IGCSE Biology (0610) Practical Opportunities

Opportunities for Practical Activities	
Syllabus reference	Practical Activity
Section1: characteristics and classification of living organisms (5% teaching time)	
1. Characteristics of living organisms **Core** • List and describe the characteristics of living organisms • Define the terms: *nutrition; excretion; respiration; sensitivity; reproduction; growth; movement*	Paper cards to match terms and definitions. Posters. Use of letters MRS GREN to remember terms
2.1 Concept and use of a classificatory system **Core** • Define and describe the *binomial system* of naming species as a system in which the scientific name of an organism is made up of two parts showing the genus and species • List the main features of the following vertebrates: bony fish, amphibians, reptiles, birds and mammals **Supplement** • Know that there are other classification systems e.g. cladistics (based on RNA/ DNA sequencing data) • List the main features used in the classification of the following groups: viruses, bacteria and fungi, and their adaptation to the environment, as appropriate	Quick check – right or wrong cards. Cards of animals - vertebrate photographs. Visit to local zoo or nature reserve. Show examples of spoiled fruit, leaves Posters. size / measurement exercise from photomicrographs

Syllabus reference	Practical Activity
2.2 Adaptations of organisms to their environment **Core** • List the main features used in the classification of the following groups: flowering plants (monocotyledons and eudicotyledons (dicotyledons)), arthropods (insects, crustaceans, arachnids and myriapods), annelids, nematodes and molluscs	Identification of local plants which are available – living specimens. Quiz to identify and classify animals from preserved and /or specimens or illustrations
3. Simple keys **Core** Use simple dichotomous keys based on easily identifiable features	Specimens of leaves or shells to prepare a simple key and to practise using keys from past exam papers.

Syllabus reference	Practical Activity
Section 11: Organisation and maintenance of the organism. (50% teaching time)	
1. Cell structure and organisation **Core** • State that living organisms are made of cells • Identify and describe the structure of a plant cell (palisade cell) and an animal cell (liver cell), as seen under a light microscope • Describe the differences in structure between typical animal and plant cells **Supplement** • Relate the structures seen under the light microscope in the plant cell and in the animal cell to their functions	Posters; if possible use of microscope or bioviewers to look at palisade cells, liver cells. Photomicrographs. Websites eg www.cellsalive.com. Paper cards to match structure and function. Drawings of organelles for posters.

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2. Levels of organisation **Core** • Relate the structure of the following to their functions: o ciliated cells – in respiratory tract o root hair cells – absorption o xylem vessels – conduction and support o muscle cells – contraction o red blood cells – transport • Define: *tissue; organ; organ system.*	Use of posters; images from websites; bioviewers, use of light microscope to view specimens.
3. Size of specimens **Core** • Calculate magnification and size of biological specimens using millimetres as units	Opportunity in previous section to practice calculating magnification and to be aware of size of cells and measurement in millimetres. To be aware that some illustrations may be reduced in size. Triangular diagram D/A/M; magnification = $\frac{\text{drawing size}}{\text{actual size}}$ use of 'x' for times without unit

Syllabus reference	Practical Activity
4. Movement in and out of cells 4.1 Diffusion **Core** • Define *diffusion.* • Describe the importance of diffusion of gases and solutes and of water as a solvent	Diffusion of alkaline [ammonia] or acidic gases along closed glass tubes using appropriate coloured litmus paper. Diffusion of coloured liquids – in gel / agar. Potassium permanganate crystals dissolving in water.
4.2 Active Transport **Supplement** • Define *active transport.* • Discuss the importance of active transport.	
4.3 Osmosis **Core** • Define *osmosis.* • Describe the importance of osmosis in the uptake of water by plants, and its effects on plant and animal tissues **Supplement** • Describe and explain the importance of a water potential gradient in the uptake of water by plants	[1] Plant tissue eg potato or other tissue – in salt / sugar solutions of different concentration – measure mass or length of pieces; [2] Destruction of membranes by leakage of coloured plant sap eg beetroot sections**.** Observe plasmolysis in red onion cells if microscope available or on video. Use of visking tubing to represent cell membrane.

Syllabus reference	Practical Activity
5. Enzymes **Core** • Define the term *catalyst.* • Define *enzymes* as proteins that function as biological catalysts • Investigate and describe the effect of changes in temperature and pH on enzyme activity **Supplement** • Explain enzyme action in terms of the 'lock and key' model • Explain the effect of changes in temperature and pH on enzyme activity • Describe the role of enzymes in the germination of seeds, and their uses in biological washing products and in the food industry (including pectinase and fruit juice) • Outline the use of microorganisms and fermenters to manufacture the antibiotic penicillin and enzymes for use in biological washing powders • Describe the role of the fungus *Penicillium* in the production of antibiotic penicillin	Use of cardboard models – jigsaw pieces to fit together. Experimental investigation on [i] temperature; [ii] pH using buffers on catalase [from fresh plant of animal tissue] / amylase [diastase] / protease eg trypsin / lipase/ rennin / pectinase / or other available enzyme. Provide a set of results to work on if short of time. Important that planning of an enzyme investigation is carried out so how to control variables and safety factors are fully realised. Practical – germination of seeds – showing activity of enzymes from seeds breaking down starch in agar plates; or extracting enzymes from cotyledons and breaking down starch in solutions; Pectinase on fruit pulp and filtering juice + and – enzyme; Washing powder activity on protein stains eg egg yolk [care needed] Large flasks can be used to show simple laboratory fermenters.

