### SOME COMMON TERMS EXPLAINED:

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Account</td>
<td>explain</td>
</tr>
<tr>
<td>Analyse</td>
<td>examine data mathematically to gain understanding of the data</td>
</tr>
<tr>
<td>Calculate</td>
<td>to find the answer using mathematics</td>
</tr>
<tr>
<td>Compare</td>
<td>give an account of similarities and difference between two factors</td>
</tr>
<tr>
<td>Construct</td>
<td>represent information in a graphical form</td>
</tr>
<tr>
<td>Deduce</td>
<td>reach a conclusion from the information given</td>
</tr>
<tr>
<td>Describe</td>
<td>give a detailed account including all relevant information</td>
</tr>
<tr>
<td>Design</td>
<td>produce a plan</td>
</tr>
<tr>
<td>Discuss</td>
<td>give an account including a range of arguments, assessment of the importance of various factors or a comparison of alternatives</td>
</tr>
<tr>
<td>Distinguish</td>
<td>give the difference between two or more different items</td>
</tr>
<tr>
<td>Draw</td>
<td>represent by means of pencil lines – include labels (unless told not to) - not to be confused with Draw a Conclusion</td>
</tr>
<tr>
<td>Estimate</td>
<td>find an approximate value</td>
</tr>
<tr>
<td>Evaluate</td>
<td>assess the limitations and implications</td>
</tr>
<tr>
<td>Explain</td>
<td>give a clear account including causes and reasons</td>
</tr>
<tr>
<td>List</td>
<td>give a sequence of names or brief answers</td>
</tr>
<tr>
<td>Identify</td>
<td>find an answer for a quantity</td>
</tr>
<tr>
<td>Measure</td>
<td>use a measuring instrument to find a value for a quantity. Always include the units of the number (value)</td>
</tr>
<tr>
<td>Outline</td>
<td>give a brief account or summary</td>
</tr>
<tr>
<td>Predict</td>
<td>give an expected result</td>
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</table>
Criterion 2: Design & evaluate experiments

Formulating a Hypothesis
Your hypothesis should
1. be feasible (i.e. be sensible and based on scientific concepts)
2. be a statement (not a question)
3. be based on observations
4. involve one independent and one dependent variable in a cause-and-effect relationship
5. be testable and measurable in a way that demonstrates cause and effect

Experimental Design
State the hypothesis to be tested (unless already stated)
1. State the independent variable and how it is manipulated
2. State the dependent variable and how it is measured
3. Describe the procedure clearly in a step-by-step fashion which could be easily followed in a laboratory or the field.
   a. Indicate sample sizes, quantities of materials and time involved Indicate how many replicas there are (if needed).
   b. Describe which variables are controlled and how. Say why fixed variables are needed. Include factors relevant for the organism – biotic and abiotic relevant in the environment.
   c. What is the control group in the experiment and why is it needed.
4. How are the results analysed.
5. Indicate any repetitions of the experiment

If required:
6. State what results would support the hypothesis and what results would not support the hypothesis
7. Discuss any foreseeable problems in conducting the experiment.
   a. variables difficult to control, sample size issues, ethical issues, animal vs human experimentation/environmental impacts etc.

Designing Experiments with Humans
Designing experiments with humans as subjects is not straightforward because there are a number of areas over which the experimenter has no control.

The impact of these unfixed/uncontrolled variables can be reduced by a number of factors including:

- use of placebos and double blind experiments/trials

Also ethical aspects need to be considered.

Trial experiments conducted in a confined situation (laboratory/greenhouse) need to precede field investigations.

