MARKHOR JUNIOR CONTEST

SCIENCE COURSE OUTLINE

LEARNER LEVEL

(Applicable to Learner III & Learner IV)

Chapter No.	Chapter Title	Topic No.	Topic Title	Concept Description
01	The Scientific Method and Investigation	1	**The Scientific Method**	Science as a cycle of asking a question, forming a hypothesis, experimenting, observing, analysing, concluding and communicating findings.
		2	**Hypotheses and Variables**	Writing a testable hypothesis ("If… then… because…") and identifying independent, dependent and controlled variables in an investigation.
		3	**Planning Fair Investigations**	Choosing suitable equipment, controlling variables, using a control group, repeating measurements for reliability and planning for safety.
		4	**Measurement and SI Units**	Measuring accurately with standard units (metre, kilogram, second, litre, degree Celsius), reading scales correctly and recognising measurement errors.
		5	**Tables, Bar Charts and Line Graphs**	Organising data in tables, choosing between bar charts and line graphs, plotting data and reading trends from graphs.
		6	**Analysing and Evaluating Evidence**	Identifying patterns and anomalous results, judging whether evidence supports a hypothesis, and suggesting improvements to an investigation.
02	Cells and the Organisation of Life	1	**Cells: The Basic Units of Life**	All living things are made of cells. Unicellular organisms consist of one cell and multicellular organisms of many. Cells are observed with a microscope.
		2	**Structure of the Animal Cell**	The cell membrane controls what enters and leaves, cytoplasm is where reactions happen, the nucleus controls the cell, and mitochondria release energy.
		3	**Structure of the Plant Cell**	Plant cells have the same parts as animal cells plus a cell wall for support, chloroplasts for photosynthesis and a large vacuole filled with cell sap.
		4	**Specialised Cells**	Cells are shaped for their jobs: red blood cells carry oxygen, nerve cells carry messages, root hair cells absorb water and guard cells open and close stomata.
		5	**Levels of Organisation**	Cells form tissues, tissues form organs, organs form organ systems and organ systems make up an organism, with plant and animal examples.
03	Plant Processes	1	**Photosynthesis and Food Production**	Green plants use light energy, carbon dioxide and water to make glucose and release oxygen. Chlorophyll in chloroplasts traps light, and carbon dioxide enters through stomata.

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		2	**Respiration in Plants**	Plants respire day and night, using oxygen to release energy from glucose and giving out carbon dioxide. Compared and contrasted with photosynthesis.
		3	**Transport in Plants**	Root hairs absorb water and minerals, xylem carries them up to the leaves, phloem carries food around the plant, and water evaporates from leaves in transpiration.
		4	**Sexual Reproduction in Flowering Plants**	The stamen (anther, filament) and carpel (stigma, style, ovary), and the sequence of pollination, fertilisation, and seed and fruit formation.
		5	**Insect and Wind Pollination**	Comparing flower adaptations: bright petals, scent and nectar in insect-pollinated flowers, and light pollen and feathery stigmas in wind-pollinated flowers.
		6	**Asexual Reproduction in Plants**	New plants grown from one parent through runners, tubers, bulbs and cuttings. Offspring are identical to the parent.
		7	**Plant Responses (Tropisms)**	Plants respond to stimuli: shoots grow towards light (phototropism) and roots grow downwards with gravity (gravitropism).
04	**Classification, Variation and Inheritance**	1	**Principles of Classification**	Grouping organisms by shared features into kingdoms such as animals, plants and fungi, and the two-part scientific naming system (for example, Panthera leo).
		2	**Classification of Plants**	Flowering and non-flowering plants. Mosses and ferns reproduce by spores, while conifers and flowering plants reproduce by seeds.
		3	**Invertebrate Groups in Depth**	Arthropods (insects, arachnids, crustaceans), molluscs, annelid worms, cnidarians (jellyfish) and echinoderms (starfish), and their distinguishing features.
		4	**Vertebrate Classes Compared**	Comparing vertebrate classes by body temperature (warm- or cold-blooded), body covering, breathing organs and method of reproduction.
		5	**Constructing Dichotomous Keys**	Designing branching keys with paired questions to identify organisms based on observable features.
		6	**Variation and Inheritance**	Differences within a species. Inherited features (eye colour) come from parents, while environmental variation (scars, language) depends on surroundings.
05	**Human Organ Systems**	1	**The Digestive System and Enzymes**	Mechanical and chemical digestion. Enzymes break large food molecules into smaller ones, villi in the small intestine absorb nutrients, and the liver produces bile.
		2	**The Respiratory System and Gas Exchange**	Air passes through the trachea and bronchi to the alveoli, where oxygen enters the blood and carbon dioxide leaves. The diaphragm controls breathing. Breathing is distinguished from respiration.
		3	**Structure and Function of the Heart**	The heart as a muscular four-chambered pump with valves that keep blood flowing one way, sending blood to the lungs and to the rest of the body.

