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SCIENCE

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Biology

Structure and function of living organisms

1. Cells and Organization

Students should be taught...

- that cells are the fundamental unit of living organisms; the hierarchical organization of multicellular organisms: from cells to tissues to organs to systems to organisms
- the similarities and differences between plant and animal cells; the functions of chloroplasts and cell walls in plant cells and the functions of the cell surface membrane, cytoplasm, mitochondria and nucleus in both plant and animal cells; the vacuole in plant cells
- the role of diffusion in the movement between plant and animal cells
- the structural adaptations of some unicellular organisms

2. Nutrition and Digestion

Students should be taught...

- the content of a healthy human diet: carbohydrates, lipids (fats and oils), proteins, vitamins, minerals, dietary fibre and water.
- the value of a balanced diet; foods which are good sources of nutrients.
- the consequences of imbalances in the diet, including deficiency diseases, obesity and starvation.
- that food is used as a fuel during respiration to maintain the body's activity and as a raw material for growth and repair

3. Gas Exchange Systems

Students can...

- the structure and functions of the gas exchange system in humans, including adaptations to function
- the mechanism of breathing to move air in and out of lungs, using a pressure model to explain the movement of gases, including simple measurements of lung volume
- the impact of exercise, asthma and smoking on the human gas exchange system



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Biology

Structure and function of living organisms

4. Reproduction in animals

Students can...

- reproduction in humans (as an example of a mammal), including the structure and function of the male and female reproductive systems; the menstrual cycle (without details of hormones), gametes, fertilization
- gestation and birth, to include the effect of maternal lifestyle on the fetus
- the physical and emotional changes which take place during adolescence

5. Reproduction in plants

Students can...

- reproduction in plants, including flower structure; wind and insect pollination, fertilization; seed and fruit formation and dispersal, including quantitative investigation of some dispersal mechanisms

6. Health

Students can...

- the effects of recreational drugs (including substance misuse) on behaviour, health and life processes.
- that the growth and reproduction of bacteria and the replication of viruses can affect health; how the body's natural defenses may be enhanced by medicines



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Biology

Material cycles and energy

1. Photosynthesis

Students should be taught...

- the reactants in, and products of, photosynthesis, and a word summary for photosynthesis; that plants need carbon dioxide, water and light for photosynthesis, and produce biomass and produce biomass and oxygen
- the dependence of almost all life on Earth on the ability of photosynthetic organisms, such as plants and algae, to use sunlight in photosynthesis to build organic molecules which are an essential energy source to maintain levels of oxygen and carbon dioxide in the atmosphere.
- the adaptations of leaves for photosynthesis; the role of stomata in gas exchanges in plants
- the role of root hairs in absorbing water and minerals from the soil; that nitrogen and other elements, in addition to carbon, oxygen and hydrogen, are required for plant growth

2. Cellular respiration

Students should be taught...

- that aerobic respiration involves a reaction in cells between oxygen and food, in which glucose is broken down to carbon dioxide and water. To summarise aerobic respiration in a word equation.
- the process of anaerobic respiration in humans, including fermentation, and a word summary for anaerobic respiration
- the differences between aerobic and anaerobic respiration; the implications for the organism
- that the reactants and products of respiration are transported throughout the body in the bloodstream
- the global significance of photosynthesis and respiration in maintaining the level of carbon dioxide in the atmosphere.

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Biology

Interactions and interdependences

1. Relationships in an ecosystem

Students should be taught...

- the interdependence of organisms in an ecosystem, including food webs
- about ways in which living things and the environment can be protected, and the importance of sustainable development
- how predation and competition for resources affect the size of populations (e.g., bacteria, growth of vegetation)

Genetics and evolution

1. Variation, classification and inheritance

Students should be taught...

- the variation between individuals within a species being continuous or discontinuous, to include measurement and graphical representation of variation
- that differences exist between species
- the classification of living things into the major taxonomic groups



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Chemistry

The particulate nature of matter

Students should be taught...

- the properties of the different states of matter (solid, liquid and gas) in terms of the particle model, including gas pressure and diffusion
- Brownian Motion
- changes of state in terms of the particle model; similarities and differences, including density differences, between solids, liquids and gases; changes with temperature in motion and spacing of particles

Atoms, elements and compounds

Students should be taught...

- the simple (Dalton) atomic model
- chemical symbols and formulae for elements and compounds
- the differences between atoms, elements and compounds
- how elements vary widely in their physical properties, including appearance, state at room temperature, magnetic properties and thermal and electrical conductivity, and to how use these properties to classify elements as metal or non-metals

Pure and impure substances; physical changes

Students should be taught...

- the concept of a pure substance
- the identification of pure substances
- to relate changes of state to energy transfers (qualitative)
- conservative of mass for physical changes
- mixtures, including dissolving
- the composition of the atmosphere
- simple techniques for separating mixtures: filtration, evaporation, distillation and chromatography
- about the variation of solubility with temperature, the formation of saturated solutions and the differences in solubility of solutes in different solvents



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Chemistry

Chemical reactions

Students should be taught...

- conservation of mass in chemical
- combustion reactions
- the production of carbon dioxide by human activity and the impact on climate
- thermal decomposition reactions
- oxidation and displacement reactions
- the order of metals and carbon in the reactivity series
- the use of carbon in obtaining metals from metal oxides
- the definition of acids and alkalis in terms of neutralization; the reactions of acids with metals to produce a salt plus hydrogen; reactions of acids with alkalis to produce a salt plus water
- the pH scale for measuring acidity/alkalinity and indicators
- the chemical properties of metal and non-metal oxides with respect to acidity
- the effect of acidity on the environment



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Physics

Energy

1. Energy resources

Students should be taught...