Syllabus reference	Practical Activity
6. Nutrition 6.1 Nutrients **Core** • List the chemical elements that make up: o carbohydrates o fats o proteins • Describe the synthesis of large molecules from smaller basic units o simple sugars to starch and glycogen o amino acids to proteins o fatty acids and glycerol to fats and oils • Describe tests for: o starch (iodine solution) o reducing sugars (Benedict's solution) o protein (biuret test) o fats (ethanol) • List the principal sources of, and describe the importance of: carbohydrates; fats; proteins; vitamins (C and D only); mineral salts	Making molecular models; link up to make polymers Posters giving examples of common foods To carry out the tests on pure substances and on different foods. It is important to be able to prepare the crushed or extracted food materials for comparative testing. Stress safety aspects of handling the reagents. Explain use of 'dip' sticks – Clinistix and Albustix. – used in health clinic testing of urine. Estimation of vitamin C with coloured solutions eg DCPIP – compare ascorbic acid with fruit juices. Prepare yoghurt using a starter obtained commercially. Collect food labels. Discuss purpose of labelling. Discuss hazards – details on labels re nut allergy, phenylalanine, etc To separate by water chromatography the different component colours in common food colourings

(calcium and iron only); fibre (roughage); water. • Describe the deficiency symptoms for: o vitamins (C and D only) o mineral salts (calcium and iron only **Supplement** • Describe the use of microorganisms in the food industry, with reference to yoghurt and single cell protein • Describe the uses, benefits and health hazards associated with food additives, including colourings	

Syllabus reference	Practical Activity
6.2 Plant nutrition 6.2.1 Photosynthesis **Core** • Define *photosynthesis* as the fundamental process by which plants manufacture carbohydrates from raw materials using energy from light • State the word equation for the production of simple sugars and oxygen • Investigate the necessity for chlorophyll, light and carbon dioxide for photosynthesis, using appropriate controls • Describe the intake of carbon dioxide and water by plants • Explain that chlorophyll traps light energy and converts it into chemical energy for the formation of carbohydrates and their subsequent storage **Supplement** • State the balanced equation for photosynthesis in symbols • Investigate and state the effect of varying light intensity, carbon dioxide concentration and temperature on the rate of photosynthesis (e.g. in submerged aquatic plants) • Define the term *limiting* factor.	To use a simple apparatus eg inverted filter funnel to demonstrate and collect oxygen bubbles from water weed. Modify to show effect of colour of light using celluloid filters; the intensity by moving a lamp closer and a heat shield; carbon dioxide by adding salts to water. To carry out a starch test on a leaf using a green leaf and a variegated leaf. Keep the leaf in the dark for 12 hours to destarch. To find the effect of lack of light on formation of starch by masking an area. Use of hydrogencarbonate indicator – observe change from red to purple by photosynthesising plant. Opportunity to visit local plant nursery.

• Explain the concept of limiting factors in photosynthesis • Explain the use of carbon dioxide enrichment, optimum light and optimum temperatures in glasshouse systems	
6.2.2 Leaf structure **Core** • Identify and label the cuticle, cellular and tissue structure of a dicotyledonous leaf, as seen in cross-section under the light microscope, and describe the significance of these features in terms of functions, to include: o distribution of chloroplasts – photosynthesis o stomata and mesophyll cells – gas exchange o vascular bundles (xylem and phloem) – transport and support	. To prepare surface views of epidermis to show distribution of stomata – stomatal index. Use of bioviewers or microscopes to observe sections of leaves Look at images on web sites or books. Posters

Syllabus reference	Practical Activity

6.2.3 Mineral requirements
 	
Core
 	
• Describe the importance of:
  o nitrate ions for protein synthesis
  o magnesium ions for chlorophyll synthesis
• Describe the uses, and the dangers of overuse, of nitrogen fertilisers
 	
Supplement
 	
• Explain the effects of nitrate ion and magnesium ion deficiency on plant growth
	Set up a simple mineral nutrition experiment with controls to grow cereal seedlings for a few weeks

6.3 Animal nutrition	
6.3.1 Diet **Core** • State what is meant by the term balanced diet and describe a balanced diet related to age, sex and activity of an individual • Describe the effects of malnutrition in relation to starvation, coronary heart disease, constipation and obesity	Energy content of food.- simple calorimetry. Compare with calorimeter illustration. Poster work. Refer to certain case studies re malnutrition. Compare energy content of different foods. Data can be found on food labels.

Syllabus reference	Practical Activity
6.3.2 Food supply **Core** • Discuss ways in which the use of modern technology has resulted in increased food production. **Supplement** • Discuss the problems of world food supplies • Discuss the problems which contribute to famine.	Map source of food available in area and mark on world map. Refer to air miles.
6.3.3 Human alimentary canal **Core** • Define *ingestion.* • Define *egestion*. • Identify the main regions of the alimentary canal and associated organs. • Describe the functions of the regions of the alimentary canal.	Paper cards to identify regions on large wall sized diagram of alimentary canal or model torso. Paper ‘ dominoes’ to match region and function.

Syllabus reference	Practical Activity
6.3.4 Mechanical and physical digestion **Core** • Define *digestion.* • Identify the types of human teeth and describetheir structure and functions • State the causes of dental decay and describe the proper care of teeth • Describe the process of chewing • Describe the role of longitudinal and circular muscles in peristalsis • Outline the role of bile in emulsifying fats. **Supplement** • Describe how fluoride reduces tooth decay and explain arguments for and against the addition of fluoride to public water supplies	Use mirrors to check own teeth, compare with the ideal set. Models or diagrams to explain structure of teeth. Swabs of teeth and saliva tested with indicator to show pH. [safety – disinfectant to dispose of used equipment] Observe diagrams or specimens of different animals' teeth. [museum visit] Observe data on use of fluoride. Look at additions to different toothpastes which are available. Poster work. Use of model torso. Demonstration of bolus [ball] passing through tubing – rubber tubing or sock or stocking.