Distinction between a few terms:

A replica is multiple identical groups within the one experiment.
A repeat is doing the experiment again at a future time.
A follow up experiment is one which builds on the original experiment in some way.
BIOLOGICAL MOLECULES

A. CARBOHYDRATES

- contain carbon, hydrogen, oxygen
- general formula: \( \text{CH}_2\text{O} \)
  - e.g. glucose = \( \text{C}_6\text{H}_{12}\text{O}_6 \)
- **main function** - energy source
- some used in growth/repair - to build new cell components etc.
- excess carbohydrates are stored in the body as:
  - starch (in plants)
  - glycogen (in animals) - in liver, muscles

**Types:**
(i) **Monosaccharides**
  - "single sugar" - e.g. glucose, fructose
  - 3 - 6 C atoms, small – can fit through pores in cell membrane.
  - soluble in water
(ii) **Disaccharides**
  - "double sugars" - e.g. sucrose (cane sugar), lactose (milk sugar)
  - too large to fit through cell membranes
(iii) **Polysaccharides**
  - "many sugars", large number (1,000’s) of monosaccharide (monomer) units joined together – form a polymer.
  - too large to fit through cell membranes
  - insoluble in water (mostly)
  - e.g. starch, glycogen, cellulose

B. PROTEINS

- contain carbon, hydrogen, oxygen and nitrogen (sometimes sulphur)
- large, complex
- are polymers - made up of a large number of individual units (monomers) called **amino acids (AA)**

  - **single AA** - (20 different types of AAs)
  - **dipeptide** - 2 amino acids joined
  - **polypeptide** - many amino acids
  - **protein** - one or more polypeptide chains, folded up to produce a specific shape

- different proteins have different AA sequences, and therefore fold up to produce different shapes.
- proteins in the diet need to be broken down (digested) into individual AAs so they can be absorbed into the blood. Inside cells (at the ribosomes) these AA’s are synthesised into new proteins.
- These proteins may be:
  - **structural proteins** – skin, muscles, hair
  - **specialised proteins** – have specific functions: e.g. haemoglobin – in red blood cells, enzymes, hormones (e.g. adrenalin, insulin), antibodies.

- **Main function of proteins** - to provide "building blocks"/raw materials for tissue growth, repair, function and metabolism.

- Need all 20 kinds of amino acids in order to make all the proteins needed by the body.
  - Of the 20 different AA’s, 9 (8 in adults and 1 extra in infants) AA’s are called **essential amino acids**. These must be included in the diet, as they cannot be made by the body.
  - If non-essential AA’s are missing in the diet, they can be made by the liver, from glucose and nitrogen-containing compounds.
- **Excess** amino acids cannot be stored in the body.

C. LIPIDS

- fats, oils
- contain carbon, hydrogen, oxygen (less O than C)
- consist of a **glycerol molecule** and usually 3 **fatty acid molecules**

- **Animal lipids** -contain saturated fatty acids.
- **Plant lipids** -contain unsaturated fatty acids.

- **Main function of lipids** – high energy source
  - (also used to build structural components - e.g. cell membranes)
D. NUCLEIC ACIDS

e.g. DNA (deoxyribonucleic acid)
RNA (ribonucleic acid)

CELL REACTIONS

(a) Decomposition /catabolic reactions
- Breaking large molecules into smaller ones
- produces/releases energy

(b) Synthesis /anabolic reactions
- Joining together small molecules to make larger ones
- Needs energy to occur

e.g. cell respiration

(b) ANAEROBIC RESPIRATION
- occurs without O₂
- occurs in cytoplasm

Overall Equation:
C₆H₁₂O₆ → ENERGY + 2C₃H₆O₃ - in animal cells
glucose     lactic acid

C₆H₁₂O₆ → ENERGY + 2C₂H₅OH + 2CO₂ - in plant & yeast cells
glucose     alcohol

When 1 molecule of glucose is anaerobically resired → 2 molecules of ATP

Brief pathway of glucose in cellular respiration

Glucose

Pyruvic acid (cytoplasm)

Acetyl Coenzyme A (mitochondria)

Carbon dioxide and water

Glycolysis takes place in cytoplasm

This reaction takes place in the mitochondria of cells, only if O₂ is present and releases large amounts of ATP
PHOTOSYNTHESIS (P/S)
an energy-storing process
- light energy is stored as “chemical” energy
  molecules of glucose

Overall Equation:
\[ 6 \text{CO}_2 + 6 \text{H}_2\text{O} \xrightarrow{\text{chlorophyll}} \text{C}_6\text{H}_{12}\text{O}_6 + 6 \text{O}_2 \]

Factors affecting the rate of photosynthesis
- Temperature
- Concentration of CO\(_2\)
- Light intensity
- Wavelength/colour of light

Compensation Point- the light intensity at which the rate of photosynthesis equals the rate of respiration.