- fuels and energy resources, including oil, gas, coal, biomass, food, wind, waves and batteries; the distinction between renewable and non-renewable resources
- that the Sun is the ultimate source of most of the Earth's energy resources and to relate this to how coal, oil and gas are formed
- that electricity is generated using a variety of energy resources

2. Changes in systems

Students should be taught...

- energy as a quantity that can be quantified and calculated
- ways in which energy can be usefully transferred and stored, comparing the starting with the final conditions of a system and describing of a system and describing increases and decreases in the amounts of energy associated with movements, temperatures, changes in positions in a field, in elastic distortions and in chemical compositions

3. Conservation of energy

Students should be taught...

- that the total energy has the same value before and after a change
- that although energy is always conserved, it may be dissipated, reducing its availability as a resource

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Physics

Motion and Forces

1. Describing motion

Students should be taught...

- scientific units
- how to determine the speed of a moving object and to use the quantitative relationship between speed, distance and time; relative motion: trains and cars passing one another
- forces as pushes or pulls, arising from the interaction between two objects; forces measured in newtons, measurements of stretch or compression as force is changed
- forces being needed to cause objects to stop or start moving, or to change their speed or direction of motion (qualitative only)
- using force arrows in diagrams, adding forces in one dimension, balanced and unbalanced forces
- that unbalanced forces change the speed or direction of objects and that balanced forces produce no change in the movement of an object
- opposing forces and equilibrium: weight held by stretched spring or supported on a compressed surface
- forces: associated with deforming objects; stretching and squashing – springs; force-extension linear relation; Hooke's Law as a special case
- forces: rubbing and friction between surfaces, pushing things out of the way; resistance to motion of air and water

2. Force and rotation

Students should be taught...

- that forces can cause objects to turn about a pivot
- that simple machines give bigger force but at the expense of smaller movement (and vice versa) – product of force and displacement unchanged
- moment as the turning effect of a force. The principle of moments and its application to situations involving one pivot



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Physics

Motion and Forces

3. Force and pressure

Students should be taught...

- pressure measured by ratio of force over area – acting normal to any surface
- the quantitative relationship between force, area and pressure and its application (e.g., the use of skis and snowboards, the effect of sharp blades)

4. Density

Students should be taught...

- density and its measurement



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Physics

Waves

1. Sound waves

Students should be taught...

- that sound needs a medium to travel; the speed of sound in air, in water, in solids; echoes, reflection and absorption of sound; that sound is produced by vibrations of objects, in loud speakers, detected by their effects on a microphone diaphragm
- the relationship between the loudness of a sound and the amplitude of the vibration causing it

2. Hearing

Students should be taught...

- that sound causes the eardrum to vibrate; the auditory range of humans and animals
- some effects of loud sounds on the ear (e.g., temporary deafness)
- the relationship between the pitch of a sound and the frequency of the vibration causing it; frequencies of sound waves, measured in hertz (Hz)

3. Light waves

Students should be taught...

- that light travels in a straight line at a finite speed in a uniform medium; that light can travel through a vacuum but sound cannot, and that light travels much faster than sound; that light waves can travel through a vacuum; speed of light (qualitative only)
- that non-luminous objects are seen because light scattered from them enters the eye
- how light is reflected at plane surfaces; the use of a ray model to explain imaging in mirrors; the pinhole camera
- how light is refracted at the boundary between two different materials
- the transmission of light through materials: absorption, diffuse scattering
- that white light can be dispersed to give a range of colours; colours and the different frequencies of light, white light and prisms (qualitative only)



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Physics

Electricity and Electromagnetism

1. Circuits

Students should be taught...

- to design and construct series and parallel circuits, and how to measure current
- about electric current, measured in amperes, series and parallel circuits, currents add where branches meet; that the current in a series circuit depends on the number of cells and the number and nature of other components; current as flow of charge that is not 'used up' by components; differences in resistance between conducting and insulating components (qualitative only)
- that energy is transferred from batteries and other sources to other components in electrical circuits

2. Magnetism

Students should be taught...

- about magnetic fields as regions of space where magnetic materials experience forces, and that like magnetic poles repel and unlike magnetic poles attract; magnetic fields by plotting with a compass; representation by field lines
- Earth's magnetism, compass and navigation

3. Electromagnets

Students should be taught...

- that a current in a coil produces a magnetic field pattern similar to that of a bar magnet.
- how electromagnets are constructed and used in devices (e.g., lifting magnets, relays, DC motors [principles only])



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Physics

Space Physics

Students should be taught...

- how the movement of the Earth causes the apparent daily and annual movement of the Sun and other stars; the seasons and the Earth's tilt; day length at different times of year, in different hemispheres
- the relative positions of the Earth, Sun and planets in the solar system. The light year as a unit of astronomical distance
- gravity forces acting at a distance on Earth and in space; that the weight of an object on Earth is the result of the gravitational attraction between its mass and that of the Earth
- about the movements of planets round the Sun and to relate these to gravitational forces.
- that the Sun and other stars are light sources and that the planets and other bodies are seen by reflected light
- the use of artificial satellites and probes to observe the Earth and to explore the solar system

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