Syllabus reference	Practical Activity
6.3.5 Chemical digestion **Core** • State the significance of chemical digestion in the alimentary canal in producing small, soluble molecules that can be absorbed • State where, in the alimentary canal, amylase, protease and lipase enzymes are secreted • State the functions of a typical amylase, a protease and a lipase, listing the substrate and end-products	Paper models of molecules – cut apart into monomers. Amylase – breakdown of starch using Iodine test. Link with model gut using visking tubing. Protease – with milk – breakdown of casein in milk or gelatine on photographic film or fresh meat Breakdown of fats to form acids with help of bile salts – litmus or pH indicator.
6.3.6 Absorption **Core** • Define *absorption* as movement of digested food molecules through the wall of the intestine into the blood or lymph • Identify the small intestine as the region for the absorption of digested food • Describe the significance of villi in increasing the internal surface area of the small intestine **Supplement** • Describe the structure of a villus. • State the role of the hepatic portal vein in the transport of absorbed food to the liver	Bioviewers and microscope to study wall of small intestine. Posters to reinforce uptake into blood or lymph. Use of data to provide opportunity to reinforce understanding of volumes involved.

• Identify the role of the small intestine and colon in absorption of water.	
6.3.7 Assimilation **Core** • Define *assimilation.* • Describe the role of the liver in the metabolism of glucose (glucose → glycogen) and amino acids (amino acids → proteins and destruction of excess amino acids) • Describe the role of fat as an energy storage substance **Supplement** • Define *deamination.* • State that the liver is the site of breakdown of alcohol and other toxins	Torso or large diagram to demonstrate position and size of liver. [link back cell structure] . Poster work to summarise digestion. Molecular models or paper models to demonstrate deamination.

Syllabus reference	Practical Activity
7. Transportation 7.1 Transport in plants **Core** • State the functions of xylem and phloem • Identify the positions of xylem and phloem tissues as seen in transverse sections of unthickened, herbaceous, dicotyledonous roots, stems and leaves	Examine whole young herbaceous dicotyledonous plants to observe roots and aerial parts. Grow from seed in pots [link with later sections on growth and germination]. Use of bioviewers or microscopes with prepared slides. Photomicrographs.
7.1.1 Water uptake **Core** • Identify root hair cells, as seen under the light microscope, and state their functions • State the pathway taken by water through root, stem and leaf (root hair, root cortex cells, xylem, mesophyll cells) • Investigate, using a suitable stain, the pathway of water through the above-ground parts of a plant **Supplement** • Relate the structure and functions of root hairs to their surface area and to water and ion uptake	Observe root hairs on plants and use hand lens. View under microscope or in photomicrographs. Poster work. Test the uptake of dyes such as methylene blue or eosin in freshly cut petioles of celery or pale coloured stems or germinated seedlings eg mung beans.

Syllabus reference	Practical Activity
7.1.2 Transpiration **Core** • Define *transpiration* • Describe how water vapour loss is related to cell surfaces, air spaces and stomata • Describe the effects of variation of temperature, humidity and light intensity on transpiration rate • Describe how wilting occurs **Supplement** • Explain the mechanism of water uptake and movement in terms of transpiration producing a tension ('pull') from above, creating a water potential gradient in the xylem, drawing cohesive water molecules up the plant. • Discuss the adaptations of the leaf, stem and root to **three** contrasting environments, to include pond, garden and desert, with emphasis on local examples (where appropriate) and the factors described in the core	Use of bioviewers or microscopes to observe TS section of leaf. Photomicrographs. Poster work to follow pathway. Preparation of epidermis to show surface view of stomata – wax impression, or peel of nail varnish layer. Some leaves are easier than others to tear in order to obtain a separate epidermis to study. *Trandescantia*, [has different coloured guard cells compared with epidermis;] *Peperonia.* Leave cut shoot without water for wilting. Use of potometer or flasks on top pan balance to show water loss in mass under different conditions. Use of capillarity tubing potometer to measure rate of water uptake to quantify this rate of water uptake. Observe leaves of succulents, water weeds.

Syllabus reference	Practical Activity
7.1.3 Translocation **Core** • Define *translocation* in terms of the movement of sucrose and amino acids in phloem; o from regions of production o to regions of storage OR to regions of utilisation in respiration or growth **Supplement** • Describe translocation throughout the plant of applied chemicals, including systemic pesticides • Compare the role of transpiration and translocation in the transport of materials from sources to sinks, within plants at different seasons	Poster work .Use of bioviewers or microscopes to study phloem. Cut bark of tree on one side to observe 'sap' escaping. Analyse sap for sugars or test stickiness.
7.2 Transport in humans **Core** • Describe the circulatory system as a system of tubes with a pump and valves to ensure one-way flow of blood • Describe the double circulation in terms of a low pressure circulation to the lungs and a high pressure circulation to the body tissues and relate these differences to the different functions of the two circuits	Large diagram of circulation of blood system. Model torso to demonstrate. Use of video.

Syllabus reference	Practical Activity
7.2.1 Heart **Core** • Describe the structure of the heart. • Describe the function of the heart in terms of muscular contraction and the working of the valves • Investigate, state and explain the effect of physical activity on pulse rate • Describe coronary heart disease.	Large diagrams to label and colour. Models of heart. Obtain a fresh heart from a legal approved source to demonstrate external and internal structures – especially thickness of the atrial and ventricular walls, the nature of the valves and coronary blood vessels. Measure pulse rate at wrist. Plan investigation on effect of exercise on pulse rate.
7.2.2 Arteries, veins and capillaries **Core** • Name the main blood vessels to and from the heart, lungs, liver and kidney • Describe the structure and functions of arteries, veins and capillaries **Supplement** • Explain how structure and function are related in arteries, veins and capillaries • Describe the transfer of materials betweencapillaries and tissue fluid	Model torso or large diagram to locate, identify and name the main blood vessels. Bioviewers of microscope slides of TS artery and vein to see the thickness of walls. Note the arteries and veins seen previously when looking at a fresh heart structure.