Enzymes are proteins which speed up (catalyse) the chemical reactions which occur in organisms. They are “biological catalysts”.

Types of enzymes
Enzymes fall into two types of categories:
1) Intracellular enzymes: these occur inside cell and catalyse metabolic reactions
2) Extracellular enzymes: these occur outside cells and catalyse reactions involved in digestion

Enzymes are also classified according to the type of substance on which they act.

Coenzyme –a non-protein molecule that has to be present before an enzyme can stimulate its specific chemical reaction. The coenzyme takes part in the reaction and is changed by it. Examples include vitamins and ATP.

Cofactor – is a mineral ion of some kind that has to be present to help activate the enzyme. Cofactors influence reactions, but do not take part in them, nor are they changed. Examples include Mg\(^{2+}\) and K\(^+\).

Inhibitors – poisons such as heavy metals and insecticides can prevent enzymes functioning by slowing down or stopping enzyme action by competing for or changing the shape of the active site.

Factors affecting enzyme activity
- Concentration of substrate
- Sensitivity to temperature changes
- Sensitivity to pH environments
- Presence of cofactors and coenzymes are required by some enzymes
- Chemical energy in the form of ATP is required by a variety of enzymes before they can act.

PROTEIN SYNTHESIS
Process of making proteins in the cell

Transcription –the synthesis of a mRNA (messenger RNA) molecule from a template strand of DNA in the nucleus.

A tRNA (transfer RNA) molecule
Translation - involves the reading of the mRNA molecule by the ribosomes and the ordered sequential joining of the amino acids to form a protein.

Codon - A group of three nucleotides (or triplet) of DNA or RNA. A codon codes for a specific amino acid.

Anticodon - A sequence of three nucleotides on a molecule of tRNA that is complementary to the base sequence on a codon of mRNA.

Mutations – A change in the sequence of nucleotide bases of the genetic material (DNA or RNA)

Changes may be:
- spontaneous (no discernible reason) -
  "base" mutation rate = 1 gene in every 100,000 per generation

or
- induced - caused by mutagens (e.g. radiation, chemicals, high temperature)

Point (gene) mutation - a mutation in the nucleotide sequence of a gene in which only one base is altered.

bases may be: added (inserted)
              deleted
              substituted

Some of these changes may result in overall change to the protein being produced.
Criterion 6 – Cells

STRUCTURE

Organelles visible with a light microscope:
- Nucleus and nuclear membrane
- Nucleolus
- Cell membrane
- Chloroplasts
- Vacuoles

\[ \text{Length of cell} = \frac{\text{Field of View}}{\text{Number of times cell fits across}} \]

- Mitochondria – site of aerobic respiration
- Chloroplasts – site of photosynthesis
- Ribosomes – site of protein synthesis
- Nucleolus – make ribosomes
- Endoplasmic reticulum – transport system
- Golgi Body – refines and packages proteins
- Lysosomes – contain digestive enzymes
- Centriole – involved in cell reproduction
- Contractile vacuole-fills with water and empties periodically to the cell environment
- Cilium (plural: cilia)-used for locomotion or movement of liquid over cell surface
- Flagellum- also used for movement

EUKARYOTIC CELLS
- distinct nucleus surrounded by a membrane
- have organelles that are surrounded by a membrane (e.g. mitochondria, ER, lysosomes)
- e.g. cells of most plants and animals

PROKARYOTIC CELLS
- no definite nucleus – DNA spread through cytoplasm.
- no membrane-bound organelles
- eg bacteria, blue-green bacteria

VIRUSES, PRIONS AND PLASMIDS

Prions: A small protein based infectious disease-causing agent that is believed to be the smallest infectious particle. A prion is neither bacterial nor fungal nor viral and contains no genetic material. Prions have been held responsible for a number of degenerative brain diseases, including mad cow disease, Creutzfeldt-Jakob disease and others.

