Overview

Variation, Homeostasis & Micro-organisms

Classification & Biodiversity

Cell division & stem cells

DNA & Inheritance

Variation & Evolution

Response & Regulation

Role of kidneys in homeostasis – TRIPLE ONLY

Micro-organisms & their applications – TRIPLE ONLY

Disease, defence & treatment

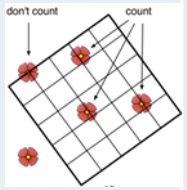
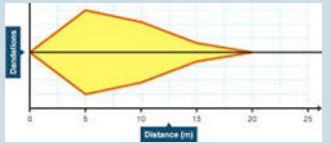
Triple Aspects

Maths Skills for Biology

Key Points to Learn

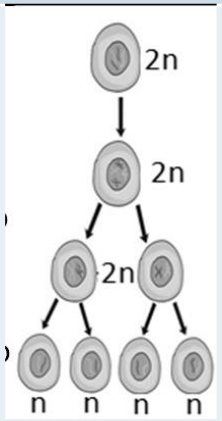
1. Classification	Putting living things into similar groups
2. Five Kingdoms	• Animal • Plant • Fungi • single-celled organisms (Protoctists) • Bacteria
3. The Animal kingdom	• Vertebrates – with a backbone • Invertebrates – without a backbone
4. The Plant kingdom	• Flowering plants • Non-flowering plants
5. Linnaean system	**K**ingdom; **P**hylum; **C**lass; **O**rder; **F**amily; **G**enus; **S**pecies **K**eeping **P**recious **C**reatures **O**rganised **F**or **G**rumpy **S**cientists
6. Binomial system	Uses the organism's genus and species to create its name. *Homo sapiens* ← In italics, Genus with capital letter, species with lower case
7. Adaptations	Features which make an organism better suited to its environment
8. Structural adaptations	Physical features eg fur, beak shape, foot size, sharp claws, thick blubber, big leaves, long roots, camouflage
9. Behavioural adaptations	Changes in behaviour to help survive eg migration, tools, pack hunting
10. Functional adaptations	Biological processes such as reproduction or metabolism eg giving birth to lots of young; hibernation; a chameleons adaptive camouflage
11. Competition	Animals compete for: 1. Light and space 2. Water 3. Mineral ions from soil Plants compete for: 1. Food 2. Mates – for reproduction 3. Territory

Key Points to Learn

12. Biodiversity	The variety of all different species in a particular ecosystem
13. Protecting endangered species	• Convention on International Trade in Endangered Species • Sites of Special Scientific Interest • captive breeding programmes • national parks • seed/ sperm banks • local biodiversity action plans
14. Population numbers	are constantly fluctuating due to: • competition for resources • predation • disease • pollution
15. Biological control	The control of a pest by the introduction of a natural enemy or predator.
16. Alien Species	Is a species introduced outside its normal distribution. Invasive alien species are alien species whose establishment and spread modify ecosystems, habitats, or species.
17. Quadrat 	Randomly chosen small area (often $1m^2$). Used to estimate total numbers E,g Total plants found in sample = $\frac{\text{total area } m^2}{\text{total sampled area } m^2}$
18. Line transect	A line along which you measure distribution of organisms using quadrats Kite graph  
19. Capture -recapture	Animals captured, counted, marked, release, recapture, count Number in sample 1 x number in sample 2 = estimate population Number in sample 2 already marked

Classification & Biodiversity

Key Points to Learn

1. Asexual reproduction	1. Only one parent 2. Cells divide by mitosis 3. Offspring are clones of parent
2. Sexual reproduction	1. Two parents 2. Fusing of male and female gametes which mixes genetic information from parents. 3. Variation between offspring
3. Gametes	Male and female sex cells: • Male: Sperm (animals) and pollen (plants) • Female: Egg (animals and plants)
4. Chromosome	Made of genes. Carry all genetic information on how to make organisms what they are. Humans have 23 pairs of chromosomes
5. Gene	Small section of DNA in a chromosome. Codes for a certain amino acid to make certain protein
6. DNA	Chemical that makes chromosomes Polymer made of two strands. Double helix shape 
7. **Mit**osis	One parent cell divides into two identical versions . **M**aking **i**dentical **t**wo. Used in growth/repair. Clones
8. Meiosis	Cell divides to make gametes (sex cells) 1. Copies genetic information 2. Cell divides into two each with full set of chromosomes 3. Two cells divide into four gametes - each with a half set of chromosomes 4. Gametes are genetically unique 