Syllabus reference	Practical Activity
7.2.3 Blood **Core** • Identify red and white blood cells as seen under the light microscope on prepared slides, and in diagrams and photomicrographs • List the components of blood as red blood cells, white blood cells, platelets and plasma • State the functions of blood components. **Supplement** • Describe the immune system in terms of antibody production, tissue rejection and phagocytosis • Describe the function of the lymphatic system in circulation of body fluids, and the production of lymphocytes • Describe the process of clotting (fibrinogen to fibrin only)	Use of photomicrographs of blood smears to identify blood cells. Video Use of bioviewers or microscopes and prepared slides. Safety – no use of blood in class. Poster work. Video. Link with vaccination in discussion.

Syllabus reference	Practical Activity
8. Respiration **Core** • Define *respiration* as the chemical reactions that break down nutrient molecules in living cells to release energy • State the uses of energy in the body of humans: muscle contraction, protein synthesis, cell division, active transport, growth, the passage of nerve impulses and the maintenance of a constant body temperature	Paper cards for words and symbols to arrange in order for the equations. Poster work for listing all of the uses.
8.1 Aerobic respiration **Core** • Define *aerobic respiration* as the release of a relatively large amount of energy in cells by the breakdown of food substances in the presence of oxygen • State the word equation for aerobic respiration **Supplement** • State the equation for aerobic respiration using symbols ($C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$)	

Syllabus reference	Practical Activity
8.2 Anaerobic respiration **Core** • Define *anaerobic respiration* • State the word equation for anaerobic respiration in muscles during hard exercise (glucose →lactic acid) and the microorganism yeast (glucose→ alcohol + carbon dioxide) • Describe the role of anaerobic respiration in yeast during brewing and bread-making • Compare aerobic respiration and anaerobic respiration in terms of relative amounts of energy released **Supplement** • State the balanced equation for anaerobic respiration in muscles ($C_6H_{12}O_6 \rightarrow 2C_3H_6O_3$) and the microorganism yeast ($C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$), using symbols • Describe the effect of lactic acid in muscles during exercise (include oxygen debt in outline only).	Prepare culture of yeast in sugar solution. Observe production of CO_2 by bubbling into water. Research bread making and flour improvers. Investigation to show comparative rising of dough in oiled measuring cylinders in warm water bath. Research brewing of wines and beer. Visit industrial sites for bakery of vineyard.

Syllabus reference	Practical Activity
8.3 Gas exchange **Core** • List the features of gas exchange surfaces in animals • Identify on diagrams and name the larynx, trachea, bronchi, bronchioles, alveoli and associated capillaries • State the differences in composition between inspired and expired air • Use lime water as a test for carbon dioxide to investigate the differences in composition between inspired and expired air • Investigate and describe the effects of physical activity on rate and depth of breathing **Supplement** • Describe the role of the ribs, the internal and external intercostal muscles and the diaphragm in producing volume and pressure changes leading to the ventilation of the lungs • Explain the role of mucus and cilia in protecting the gas exchange system from pathogens and particles • Explain the link between physical activity and rate and depth of breathing in terms of changes in the rate at which tissues respire and therefore of carbon dioxide concentration and pH in tissues and in the blood	Possible to obtain a set of lungs from legal source to pump air into lungs [car tyre pump] to observe rise and fall. Model torso or large diagram for structure. Demonstrate indicator colour changes – limewater and hydrogencarbonate. Compare inhaled and exhaled air using simple apparatus [huff- puff apparatus mouthpiece with tubing]. Use of bell jar apparatus with rubber sheet for diaphragm. Rib model to illustrate muscles. Use of spirometer and recording or use large diagram to show apparatus. Vital capacity – use inverted plastic container of bell jar with measurements to determine vital capacity

Syllabus reference	Practical Activity
9. Excretion in humans **Core**	
• Define *excretion*. Substances should include carbon dioxide, urea and salts • Describe the function of the kidney in terms of the removal of urea and excess water and the reabsorption of glucose and some salts (details of kidney structure and nephron are **not** required) • State the relative positions of ureters, bladder and urethra in the body • State that urea is formed in the liver from excess amino acids • State that alcohol, drugs and hormones are broken down in the liver	Demonstration using the torso or use of large diagrams Video for demonstration Poster work Large diagrams of kidney and kidney tubule to label for functions. Revise transport across membranes and filtration. Dissection of animal kidney to show difference between cortex and medulla. [to obtain from local butcher or abattoir 'in fat / suet to preserve the ureter and blood vessels]
Supplement • Outline the structure of a kidney and outlinethe structure and functioning of a kidney tubule including: • role of renal capsule in filtration from blood of water, glucose, urea and salts • role of tubule in reabsorption of glucose, most of the water and some salts back into the blood, leading to concentration of urea in the urine as well as loss of excess water and salts • Explain dialysis in terms of maintenance of glucose and protein concentration in blood and diffusion of urea from blood to dialysis	Diagrams to compare composition of filtrate to urine along the length of kidney tubule. Video. Use of visking tubing to demonstrate diffusion. Samples of coloured water containing sugar, protein –use diluted cold tea to

fluid • Discuss the application of dialysis in kidney machines • Discuss the advantages and disadvantages of kidney transplants, compared with dialysis	provide colour] Simple food test or clinistix to identify samples.