Viruses: Small, infectious agent that can only replicate within the cell of a living organism. Viruses include both protein and genetic material.

Plasmids: are short, usually circular, and double-stranded segment of DNA that is found in the cytoplasm separate from the main bacterial chromosome.

Plasmids usually contain between 5 and 100 genes that are not required for the survival of the bacteria. Plasmids have the ability to replicate, or copy, themselves.
**EXCHANGE OF MATERIALS**

**Diffusion** - movement of solute

**Osmosis** - movement of water from an area of lower concentration ("weak" solution) to an area of higher concentration ("strong" solution), through a semi-permeable membrane

**Active transport** - movement of solute from an area of lower concentration to any area of higher concentration with the use of energy

**Endocytosis** - movement of LARGE substances (too large to fit through pores in cell membrane) INTO a cell.
- e.g. phagocytosis – engulfing solid particles; pinocytosis – engulfing liquid droplets

**Exocytosis** - movement of LARGE substances OUT OF a cell.
- e.g. secretion of useful substances made in the cell (e.g. enzymes); excretion of wastes.

**Fluid mosaic model**

Membranes are composed of a Phospholipid Bilayer with various protein molecules floating around within it. The 'Fluid' part represents how some parts of the membrane can move around freely, if they are not attached to other parts of the cell. The 'mosaic' part illustrates the 'patchwork' of proteins that is found in the Phospholipid Bilayer.

**Isotonic** - the same concentration as ...

**Hypertonic** - more concentrated than ...
- e.g. seawater is hypertonic to freshwater.

**Hypotonic** - less concentrated than ...
- e.g. freshwater is hypotonic to seawater.

**Relative Sizes of Molecules**

The cell membrane has pores of a particular size to allow particles of certain sizes through.

The cell membrane is **semi-permeable**.

**Factors affecting the rate of diffusion**

- concentration gradient (conc. difference)
- temperature
- SA : Vol ratio
- medium of transport

**Adaptation to changing salinity**

Organisms that live in environments where the concentration changes (e.g. estuaries) respond to these changes in two main ways:

**Osmoconformers** - allow internal concentration to change

**Osmoregulators** - maintain a relatively constant internal environment
**Contractile vacuoles** can be used to maintain equilibrium in some protists.

**Plasmolysis** - contraction of cytoplasm of a plant cell as a result of osmosis out of the cell.

**Surface area: Volume ratio (SA : Vol ratio)**

Important for cell functioning. Relates to cell size and shape.

**CELL DIVISION**

There are two types of division:

**Mitosis** – process of cell division in which daughter cells are identical to parent cells. Process used in growth, repair and replacement of cells.

**Meiosis** – process of gamete (egg and sperm) production in most organisms. Gametes contain half the number of chromosomes as parent cells.

**Diploid 2n** - Full number of chromosomes in the nuclei

**Haploid n** - Half the number of chromosomes in the nuclei. Usually found in the gametes.
DIGESTION SYSTEM IN HUMANS

Cross section through villi

Gas exchange at the alveoli

Stages in acquisition of nutrients

RESPIRATORY SYSTEM IN HUMANS

TRANSPORT SYSTEM IN HUMANS
Components of blood

Plasma (55%)
- Water
- Dissolved substances
- Plasma proteins

Cells (45%)
- Red blood cells
- Lymphocytes
- Phagocytes
- Platelets
Fate of excess amino acids

- Carbohydrate → Energy, or stored as fat
- amino acids
- Ammonia → Urea → Uric acid

Comparison of nitrogenous waste products

<table>
<thead>
<tr>
<th></th>
<th>Ammonia</th>
<th>Urea</th>
<th>Uric acid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solubility</td>
<td>Soluble</td>
<td>Soluble</td>
<td>Insoluble</td>
</tr>
<tr>
<td>Toxicity</td>
<td>Toxic</td>
<td>Less toxic</td>
<td>Least toxic</td>
</tr>
<tr>
<td>Energy required for conversion</td>
<td>None</td>
<td>Some</td>
<td>Most energy demanding</td>
</tr>
</tbody>
</table>