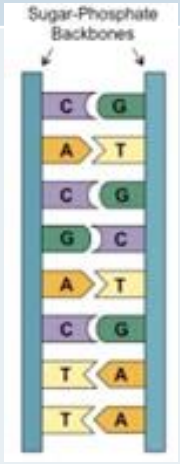
Key Points to Learn

9. Clone	Genetically identical
10. Cancer	Is the result of uncontrolled mitosis – forming a tumour
11. Cancer causes	Chemicals – carcinogens – damage DNA – mutations Lifestyle; UV; smoking; alcohol; diet
12. Stem cells	Cells in the early stages of the development of an embryo are known as stem cells Undifferentiated – not specialised yet Some adult cells are stem cells. Found in limited areas of: brain; eyes; blood; bone marrow; heart; liver; skin; muscle.
13. Uses of stem cells	Treat diseased/damaged tissue Using own stem cells prevents: • Tissue typing • Organ donors • Rejection
14. Diseases to treat	• type 1 diabetes • multiple sclerosis, which can lead to paralysis • spinal cord or brain injury, which have led to paralysis • blood cell cancer, eg leukaemia and lymphoma • when blood cells have been destroyed, eg during cancer treatment
15. Clinical issues	• No guarantee it will be successful • Difficulty in finding donors • Hard to obtain stem cells before birth just in case • Mutations likely/contamination
16. Ethical issues	• Use of embryos • Culturing embryos not to live but to treat • At what point is an embryo a person
17. Social Issues	• Do benefits outweigh risks • Private companies running – not checked thoroughly • Educating public important • Potential expensive – exploiting the ill and desperate

Cell division & stem cells

Key Points to Learn

1. DNA	Polymer made two long chains of alternating sugar and phosphate connected by bases. Double helix shape
2. Complementary base pairing	There are four different bases in DNA: • thymine, T • adenine, A • guanine, G • cytosine, C They always pair up in a particular way, called complementary base pairing: • thymine pairs with adenine (T–A) • guanine pairs with cytosine (G–C) The order that these bases are found in the genes determines the order of the amino acids they code for.
3. Allele	Single gene that controls one inherited characteristic e.g. eye colour
4. Triplet code	The sequence of every amino acid in a protein is determined by the triplet code, which is a code of three bases. Therefore each specific amino acid will have a triplet code of different bases.
5. Gamete	Male and female sex cells - Half chromosomes of normal cell
6. Chromosome	Humans have 23 pairs of chromosomes
7. Gene	A section of DNA in a chromosome. Codes for amino acid to make protein
8. Genotype	Allele version present e.g. BB, Bb or bb
9. Phenotype	Characteristic displayed e.g. blue eye. Most phenotypic features are the result of multiple genes rather than single gene inheritance
10. Dominant	Allele that wins if present e.g. B
11. Recessive	Allele that submits to dominant e.g. b
12. Heterozygous	Both alleles are identical e.g. BB or bb
13. Homozygous	Both alleles are different e.g. Bb
14. Selfing	Self-fertilization – extreme in-breeding



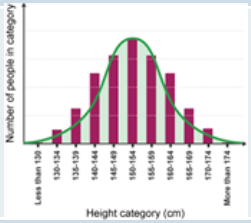
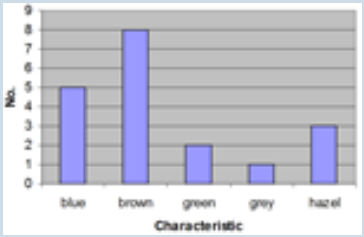
Key Points to Learn