Syllabus reference	Practical Activity
10. Coordination and response 10.1 Nervous control in humans **Core** • Describe the human nervous system in terms of the central nervous system (brain and spinal cord as areas of coordination) and the peripheral nervous system which together serve to coordinate and regulate body functions • Identify motor (effector), relay (connector) and sensory neurones from diagrams • Describe a simple reflex arc in terms of sensory, relay and motor neurones, and a reflex action as a means of automatically and rapidly integrating and coordinating stimuli with responses • State that muscles and glands can act as effectors • Describe the action of antagonistic muscles to include the biceps and triceps at the elbow joint • Define sense *organs* as groups of receptor cells responding to specific stimuli: light, sound, touch, temperature and chemicals • Describe the structure and function of the eye, including accommodation and pupil reflex.	Poster work. Videos. Simple examples of voluntary and involuntary actions linking the control with the action of muscles and glands. List the different steps in a learning activity to catch a ball. Use large diagrams and models of brain to demonstrate different parts of the brain and to show the protection of the brain by the skull. Diagrams to label of spinal cord to show grey matter and white matter. Demonstrations of size of neurones – bioviewers or photomicrographs. Demonstrations of reflex actions – pupil / iris reflex, blinking etc. Plan an investigation to find speed of reaction – dropping the ruler or online tests. Diagrams or models of muscles and bones of forearm. Bones on skeleton to identify types of joints and movement. Demonstrations of sense of temperature and touch by individuals. Paper clip tip touch investigation to show sensitivity. Temperature reception of differences not actual temperatures – compare with thermometers. Model eye. Videos. Demonstration with lenses to form a sharp clear image.

Supplement • Distinguish between voluntary and involuntary actions • Distinguish between rods and cones, in terms of function and distribution	Diagrams of rods and cones to appreciate size and function. Opportunity to check colour vision with test charts of books.
10.2 Hormones **Core** • Define a *hormone* as a chemical substance, produced by a gland, carried by the blood, which alters the activity of one or more specific target organs and is then destroyed by the liver • State the role of the hormone adrenaline in chemical control of metabolic activity, including increasing the blood glucose concentration and pulse rate • Give examples of situations in which adrenaline secretion increases • Compare nervous and hormonal control systems. **Supplement** • Discuss the use of hormones in food production	Large diagrams and torso to locate endocrine glands. Paper based cards ‘dominoes’ to match hormones with glands and control actions. Discussion of the adrenaline control and when this hormone maybe secreted. Video and web sites for industrial uses. If combined with site visits to farms or laboratories or factories.

Syllabus reference	Practical Activity
10.3 Tropic responses **Core** • Define and investigate *geotropism* (as a response in which a plant grows towards or away from gravity) and *phototropism* (as a response in which a plant grows towards or away from the direction from which light is coming). **Supplement** • Explain the chemical control of plant growth by auxins including geotropism and phototropism in terms of auxins regulating differential growth, and the effects of synthetic plant hormones used as weedkillers	Grow bean or cereal seedlings in gas jars to keep shoot or coleoptiles and root systems straight. Turn onto side and pin onto board to show positive geotropism of roots and negative geotropism of coleoptiles. Pin some germinating beans to clinostat or keep rotating growth of seedlings. Grow cress / cabbage seedlings in pot to show response to light from one side. If possible use different growth boxes with coloured filters to experiment with differing wavelengths. Observe use of weedkillers by looking at parks / golf courses where areas have been sprayed. Grow seedlings of broad leaved plants and grasses together in trays and spray with weedkiller to show differential killing of plants [takes several weeks].
10.4 Homeostasis **Core** • Define *homeostasis*. • Identify, on a diagram of the skin: hairs, sweat glands, temperature receptors, blood vessels and fatty tissue • Describe the maintenance of a constant body temperature in humans in terms of insulation and the role of temperature receptors in the skin, sweating, shivering, vasodilation and vasoconstriction of arterioles supplying skin surface capillaries and the coordinating role of the brain. **Supplement**	Video. Magnifying glass to observe own skin. Observe the sweat pores on the finger tips and unique arrangement of ridges – link with fingerprinting. Use dry cobalt chloride papers on sweaty palms to show colour change. Note the distribution of hairs on front and back of hands and on arms. Observe photomicrographs. Use various glass containers and coverings to investigate cooling of hot water - effect of size [mother v baby]; stature ; clothing layers v wet covering; link with surface area volume ratios. Chill factors with varying wind speed.

• Explain the concept of control by negative feedback	Group of test tubes to demonstrate the 'herding' instinct of animals.
• Describe the control of the glucose content of the blood by the liver, and by insulin and glucagon from the pancreas	Discussion of diabetes.
10.5 Drugs **Core** • Define a drug as any substance taken into the body that modifies or affects chemical reactions in the body • Describe the medicinal use of antibiotics for the treatment of bacterial infection • Describe the effects of the abuse of heroin: a powerful depressant, problems of addiction, severe withdrawal symptoms and associated problems such as crime and infection e.g. HIV/AIDS • Describe the effects of excessive consumption of alcohol: reduced self-control, depressant, effect on reaction times, damage to liver and social implications • Describe the effects of tobacco smoke and its major toxic components (tar, nicotine, carbon monoxide, smoke particles) on the gas exchange System. **Supplement**	Investigate the effect of caffeine on heart rate of microscopic invertebrate aquatic animal eg *Daphnia.* Effects of antibiotic disks on growth of bacteria on agar plate [use only recommended permitted bacterial strains from reliable sources] or photographs. Poster work based on videos. Alcohol intake measured in units and link with vehicle driving and road accidents. Videos to warn of the dangers of smoking. Smoking in fume cupboard of cigarette attached to water pump and collect tar on cotton wool.
• Explain why antibiotics kill bacteria but not viruses	

<table>
<tr><th colspan="2">Section III: Development of the organism and the continuity of life. (25% teaching time)</th></tr>
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<tr><td rowspan="2">1. Reproduction

1.1 Asexual reproduction

Core

• Define asexual reproduction as the process resulting in the production of genetically identical offspring from one parent

• Describe asexual reproduction in bacteria spore production in fungi and tuber formation in Potatoes.