HOMEOSTASIS

- Factor Increase
- Optimal status for factor
- Factor Norm
- Factor Decrease
- Corrective Response
- Receptors → Effectors
- message

Negative feedback – a change which reverses a particular trend

Positive feedback – a change in some variable triggers variables which amplify the change

Comparison of control systems

<table>
<thead>
<tr>
<th></th>
<th>Nervous</th>
<th>Endocrine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nature of message</td>
<td>Electrochemical impulses</td>
<td>Chemical compounds (hormones)</td>
</tr>
<tr>
<td>Route of message</td>
<td>Specific nerve cells</td>
<td>General blood system</td>
</tr>
<tr>
<td>Types of effects</td>
<td>Rapid, but usually short term</td>
<td>Usually slower, but generally longer lasting</td>
</tr>
</tbody>
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PLANT TRANSPORT SYSTEM

Transpiration – Movement of water up the xylem to the leaves where it is lost through the stomata by evaporation.

Translocation – the transfer of soluble food materials (eg sugars, vitamins etc) from the leaves where they are made by photosynthesis down and up through the phloem.

VASCULAR BUNDLES
- xylem and phloem tissue occur together and form vascular bundles.
- vascular bundles in leaves form veins → branch into finer units → no cell is far from a vascular bundle
- in herbaceous dicotyledons, vascular bundles are arranged around edge of stem/root (xylem is on inside)

Xylem vessels

Cell contents die, leaving an empty tube.

The cell walls of the cells wither away and water can pass from one cell to another.

The cell walls are toughened with lignin which is laid down in various patterns.
Phloem vessels

Sieve plate: the end wall of the sieve tube, so called because it has holes in it which allow sugars to pass from one cell to the next.

Sieve tube: made of a long line of cells joined end to end. Sieve tubes carry the sugar. The living cells which form them have thin cytoplasm and no nuclei.

Companion cells: have thick cytoplasm and large nuclei. They do not carry sugar, but are thought to help the sieve tubes to do so.

Surface view of stomata

Internal section of a leaf

Transpiration system

The path of water from soil across the root to the xylem and into the leaf

The path of water and particles from soil across the root
**Cohesion – adhesion, tension**

Describes the movement of water from roots to the leaves of a plant. Because of osmosis, water from soil reaches the xylem of roots of a plant. Water molecules are bonded to each other by hydrogen bonding, hence water forms a string of molecules during its movement through the xylem. The water molecules stick together and get pulled up by the force called tension. This force is exerted because of the evaporation at the surface of the leaf.

The theory is based on the following features:
- Cohesive and adhesive properties of water molecules to form an unbroken continuous water column in the xylem.
- Transpiration pull or tension exerted on this water column
Criterion 8: Continuity and survival of changes

ASEXUAL AND SEXUAL REPRODUCTION

Asexual reproduction - production of daughter cells (offspring) which are genetically identical to the parent cell.

Sexual reproduction - involves fertilization – the joining together of 2 gametes (sex cells – sperm and ovum) to produce a zygote.

Ovum + sperm → zygote

Fertilization requires moisture

- May be external (e.g. fish, frog) internal (e.g. mammals, birds) or
- May involve separate “male” and “female” individuals (cross fertilization) or
- “male” and “female” parts of the same individual (self-fertilization) [hermaphrodites – have both male and female reproductive organs – e.g. snails, earthworms → can self or cross-fertilize]

GENETICS

Gene – the basic unit of inheritance for a given characteristic

Allele – Alternate forms of the same gene responsible for determining contrasting characteristics (T or t)

Homozygous – individuals have identical alleles for a particular characteristic e.g. TT or tt

Heterozygous – individuals have different alleles for a particular characteristic e.g. Tt

Phenotype – The physical or chemical expression of a characteristic

Genotype – The genetic expression of a characteristic

Monohybrid cross – A cross where only one gene or characteristic is being considered

Dominant allele – If present, hides the effect of the recessive allele. E.g. T is dominant over t → a Tt individual will have the characteristic for which T is dominant

Recessive allele – Only expressed in the phenotype if no dominant allele is present e.g. must be tt to be dwarf

F1 generation - the generation produced by crossing two parental stocks.