15. F1 & F2	The offspring of two genetically distinct organisms, are referred to as F1. The offspring of two F1 parents is referred to as F2.
16. Monohybrid crosses	• Genetic crosses of **single gene** combinations • Using a Punnett square. • Possible offspring combinations that can be produced • Calculate the probability of these different combinations occurring. Ratio 3:1 75% dominant phenotype PP – homozygous dominant Pp – heterozygous pp – homozygous recessive
17. Gender	Females – XX. Males – XY. One pair of chromosomes – separate and pair randomly at fertilisation.
18. Zygote	Fertilised egg
19. Genetic profiling	Small part of DNA is specific to individual Profile can be made – used for paternity, criminal cases, checking species affinity • **Advantages**: reliable, solve crimes, identify genetic disorders early, classifying new species • **Disadvantages**: Insurance companies could exploit, privacy concerns, DNA could be planted at scene of crime
20. Genetic engineering	Involves taking genes from one organism and placing them into the genome of another • **Advantages:** genetic advantage, pest resistant crops, improved yield, climate resistant crops • **Disadvantages:** creation of super-weeds, affect on insects, large company domination of price, unknown effects from eating GM foods, less need to import from developing countries

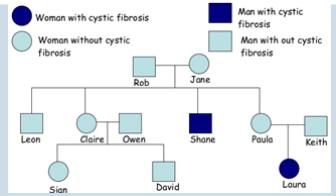
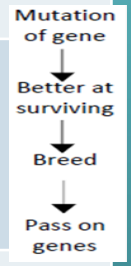
	P	p
P	PP	Pp
p	Pp	pp

DNA & Inheritance

Key Points to Learn

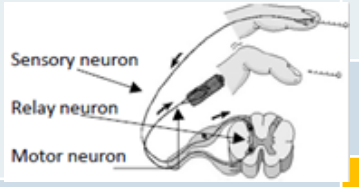
1. Variation	Differences between individuals in a species. Caused by combination of genes and environment **Genetic:** Eye colour, hair colour, freckles, blood group, gender **Environment**: Scars, tattoos, piercings, language
2. Continuous variation	A characteristic that changes gradually over a range of values shows continuous variation • Height, hand span, shoe size • Bell shaped curve • Strongly affected by environment 
3. Discontinuous variation	A characteristic of any species with only a limited number of possible values shows discontinuous variation. • Eye colour, blood group • Distinct categories • Unaffected by environment 
4. Reproduction	• Sexual – 2 parents, variety of offspring, mixing of genes – gives rise to variation • Asexual – 1 parent, clones, no change of gene
5. Mutations	Changes in DNA code. Occur continuously Responsible for all different phenotypes Can be inherited **Causes:** • Spontaneous • Chemical mutagens – tar in cigarettes • Ionising radiation – greater the dose – greater the effect
6. Effects of Mutation	**Some can be beneficial:** • Sickle cell disease carriers – resistant to malaria **Others harmful:** • Cancer • Genetic disease – cystic fibrosis **Some can be neutral** • Protein that a mutated gene produces may work just as well.

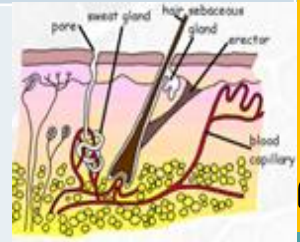
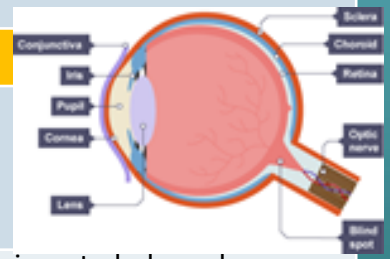
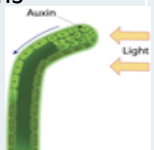
Key Points to Learn