Supplement

• Discuss the advantages and disadvantages to a species of asexual reproduction</td><td>Observe various plant specimens, to include the potato and other tubers, runners.

To observe growth of moulds and spore production – can use ‘blue-vein’ cheese if microscopes are available.

Discuss cloning.</td></tr>
<tr><td>1.2 Sexual reproduction

Core

• Define sexual reproduction as the process involving the fusion of haploid nuclei to form a diploid zygote and the production of genetically dissimilar offspring.

Supplement

• Discuss the advantages and disadvantages to a species of sexual reproduction</td><td></td></tr>
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Syllabus reference	Practical Activity
1.2.1 Sexual reproduction in plants **Core** • Identify and draw, using a hand lens if necessary, the sepals, petals, stamens, anthers, carpels, ovaries and stigmas of one, locally available, named, insect-pollinated, dicotyledonous flower, and examine the pollen grains under a light microscope or in photomicrographs • State the functions of the sepals, petals,anthers, stigmas and ovaries • Define *pollination* as the transfer of pollen grains from the male part of the plant (anther of stamen) to the female part of the plant (stigma) • Name the agents of pollination • Compare the different structural adaptations of insect-pollinated and wind-pollinated flowers • Describe the growth of the pollen tube and its entry into the ovule followed by fertilisation (production of endosperm and details of development are **not** required) • Investigate and describe the structure of a non-endospermic seed in terms of the embryo (radicle, plumule and cotyledons) and testa, protected by the fruit • Outline the formation of a seed. • State that seed and fruit dispersal by wind and by animals provides	Observe large, insect pollinated flowers from a local source. Use a hand lens to see detail of stigma, nectary, etc.. Germinate pollen grains to view pollen tubes and observing the microscopic extension [in a short time] in suitable medium on glass slides. Large diagrams posters to show the route taken by pollen tubes. Posters / charts to follow the fate of different parts of the flower when fertilisation has taken place. Use a hand lens to identify and describe the anthers and stigmas of one, locally available, named, wind-pollinated flower. Examine the pollen grains under a light microscope or in photomicrographs. Candidates should expect to apply their understanding of the flowers they have studied to unfamiliar flowers.

a means of colonising new areas • Describe, using named examples, seed and fruit dispersal by wind and by animals by wind and by animals. **Supplement** • Distinguish between self-pollination and crosspollination • Discuss the implications to a species of self –pollination and cross-pollination	Observe large soaked seeds eg beans to observe cotyledons, plumule and radicle and grow some seeds to show both hypogeal and epigeal types of germination.. Observe a range of fruits and discuss dispersal means.
1.2.2 Sexual reproduction in humans **Core** • Identify on diagrams of the male reproductive system, the testes, scrotum, sperm ducts, prostate gland, urethra and penis, and state the functions of these parts • Identify on diagrams of the female reproductive system, the ovaries, oviducts, uterus, cervix and vagina, and state the functions of these parts • Describe the menstrual cycle in terms of changes in the uterus and ovaries • Outline sexual intercourse and describe fertilisation . • Outline early development of the zygote. • Outline the development of the fetus • Describe the function of the placenta andumbilical cord. • Describe the ante-natal care of pregnant women including special	Use of models or large diagrams.. video Construct charts to align events in the basic 28 day cycle - the hormones and changes in ovary and thickening of the uterus wall prior to ovulation. Models and completion of fact sheets on fetal development

dietary needs and maintaining good health • Outline the processes involved in labour and birth **Supplement** • Compare male and female gametes in terms of size, numbers and mobility • Explain the role of hormones in controlling the menstrual cycle (including FSH, LH, progesterone and oestrogen) • Indicate the functions of the amniotic sac and amniotic fluid • Describe the advantages and disadvantages of breast-feeding compared with bottle-feeding using formula milk	Video Comparison of different formula milk available.

Syllabus reference	Practical Activity
1.3 Sex hormones **Core** • Describe the roles of testosterone and oestrogen in the development and regulation of secondary sexual characteristics at puberty. **Supplement** • Describe the sites of production and the roles of oestrogen and progesterone in the menstrual cycle and in pregnancy (cross reference 1.2.2)	
1.4 Methods of birth control **Core** • Outline the following methods of birth control: o natural (abstinence, rhythm method) o chemical (contraceptive pill, spermicide) o mechanical (condom, diaphragm, femidom, IUD) o • surgical (vasectomy, female sterilisation) **Supplement** • Outline artificial insemination and the use of hormones in fertility drugs, and discuss their social implications	Possible to arrange visit by local health adviser.

Syllabus reference	Practical Activity
1.5 Sexually transmissible diseases **Core** • Describe the symptoms, signs, effects and treatment of gonorrhoea • Describe the methods of transmission of human immunodeficiency virus (HIV), and the ways in which HIV/AIDS can be prevented from spreading. **Supplement** • Outline how HIV affects the immune system in a person with HIV/AIDS	Web sites for data such as World Health Organisation.
2. Growth and development **Core** • Define *growth* in terms of a permanent increase in size and dry mass by an increase in cell number or cell size or both • Define *development* in terms of increase in complexity • Investigate and state the environmental conditions that affect germination of seeds: requirement for water and oxygen, suitable temperature	Measuring growth of plants eg increase in height with time and determine dry mass by drying in the sun or in an oven to constant mass. Observe examples of seed germination using different seeds. Germinate seeds in shallow trays or petri dishes, in different places differing in temperature. Germinate seeds in vacuum flasks with thermometers to demonstrate rise in temperature. Seal seeds under oil in water to test germination with suitable controls to show need for oxygen / air.