F2 generation - the generation produced by crossing two F1 organisms

Incomplete (Partial) dominance – the condition where the alleles do not fully express themselves when in the heterozygous genotype and the offspring may be an “average” of the two characteristics

Co-dominance – the condition where both alleles express themselves in the heterozygous genotype. Usually expressed as CR CW

Pedigree – chart showing the family history of a particular condition

Types of chromosomes

Autosome – chromosome not associated with sex. In humans there are 22 autosomes

Sex – chromosome that determines the sex of an individual

Types of inheritance

- Autosomal Dominant

- Autosomal Recessive

- X-linked Dominant

- X-linked Recessive

Multiple alleles

A multiple allele is defined as the existence of two or more sets of alternative gene states where only two can be present in an individual.

For example multiple alleles determine human blood groups A, B, and O. A person can only have two of the three alleles I^A, I^B and i (where i is recessive)
**NATURAL SELECTION AND SPECIATION**

A **species** is a population of organisms that can potentially interbreed under natural conditions to provide fertile offspring.

An extension of the species concept is a **cline**. A cline is a gradual change in the structures among members of a species due to ecological or geographical distribution. E.g. in the Snow Gum the length of leaves is shorter at high altitude than at low altitude. Usually the trees next to each other are capable of interbreeding even though they look different and a common gene pool exists in the cline.

**Hybrids** are offspring produced from parents of different species. They are sterile (can’t reproduce). Examples include zebroids (zebra and horse), mules (donkey and horse)

**Speciation** begins when **gene flow** is prevented between populations of a species. Thereafter, mutation, natural selection, and genetic drift operate independently in each population and lead to irreversible genetic divergence of one from the other.

- Individuals remain members of the same species even if they are geographically isolated *provided* that gene flow still occurs.
- Gene flow is the physical movement of alleles into and out of a population. These alleles counter the differences in populations that may occur through mutation, natural selection and genetic drift.

To produce a new species, evolution must generate large enough genetic changes between populations so that mating cannot occur or the offspring produced are sterile.

**Isolating mechanisms:**

1. **Geographical Isolation**
   A single population is split into two separate populations by a physical barrier such as a river or mountain range. This prevents the organisms from mating and therefore each new population may develop large genetic differences and become separate species.

2. **Reproductive Isolation**
   - Behavioural Isolation – the mating rituals of many species stops interbreeding e.g. female frogs will only respond to the correct call of the male of their species.
   - Mechanical Incompatibility – the reproductive parts of the organism simply won’t “fit” together.
   - Seasonal Isolation – interbreeding cannot occur if mating happens at different times of the year.
   - Developmental Isolation – fertilisation may occur but the embryo does not survive.

**PATHOGENS AND DISEASE**

**Non-infectious diseases** - are not caused by pathogens and are not transmitted from one individual to another.

**Infectious diseases** - are caused by a pathogen or pathogenic agent that can be passed from one individual to another.

**Host** - the infected organism.

**Pathogen** – infectious agent that causes disease.

**Virulence** – the intensity of the effect of the pathogen.

**TYPES OF PATHOGENS**

**PATHOGENIC AGENTS**

- Prions
- Viruses

**PATHOGENIC ORGANISMS**

- Bacteria
- Fungi
- Protists
- Parasites
  - Endoparasites
  - Ectoparasites
PLANT DEFENCES

Mechanical - cuticle, leaf ‘hairs’, spines, thorns, prickles.

Chemical – toxins, antibacterial and antifungal agents.

TRANSMISSION OF DISEASES

- Direct contact
- Body fluids
- Food
- Water
- Air
- Vectors (living organisms)

NON-SPECIFIC IMMUNE RESPONSE

FIRST LINE OF DEFENCE

Barriers

Structural, chemical and biological features can act as barriers to pathogens as a first line of defence.

SECOND LINE OF DEFENCE

If a pathogen invades the body it will be dealt with by the host’s immune system.