7. Cystic Fibrosis	Inherited mutation Affects mucus production Lungs and pancreas Recessive allele Can be tracked using family trees 
8. Gene therapy	Inserting copies of a normal allele into the chromosomes of an individual who carries the faulty cystic fibrosis allele. It is not always successful, and research is continuing. • cutting out the normal allele – special enzymes are used to do this • making many copies of the allele • putting copies of the normal allele into the cells of a person who has the disorder
9. Evolution	Change in inherited characteristics over time due to natural selection Individual organisms in a particular species may show a wide range of variation because of differences in their genes (heritable variation).
10. Alfred Russel Wallace	• Known for independently conceiving the theory of evolution through natural selection; • genes which have enabled these better adapted individuals to survive are then passed on to the next generation
11. Darwin's Theory of evolution - natural selection	All living things evolved from simple life forms over 3 billion years ago 1. Different phenotypes in species 2. Some phenotypes are better suited to environment 3. Individuals with better suited phenotypes survive and breed 4. Successful phenotypes are passed on to next generation 
12. Ongoing evolution	• Antibiotic resistant bacteria – MRSA • Warfarin resistant rats • Speciation • Extinction
13. Using the Human Genome	1. Search for genes related to certain diseases 2. Treating inherited disorders 3. Study human migration patterns

Variation & Evolution

Key Points to Learn

1. Sense organs	Detect changes known as **stimuli**. The sense organs contain cells called **receptor cells** which produce electrical impulses in response to stimuli: **Skin** Temperature, pressure and pain **Tongue** Chemical tastes (in food and drink) **Nose** Chemical smells (in the air) **Eye** Light **Ear** Sound
2. Receptor cells	Relay information as electrical impulses along **neurones** to the central nervous system
3. CNS	Central Nervous System : Brain, spinal cord & nerves
4. Neurone	Specialised cell that carries electrical impulse in nervous system
5. Reflex actions	• Automatic, rapid actions that do not use conscious part of brain. • Safety mechanism for our body • E.g. Blinking, jumping at loud sounds
6. Reflex arc	The sequence in a reflex action e.g. tasting something sour: 1, Stimulus – hot surface 2. Receptor – temperature sensor in finger 3. Sensory neuron – carries impulse to coordinator 4. Relay neuron in Coordinator – spinal cord 5. Motor neuron – carries impulse to effector 6. Effector – muscle in wrist 7. Response – muscle contracts – move hand 
7. Synapse	Gap between two neurones.
8. Muscle	Tissue that can contract or relax to cause movement
9. Homeostasis	Automatic control of conditions inside a cell or organism so that enzymes and cells work effectively • In the human body it controls: 1. Blood glucose concentration 2. Body temperature 3. Water levels • Uses receptors, coordination centres and effectors

10. Hormones	Chemical messages in the body, carried by blood
11. Pancreas	• Monitors and controls blood glucose levels • Releases insulin hormone if blood glucose concentration too high • Releases glucagon if blood glucose concentration too low
12. Insulin	Causes cells to take glucose from blood. Liver and muscle cells store as glycogen
13. Glucagon	Converts glycogen into glucose. Interacts with insulin in negative feedback cycle to control glucose
14. Diabetes	**Type 1:** Pancreas does not produce enough insulin when glucose concentration too high. Needs insulin injections **Type 2**: Body no longer responds to insulin. Controlled by diet and exercise Obesity a risk factor for this diabetes
15. Skin	The skin has structures that help regulate temperature **Too Hot**: Sweat; hair lies flat. Blood vessels dilate **Too Cold**: Shiver; hair raised to trap air. Blood vessels contract 
16. Negative feedback	Corrective mechanisms: If the level of something rises, control systems reduce it again and vice versa
	Triple Only
17. The Eye	The structure and function of: sclera, cornea, pupil, iris, lens, choroid, retina, blind spot and optic nerve 
18. Plant tropisms	 Plants developed responses called tropisms to help make sure they grow towards sources of light and water. Positive tropism is when a plant grows towards the stimulus. Negative= away Auxin – plant hormone. In shoots and roots. Phototropism – response to light. Gravitropism – to gravity

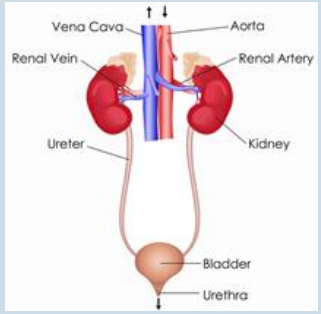
Response & regulation

Key Points to Learn

1. Excretory System

Excretion: process by which waste products of metabolism and other non useful materials are from an organism.