Syllabus reference	Practical Activity
3. Inheritance **Core** • Define *inheritance.*	
3.1 Chromosomes **Core** o Define the terms:*chromosome;* o *gene* as a length of DNA and codes for a specific protein. o *allele* as any of two or more alternative forms of a gene o *haploid nucleus* as a nucleus containing a single set of unpaired chromosomes (e.g. sperm and egg) o *diploid nucleus* as a nucleus containing two sets of chromosomes (e.g. in body cells) o Describe the inheritance of sex in humans (XX and XY chromosomes)	Build paper models of DNA and chromosomes. Video on the discovery of DNA. Look at web sites, diagrams of the Human genome project. Look at diagrams of chromosomes. To observe images of human chromosomes - karyotypes. Identify the sex chromosomes and discuss the genes located on these chromosomes with the human genome project details.

Syllabus reference	Practical Activity
3.2 Mitosis **Core** • Define *mitosis* as nuclear division giving rise to genetically identical cells in which the chromosome number is maintained by the exact duplication of chromosomes (details of stages are **not** required) • State the role of mitosis in growth, repair of damaged tissues, replacement of worn out cells and asexual reproduction	Video or link to website to show this process of cell division– animated. Observe photomicrographs. Recognise the sequence of stages in cell cycle and where DNA is copied. Use of coloured drinking straws to represent chromosomes and chromatids. Link with cloning – identical genetic material.
3.3 Meiosis **Core** • Define *meiosis* as reduction division in which the chromosome number is halved from diploid to haploid (details of stages are **not** required) • State that gametes are the result of meiosis • State that meiosis results in genetic variation so the cells produced are not all genetically identical	Poster work to show meiosis where this takes place. Use of coloured drinking straws to represent chromosomes pairing before meiosis. Video to show this type of division. Discuss haploid and diploid status and genetic variation.

Syllabus reference	Practical Activity
3.4 Monohybrid inheritance **Core** • Define the terms: *genotype* as genetic makeup of an organism in terms of the alleles present (e.g. Tt or GG) o *phenotype* as the physical or other features of an organism due to both its genotype and its environment (e.g. tall plant or green seed) o *homozygous* as having two identical alleles of a particular gene (e.g. TT or gg). Two identical homozygous individuals that breed together will be pure-breeding o *heterozygous* as having two different alleles of a particular gene (e.g. Tt or Gg), not pure-breeding o *dominant* as an allele that is expressed if it is present (e.g. T or G) o *recessive* as an allele that is only expressed when there is no dominant allele of the gene present (e.g. t or g) • Calculate and predict the results of monohybrid crosses involving 1 : 1 and 3 : 1 ratios. **Supplement** • Explain codominance by reference to the inheritance of ABO blood groups, phenotypes, A, B, AB and O blood groups and genotypes.	Poster or board work on inheritance of one characteristic eg seed colour. Purchase seeds from specific crosses to germinate eg Tobacco seeds, upon germination have cotyledons with and without chlorophyll in 3:1 ratio. Use Punnett squares to follow inheritance. Discussion of back crossing and test crossing. Discuss how it is easier to experiment with plants. Explain convention of circling gametes in inheritance diagrams. Poster work and board work to explain the inheritance of alleles which show codominance.

Syllabus reference	Practical Activity
3.5 Variation **Core** • State that continuous variation is influenced by genes and environment, resulting in a range of phenotypes between two extremes, e.g. height in humans • State that discontinuous variation is caused by genes alone and results in a limited number of distinct phenotypes with no intermediates e.g. A, B, AB and O blood groups in humans • Define *mutation* as a change in a gene or chromosome • Describe mutation as a source of variation, as shown by Down's syndrome • Outline the effects of ionising radiation and chemicals on the rate of mutation **Supplement** • Describe sickle cell anaemia, and explain its incidence in relation to that of malaria	To show continuous variation in plants as well as humans, measure size of fruits or seeds, number of beans to be picked up in one hand, height, hand span, etc. Work out the frequency of large data sets and plot histograms. To discuss inheritance of different characteristics in plants as well as humans to show discontinuous variation.eg tasters v non tasters, lobed ears v attached ears. Observe human karyotype to identify trisomy [chromosome 21] with Downs Syndrome and to look at the incidence through data on web sites. Poster work on inheritance of sickle cell anaemia and incidence in the world.

3.6 Selection **Core** • Describe the role of artificial selection in the production of varieties of animals and plants with increased economic importance • Define *natural selection* as the greater chance of passing on of genes by the best adapted organisms **Supplement** • Describe variation and state that competition leads to differential survival of, and reproduction by, those organisms best fitted to the environment • Assess the importance of natural selection as a possible mechanism for evolution • Describe the development of strains of antibiotic resistant bacteria as an example of natural selection	Opportunity to visit local museum to observe evolution galleries. Diagram and discussion of some plant and animal examples of artificial selection eg bread wheat.
3.7 Genetic Engineering **Core** • Define *genetic engineering* as taking a gene from one species and putting it into another species **Supplement** • Explain why, and outline how, human insulin genes were put into bacteria using genetic engineering	Poster work to show stages in process in the development of humilin. Video. Discuss examples of genetically engineered organisms in many crop plants and the advantages of these.