CELLS & MOLECULES OF NON-SPECIFIC IMMUNE SYSTEM

Leukocytes – general term for all white blood cells (WBC’s) – all WBCs are produced in the bone marrow.

Phagocytes

- Neutrophils (granulated) – scavenger WBCs which circulate in the blood and are attracted to site of infection and involved in phagocytosis. After engulfing they die in large numbers to produce pus.
- Monocytes (not granulated) – macrophages that engulf and destroy bacteria.

Eosinophils (granulated) – contain powerful enzymes that can rupture the cell walls of pathogens.

NK cells – natural killer cells (type of lymphocyte). They patrol the body and mark cancer or cells infected with virus.

Basophils – participate in the expression of acute, chronic and allergic diseases, including anaphylaxis asthma and hay fever.

Dendritic cells - are antigen presenting cells. Their main function is to present antigens on their cell surface to T- cells of the specific immune system

Histamine – a chemical that is released from basophils and mast cells in response to injury. Can cause pain and swelling.

Cytokines – e.g. interferon. Released by macrophages and T lymphocytes. Stimulate other phagocytes to move to area of infection.

Complement proteins – they bind to the surface of pathogens thus signalling to phagocytes to engulf them. Promote inflammation and rupture cell membranes of pathogens.

Chemotaxis – movement of cells towards particular chemicals.

INFLAMMATION

Occurs when cells are killed or damaged by physical injury or invading pathogens.

LYMPHATIC SYSTEM

Is an extensive network of transparent lymph vessels and lymph nodes. It returns excess tissue fluid (lymph) to the circulation. Bacteria that is not destroyed by WBCs can enter the lymphatic system and then into lymph nodes.

Lymph nodes – range in size from 1 to 20mm and contain many macrophages which engulf bacteria as well as other foreign matter and debris. They act as filtering beds for bacteria.

Lymph – colourless or pale yellow fluid which contains lymphocytes.

Spleen

Filters blood and contains macrophages which destroy any foreign matter.
THIRD LINE OF DEFENCE

SPECIFIC IMMUNE RESPONSE

Cells can detect and distinguish between different types of pathogens and display memory.

If the pathogen overwhelms the macrophages and other WBCs then the humoral or cell mediated response is activated.

Antigens – a toxin or other foreign substance which induces an immune response in the body, especially the production of antibodies.

Antibodies

- Large protein molecules made up of four polypeptide chains arranged in the shape of a Y.
- Each antibody is specific to its antigen.

Antibody structure

HUMORAL IMMUNITY

Lymphocytes – specialised WBCs that respond to specific antigens. Each B and T lymphocyte only has one specific receptor on its surface.

B-lymphocytes - produced and mature in the bone marrow. Produce antibodies.

Plasma cells - type of B lymphocyte that produces antibodies.

B cell proliferation – B Lymphocytes divide and change function. Some become plasma B cells and others become memory B cells.

SELF vs NON-SELF

Genetically unique markers on the surface of plasma membranes of each cell identifies them as ‘self’ to the immune system. They are unique to each individual. All other cells without these markers are ‘non-self’ and treated as antigens.

CELL MEDIATED IMMUNITY

T-lymphocytes – produced in bone marrow but mature in the thymus. T cells do not secrete antibodies.

Cytotoxic T cells – produce chemicals cause death in foreign, infected and cancerous cells.

Helper T cell – release cytokines which activate B cells to produce antibodies.

Memory T cell - store the memory of past infections. Can be activated quickly when presented with the same antigen.

Regulatory T cells - suppress the action of phagocytes thus preventing the immune system from overreacting

PASSIVE OR ACTIVE IMMUNITY

NATURALLY AQUIRED IMMUNITY

Active – antigens enter body and promote antibody and memory B cell production.

Passive – antibodies passed from mother to baby. No memory cells produced in baby.

ARTIFICIALLY AQUIRED IMMUNITY

Active – antigens introduced via vaccines. Promote antibody and memory B cell production.

Passive – preformed antibodies in serum are injected into body. No memory cells produced.