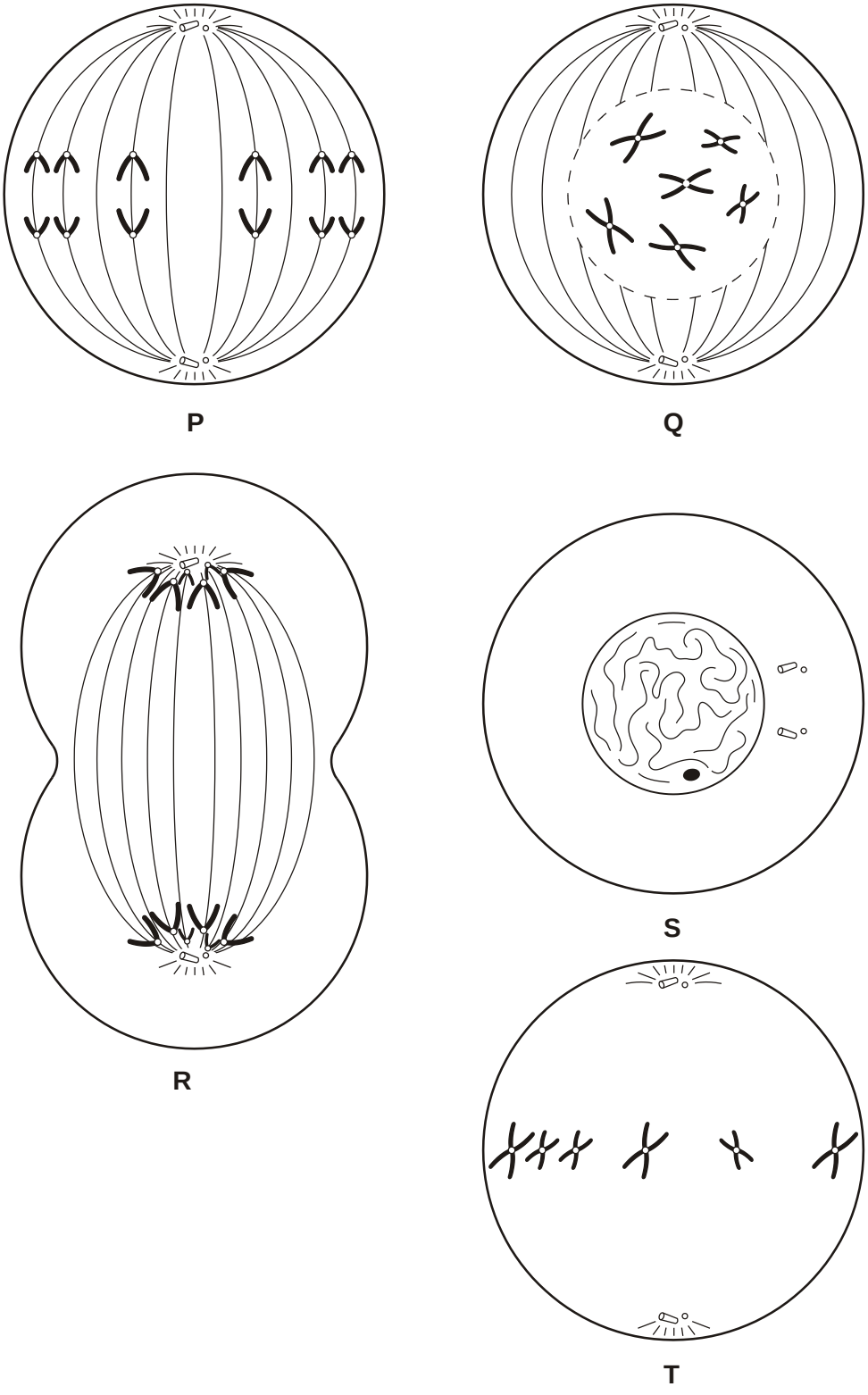
1 .....

2 .....

3 .....

[Total 3 marks]

3. The figure below shows some drawings of a cell during different stages of mitosis.



P

Q

R

S

T

Place stages **P**, **Q**, **R**, **S** and **T** in the correct sequence.

The first stage has been identified for you.

S

.....

[Total 4 marks]

4. Name the stage of mitotic cell division during which each of the following takes place.

(i) Nuclear envelope reforms.

.....

[1]

(ii) Chromosomes align at equator.

.....

[1]

(iii) Chromosomes become visible.

.....

[1]

(iv) Chromatids move towards the poles.

.....

[1]

(v) Spindle microtubules shorten.

.....

[1]

[Total 5 marks]

5. The figure below is a diagram of a mammalian sperm cell.

Explain how the structure of the sperm cell is specialised for carrying out its role.

.....

.....

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.....

.....

[Total 3 marks]