Section IV: Relationships of organisms with one another and with their environment. (20% teaching time)	
Syllabus reference	Practical Activity
1. Energy flow **Core** • State that the Sun is the principal source of energy input to biological systems • Describe the non-cyclical nature of energy flow	
2. Food chains and food webs (emphasis on examples occurring locally) **Core** • Define the terms: o *food chain* as a chart showing the flow of energy (food) from one organism to the next beginning with a producer (e.g. mahogany tree → caterpillar → song bird → hawk) o *food web* as a network of interconnected food chains showing the energy flow through part of an ecosystem o *producer* as an organism that makes its own organic nutrients, usually using energy from sunlight, through photosynthesis o *consumer* as an organism that gets its energy by feeding on other organisms • *herbivore* as an animal that gets its energy by eating plants o *carnivore* as an animal that gets its energy by eating other animals	Opportunity to go into a natural area locally and identify the feeding relationships of the organisms which can be seen. If this is not possible not then bring into the class room - living plants eg nettles or leaf litter and identify the species and the feeding relationships. Watch a video –and build up food chains and food webs, perhaps of a different ecosystem. Visit a farm centre, library or a field centre to find out more examples. Talk about energy and discuss units. Use a simple calorimeter to find energy content of seeds or food items. When searching for living specimens in leaf litter or on plants for animals, identify [recall use of keys to identify organisms] and assign to trophic feeding levels. These can be weighed [fresh weight] or counted to draw the trophic blocks in pyramid diagrams.

o *decomposer* as an organism that gets its energy from dead or waste organic matter o *ecosystem* as a unit containing all of the organisms and their environment, interacting together, in a given area e.g. decomposing log or a lake o *trophic level* as the position of an organism in a food chain, food web or pyramid of biomass, numbers or energy o Describe energy losses between trophic levels o Draw, describe and interpret pyramids of biomass and numbers **Supplement** • Explain why food chains usually have fewer than five trophic levels • Explain why there is an increased efficiency in supplying green plants as human food and that there is a relative inefficiency, in terms of energy loss, in feeding crop plants to animals	Have data available if unable to do this and build up diagrams. Consult tables for dry biomass to preserve the specimens and return to the environment.

Syllabus reference	Practical Activity
3. Nutrient cycles **Core** • Describe the carbon and the water cycles **Supplement** • Describe the nitrogen cycle in terms of: o the role of microorganisms in providing usable nitrogen-containing substances by decomposition and by nitrogen fixation in roots o the absorption of these substances by plants and their conversion to protein • followed by passage through food chains, death, decay • nitrification and denitrification and the return of nitrogen to the soil or the atmosphere (names of individual bacteria are not required) • Discuss the effects of the combustion of fossil fuels and the cutting down of forests on the oxygen and carbon dioxide concentrations in the atmosphere	Videos. Diagrams. Observe plant roots of the pea and bean family. [legumes] Look for the pink coloration as these are actively fixing nitrogen [symbiosis / mutualism – explain term] Use of bioviewers, microscopes or photomicrographs to observe sections through nodules.

Syllabus reference	Practical Activity
4. Population size **Core** • Define *population* as a group of organisms of one species, living in the same area at the same time • State the factors affecting the rate of population growth for a population of an organism (limited to food supply, predation and disease), and describe their importance • Identify the lag, exponential (log), stationary and death phases in the sigmoid population growth curve for a population growing in an environment with limited resources • Describe the increase in human population size and its social implications • Interpret graphs and diagrams of human population growth **Supplement** • Explain the factors that lead to the lag phase, exponential (log) phase and stationary phase in the sigmoid curve of population growth making reference, where appropriate, to the role of limiting factors	Grow a yeast culture in a flask with low sugar content. Start with low density of cells and observe. Data handling of count numbers or test turbidity of yeast culture. Poster work / large diagrams of growth curve perhaps handling data from a published source. Interpretation of human population pyramids and diagrams – available from web sites or published data in journals. Work with published data to find areas where human populations are highest and lowest and discuss the reasons for this pattern of distribution.

Syllabus reference	Practical Activity
5. Human influences on the ecosystem **Core** • Outline the effects of humans on ecosystems, with emphasis on examples of international importance (tropical rain forests, oceans and important rivers)	
5.1 Agriculture **Core** • List the undesirable effects of deforestation (to include extinction, loss of soil, flooding, carbon dioxide build up) • Describe the undesirable effects of overuse of fertilisers (to include eutrophication of lakes and rivers)	
5.2 Pollution **Core** • Describe the undesirable effects of pollution to include: o water pollution by sewage and chemical waste o air pollution by sulfur dioxide o air pollution by greenhouse gases (carbon dioxide and methane) contributing to global warming o pollution due to pesticides and herbicides	Opportunity to visit to sample local streams or rivers to find diversity of invertebrates to estimate Biological oxygen demand and determine level of pollution. Measure oxygen content of water from ponds using methylene blue tests or oxygen meters if available. Observe safety at all times.

o pollution due to nuclear fall-out **Supplement** • Discuss the effects of non-biodegradable plastics in the environment • Discuss the causes and effects on the environment of acid rain, and the measures that might be taken to reduce its incidence • Explain how increases in greenhouse gases (carbon dioxide and methane) are thought to cause global warming	Possible to show bleaching effect of sulfur dioxide in a fume cupboard on paper or mosses. [effective at low concentrations]
5.3 Conservation **Core** • Describe the need for conservation of: • species and their habitats • natural resources (limited to water and non-renewable materials including fossil fuels) **Supplement** • Explain how limited and non-renewable resources can be recycled (including recycling of paper and treatment of sewage to make the water that it contains safe to return to the environment or for human use)	Opportunity to visit conservation sites or to watch videos or TV programs. Put up local nesting boxes for birds. Keep an area of garden for wildlife. Plant insect loving shrubs and flowering plants eg *Buddleja.* Opportunity to visit sewage treatment plant and to refer to a simple flow chart to understand the processes. To understand local or country wide legislation for sewage treatment – discussion. Opportunity to visit local industrial processing sites involved with re-cycling of paper, aluminium or glass.