1.13 Cell Specialisation

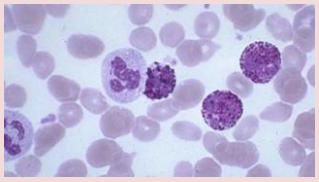
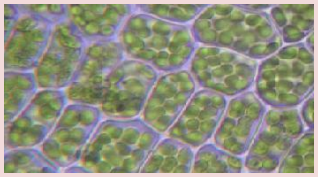
Stem cells and cell adaptations to particular functions

Cell Differentiation

A **stem cell** is a cell which is potentially capable of becoming any one cell which is found in the organism it belongs to. These cells are described as being **omnipotent** (all types), **totipotent** (any type), **pluripotent** (every type) and **multipotent** (many types) – all of these words mean the same thing basically.

Stem cells only occur in small numbers in adult animals. In humans, they can be found in bone marrow. The stem cells here can become any type of blood cell or bone cell needed. They can **differentiate** into different **specialised cells** by switching on or off certain genes. Cells can differ in size, shape and the number (or presence) of certain organelles. **Cell differentiation** is an irreversible process.

Specialised Cells

Cell	Structure	Function
Erythrocyte (red blood cell) 	Packed with haemoglobin (Hb)	Hb bind reversibly with oxygen to carry it around the body
	Biconcave disc (concave on both sides of the cell)	Provides an increased surface area for exchange; and makes it more flexible to pass through narrow capillaries
	No nucleus	Allows for more space for haemoglobin
Neutrophil (phagocyte) 	Granular cytoplasm due to many lysosomes	Allows the breakdown of ingested pathogens
	Lobed nucleus	Gives the cell greater flexibility to make movement easier
Sperm cell 	Undulipodium	Rapid undulation gives the cell propulsion for movement
	Acrosome (with hydrolytic enzymes)	Breaks down the outer coating of the egg cell
	Haploid cell (only has half the chromosomes of an adult)	Means that the full complement is restored after fusion with the egg
	Many mitochondria	Produce ATP for movement
Palisade cell 	Large numbers of chloroplasts	Capture a lot of sunlight for photosynthesis
	Chloroplasts circulate around cell	Minimalises the heat damage to organelles
	Tall, thin and long in shape	Means there are fewer cell walls for the sunlight to pass through
Root hair cell 	Long hair-like projection	Increases the cell surface area, allowing for a more rapid absorption rate of water

Erythrocytes (red blood cells) and **neutrophils** (phagocytes – a certain type of white blood cell) play very different roles, both are human cells and each began with the same set of chromosomes, so each is potentially capable of carrying out exactly the same function. All blood cells are produced from *undifferentiated* stem cells in bone marrow.

The cells destined to become erythrocytes lose their nucleus, mitochondria, Golgi body and rough ER. They become packed full of the protein haemoglobin (Hb) and their shapes change dramatically into biconcave discs.

Cells destined to become neutrophils keep their nucleus, and it becomes lobed (the picture to the right shows what a lobed nucleus looks like). Their cytoplasm appears granular due to the enormous numbers of lysosomes which are produced. These potent enzymes have a role in the blood, which is to kill invading pathogens, so these are specialised to attack all invading microorganisms.