1. Kidney
2. Ureters
3. Urethra
4. Rental artery
5. Renal veins

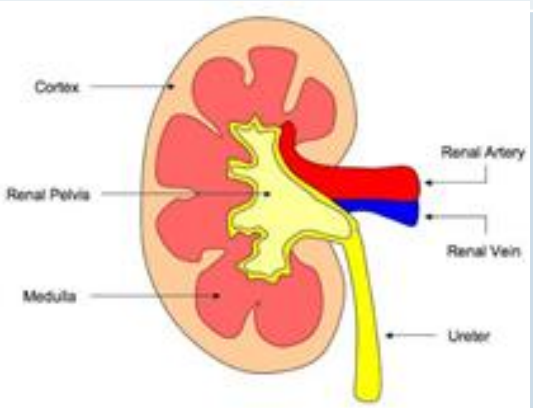


2. Kidneys

Two important functions in the body: Regulate water & excrete toxic waste products of metabolism

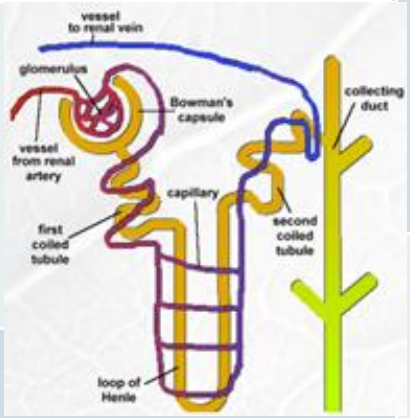
3. Structure of Kidneys

The inner part of the kidney called the medulla and part is the cortex.



4. Nephrons

Nephrons start in the cortex of the kidney loop down into the medulla and back cortex.
The nephron regulates the level of water, and salts and removes urea the blood.



5. Bowman's capsule

- High pressure in the capillary knot
- Causes **ultrafiltration:** water, salts, small molecules pass out and into the Bowman's capsule
- Proteins and blood cells are too big to leave
- Then selective reabsorption of glucose, some salts & most water.

Key Points to Learn

6. Blood in the Kidney

Blood entering the kidney	**Blood leaving the kidney**
High in urea	No urea
High in oxygen	Low in oxygen
No CO_2	High CO_2
High level glucose	Lower level glucose

7. Urine

A waste solution containing urea and salts
Stored in the bladder

8. Kidney disease

Testing urine can diagnose some diseases
Too much glucose can indicate diabetes
Protein or blood in urine can indicate kidney disease – protein should be too big to pass into nephron.

9. Anti-diuretic hormone (ADH)

Released by gland in brain that monitors concentration of plasma contents.

- excess drinking (increases water content)
- excess sweating (decreases water content)
- consumption of salty foods (decreases water content)

ADH increase prevents water loss and vice versa
Urine can become more dilute or concentrated depending on ADH level
An example of **negative feedback system**.

10. Kidney Dialysis

Mechanical way to clean blood
Blood enters semipermeable membrane and excess salts move into dialysis fluid
Dialysis fluid has same glucose and salts concentration as healthy blood
Clean blood returns to body.

Advantages	Disadvantages
Keeps patient alive	Expensive
No major surgery	Need to follow strict diet
	Only works for limited time

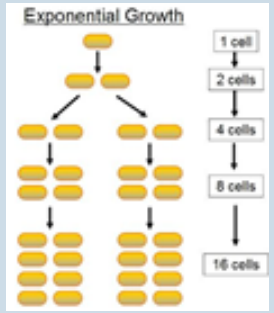
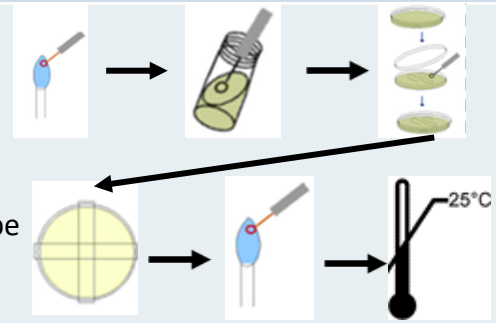
11. Kidney Transplant

Replacing one kidney
Patient can function on just one
Donor kidney transplanted close to bladder
Can use living donors – family close tissue types

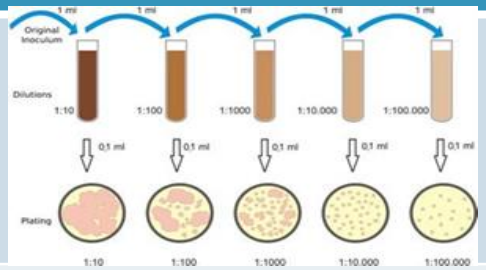
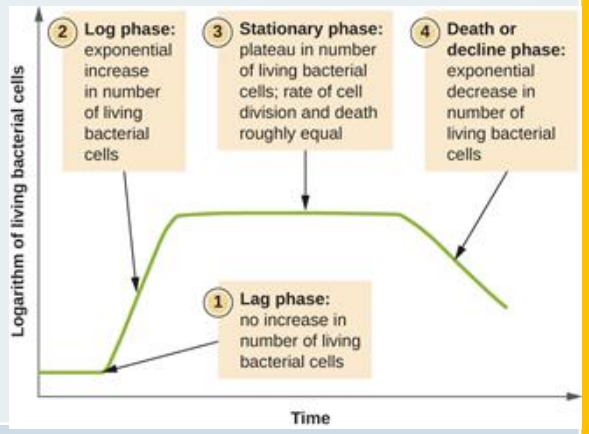
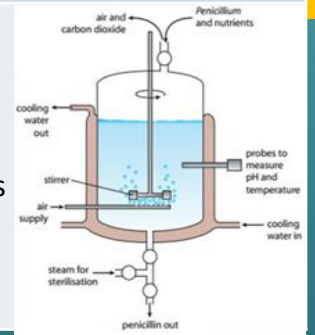
Advantages	Disadvantages
Long term cure	Shortage of donors
No more diet resrictions	Major surgery
No more dialysis	On life long immunosuppressants
	Risk of rejection

Role of kidneys in homeostasis – TRIPLE ONLY

Key Points to Learn

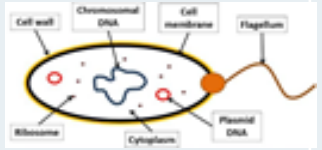
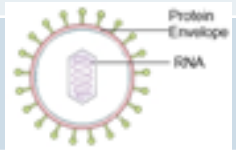
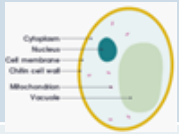
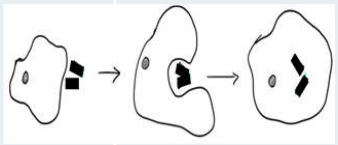
1. Bacterial growth	Bacteria can replicate approximately every 20 minutes by binary fission, which is a simple form of cell division. This level of replication will depend on the availability of nutrients and other suitable conditions, such as temperature Exponential Growth. 
2. Culture bacteria	Two ways: • nutrient broth solution • colonies on an agar plate
3. Agar plates	Are created by pouring hot molten agar into sterile petri dishes, which is then allowed to set. Bacteria can be spread onto the plates, and allowed to form individual colonies of the specific bacterium. Important that any petri dish or agar used is sterilised before use, and that aseptic techniques are used to inoculate the plates.
4. Aseptic technique	• Heat inoculating loop • Allow to cool before collecting sample • Streak onto plate • Close plate lid • Seal petri dish with tape • Re heat loop to clean • Incubate at 25°C 
5. Colonies of bacteria	Individual bacteria cells cannot be seen without a microscope. When grown on agar in a Petri dish, each individual cell divides multiple times to form a visible colony. If we count the number of individual colonies of bacteria on the plates, it is possible to estimate the numbers of individual bacteria in the original sample.

Key Points to Learn

6. Serial Dilutions	To estimate accurately, the original sample must be diluted When dilute, individual colonies can be grown 
7. Growth Phases	1. Lag phase – bacteria adapt to conditions and synthesis RNA 2. Log Phase – bacteria grow very rapidly- exponential growth 3. Stationary phase – growth and death are equal as nutrients run out 4. Death phase – bacteria die due to lack of nutrients 
8. Effect of temperature	The rate at which bacteria divide can be reduced by reducing the temperature. • Keeping food in the refrigerator slows bacterial growth and food can be kept for longer before spoiling. • If food is frozen, then bacterial growth stops. However, the bacteria are not killed, so any increase in temperature would increase bacterial growth. • Cooking food at a very high temperature will kill bacteria.
9. Industrial uses - Fermenters	Fermenters are containers used to grow bacteria and fungi in large amounts, eg Penicillium mould. It is grown in a liquid culture containing sugar and other nutrients including a source of nitrogen. As the mould grows, it uses up the sugar and starts to make penicillin only after using up most of the nutrients for growth. After 200 hours it can be tapped off. 

Micro-organisms & their application – TRIPLE ONLY

Key Points to Learn

1. Micro-organisms	Most micro-organisms cause no harm, some are essential. Found everywhere.**Pathogens** are micro-organisms that cause harm.
2. Bacteria 	Single Celled **All have**: no nucleus; cell wall; cell membrane; cytoplasm; DNA; no mitochondria; divide by binary fission **Some have:** slime capsule; pilli to attach or flagella to move **Pathogens:** Salmonella, cholera
3. Virus 	Not considered alive Made up of DNA/RNA in a protein coat **Pathogens**: Common cold, Covid-19; Measles
4. Protists	Eukaryotic; have a nucleus; most have mitochondria **Pathogens:** CJD (mad cow disease), malaria
5. Fungi 	Have a cell wall made of chitin Can be multi or single cellular **Pathogens**: Athletes foot
6. Communicable diseases	Can be spread from person to person by: contact, aerosol, body fluids, water, vectors (animals/insects),food
7. Defences	**Skin** – forms a barrier **Nose** – mucus to trap micro-organisms **Bronchi** - tubes in lungs produce mucus to trap **Stomach** – acid to kill bugs **Blood** – clots to seal wounds **Immune system** – phagocytes engulf micro-organisms & lymphocytes produce antibodies & antitoxins
8. White blood cells 	1. Phagocytosis Ingest microbes 2. Produce antibodies chemicals to destroy microbes  3. Produce antitoxins chemicals to cancel-out toxins made by pathogens 

Key Points to Learn

9. Vaccinations	• An inactive form of a pathogen used to prepare your immune system – stimulate lymphocytes • White blood cells are able to respond quickly to prevent infection • MMR is a vaccine against mumps, measles and rubella
10. How vaccines help	Protect from disease Not compulsory Some people against vaccines – know reasons why
11. Immunity	The immune response is slow if first encounter with pathogen. Vaccine or natural infection leave memory cells that can respond very quickly to produce antibodies if encounter again.
12. Antibiotics	Medicines that kill specific bacteria. Greatly reduced deaths from bacterial diseases Cannot kill viruses
13. Resistance	Some bacteria are becoming resistant which is very concerning Over prescribing, fed to animals MRSA – hygiene in hospital, washing, sanitizer can help.
14. Prevention & treatments	Good hygiene; antibiotics, healthy diet, clean water and vaccinations
15. Making new medicines	Need to be checked for toxicity, effectiveness and dose First trials are done using cells, tissues and live animals Clinical trials use healthy volunteers and patient: 1. Very low doses at start of trial 2. If safe, more trials done 3. In double blind trial some patients given placebo(no drug)
16. monoclonal antibodies	Identical copies of one type of antibody. B-lymphocytes are fused with tumour cells forming a hybridoma - this divides rapidly in laboratory conditions to form a clone. The hybridoma continuously produces specific antibodies called monoclonal antibodies.
17. Uses	Treatment of cancer. Some cancer has tumour markers, monoclonal antibodies can be used to take treatment to the tumour or encourage immune system to attack cancer directly. Used in immunoassays.

Disease, defence & treatment

Key Points to Learn

Disease, defence & treatment – TRIPLE ASPECTS

1. HIV / AIDS	AIDS (Acquired Immune Deficency Syndrome) is caused by HIV (Human Immunodeficiency Virus). HIV specifically targets CD4 cells (type of lymphocyte), the body's principal defenders against infection, using them to make copies of themselves. Without immunity, the body can become infected with a variety of micro-organisms, e.g. tuberculosis or pneumonia. The virus is spread by blood to blood contact, especially during sexual intercourse. Methods of prevention include the use of condoms and disposable gloves should be used where there is any danger of contact with contaminated blood. Antiretroviral drugs target specific stages of the 'HIV lifecycle' to stop HIV from replicating. Antiviral agents can be used, but they only prevent the multiplication of the virus inside cells and must be taken throughout life.
2. Chlamydia	The most common sexually transmitted disease in Britain. It is caused by the bacterium *Chlamydia trachmatis* and is spread during sexual intercourse via the vagina and urethra. Its spread can be prevented by the use of condoms. It is symptomless for the majority of people. It can be treated with antibiotics such as tetracycline or erythromycin. However, if left untreated, it could cause infertility in adults. It could also cause conjunctivitis in babies during the process of birth if the mother is infected. It can also spread to the babies lungs.
3. Malaria 	Spread by female mosquitoes which carry the *Plasmodium* protist. When a mosquito bites an infected person, a small amount of blood is taken in which contains microscopic malaria parasites. About 1 week later, when the mosquito takes its next blood meal, these parasites mix with the mosquito's saliva and are injected into the person being bitten. As malaria parasites are carried by red blood cells they can be passed from mother to baby, by sharing needles and blood transfusion. It is not spread from person to person like the flu. The symptoms of malaria include fever, sweats and chills, headache, vomiting and diarrhoea. The only way to diagnose it is with a blood test and by looking for what looks like an engagement ring inside a red blood cell. Of the 200 million people infected each year, up to half die from the disease. Infection can only be prevented by stopping individuals from being bitten. People sleep under mosquito nets and wear insect repellent to avoid bites. Anti-malarial drugs are also taken, which treat the symptoms and can prevent infection.

Maths Skills

Quadrat population estimate

$$\text{Total grass plants found in sample} \times \frac{\text{Total area } (m^2)}{\text{Total area sampled } (m^2)}$$

Capture – recapture calculation

$$\text{To estimate population} = \frac{\text{Number in sample 1 x number in sample 2}}{\text{Number in sample 2 already marked}}$$

Calculating nerve impulse speed

$$\text{Speed m/s} = \frac{\text{distance m}}{\text{Time s}}$$

Use scatter diagrams to identify correlation between factors.

Using samples to estimate population trends

Find the mean, mode and median for a set of data

eg. 1, 2, 3, 4, 5, 5, 6

- Mean = (1+2+3+4+5+5+6) ÷ 7 = **3.7** (2sf)
- Median (middle number) = **4**
  Mode (most common number) = **5**

Standard Form

In standard form, a number is always written as:

$A \times 10^{n}$

A is always between 1 and 10.

n tells us how many places to move the decimal point.

15 000 000 would be 1.5×10^{7}

Move your decimal point to the LEFT is a POSITIVE number

$0.000467 = 4.67 \times 10^{-4}$

Move your decimal point to the RIGHT is a NEGATIVE number

Adding and subtracting numbers in standard index form

Convert them into ordinary numbers, do the calculation, then change them back if you want the answer in standard form.

$4.5 \times 10^4 + 6.45 \times 10^5$

$= 45{,}000 + 645{,}000$

$= 690{,}000$

$= 6.9 \times 10^5$

Multiplying and dividing numbers in standard form:

Here you can use the rules for multiplying and dividing powers. Remember these rules:

To multiply powers you add, eg, $10^5 \times 10^3 = 10^8$

To divide powers you subtract, eg, $10^5 \div 10^3 = 10^2$