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		4	**Blood and Blood Vessels**	Arteries carry blood away from the heart, veins return it and capillaries allow exchange. Blood consists of red cells, white cells, platelets and plasma.
		5	**Skeletal and Muscular Systems**	Hinge and ball-and-socket joints, cartilage, ligaments and tendons, and antagonistic muscle pairs such as the biceps and triceps.
		6	**The Nervous System**	The brain, spinal cord and nerves carry messages. Stimulus and response, and how a reflex action protects the body quickly.
		7	**The Eye and the Ear**	Light enters the eye through the pupil and the lens focuses it on the retina. Sound vibrates the eardrum and the cochlea sends signals to the brain.
		8	**The Excretory System**	Removal of waste: kidneys filter blood to make urine, lungs remove carbon dioxide and skin releases sweat.
06	**Nutrition, Microorganisms and Health**	1	**Energy in Food and Diet-Related Disorders**	Food provides energy measured in kilojoules. Deficiency diseases (scurvy, rickets, anaemia) and problems from excess intake such as obesity.
		2	**Types of Microorganisms**	Bacteria, viruses, fungi and protozoa compared by size, structure and how they grow or reproduce.
		3	**Useful Microorganisms**	Microorganisms decompose dead matter, fix nitrogen in soil, ferment yogurt and bread, and produce antibiotics such as penicillin.
		4	**Pathogens and Infectious Diseases**	How pathogens spread through water (cholera), insects (malaria via mosquitoes), air (influenza) and contact, and how spread is reduced.
		5	**Body Defences, Vaccines and Antibiotics**	Skin, mucus and white blood cells defend the body. Vaccines prepare the immune system, and antibiotics kill bacteria but not viruses.
07	**The Particle Model of Matter**	1	**The Particle Model**	Arrangement, movement and attraction of particles in solids, liquids and gases explain their properties of shape, volume, flow and compressibility.
		2	**Changes of State Explained**	Particles gain or lose energy during melting, boiling, condensing and freezing. Melting and boiling points (water: 0 °C and 100 °C at sea level), and boiling compared with evaporation.
		3	**Diffusion**	Particles spread from areas of high concentration to low concentration. Diffusion is faster in gases than liquids and faster at higher temperatures.
		4	**Mass, Volume and Density**	Density equals mass divided by volume. Measuring irregular volumes by displacement, and why ice and oil float on water.
08	**Atoms, Elements and Compounds**	1	**Atoms and Molecules**	An atom is the smallest particle of an element, with a central nucleus surrounded by electrons. A molecule is two or more atoms joined together.

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		2	**Elements and the Periodic Table**	Elements contain only one type of atom. About 118 known elements are arranged in the Periodic Table and grouped as metals and non-metals.
		3	**Chemical Symbols and Simple Formulas**	Common symbols (H, O, C, N, Na, Fe, Cl) and what simple formulas such as H_2O, CO_2, O_2 and NaCl show about the atoms in a substance.
		4	**Compounds**	Compounds form when elements join chemically and have different properties from those elements. For example, sodium and chlorine form table salt.
		5	**Elements, Compounds and Mixtures Compared**	Fixed composition of compounds compared with the variable composition of mixtures, and why mixtures separate easily while compounds do not.
09	**Mixtures, Solutions and Separation**	1	**Solutions, Solutes and Solvents**	A solute dissolves in a solvent to form a solution. Saturated solutions, and how solubility changes with temperature.
		2	**Factors Affecting Dissolving**	Investigating how temperature, stirring and particle size affect the rate of dissolving.
		3	**Separation Techniques**	Choosing filtration, evaporation, crystallisation, distillation, chromatography, decanting or magnetic separation according to the properties of a mixture.
		4	**Water Purification**	Making water safe to drink through sedimentation, filtration, chlorination and boiling.
10	**Chemical Changes and Reactions**	1	**Physical and Chemical Changes**	Signs of a chemical change: a new substance, gas production, colour change, temperature change or light. Compared with physical changes.
		2	**Combustion and Rusting**	Burning needs fuel, oxygen and heat (the fire triangle). Rusting happens when iron reacts with oxygen and water, and can be prevented by painting, oiling or galvanising.
		3	**Conservation of Mass**	In a closed system total mass stays the same during a reaction, because atoms are rearranged, not created or destroyed.
		4	**Acids and Bases**	Properties and everyday examples of acids (lemon juice, vinegar) and bases (soap, baking soda), safe handling, and neutralisation.
		5	**Indicators and the pH Scale**	Litmus, red cabbage and universal indicator show acidity. The pH scale runs from 0 to 14, with 7 neutral, below 7 acidic and above 7 alkaline.
		6	**Properties and Uses of Common Materials**	Metals (conduct, malleable), plastics, ceramics, glass and natural fibres, and how their properties determine their uses.
11	**Forces and Motion**	1	**Forces and Their Effects**	Forces are measured in newtons with a forcemeter and can change an object's speed, direction or shape.
		2	**Balanced and Unbalanced Forces**	Balanced forces keep an object still or moving at constant speed. Unbalanced forces make it speed up, slow down or change direction.

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		3	**Gravity, Mass and Weight**	Mass (kg) is the amount of matter and weight (N) is the pull of gravity. An object weighs about one-sixth as much on the Moon.
		4	**Friction and Drag**	Factors affecting friction, air and water resistance (drag), streamlining, and the benefits and problems of friction.
		5	**Speed and Motion**	Speed equals distance divided by time (m/s, km/h), and reading simple distance–time graphs.
		6	**Pressure**	Pressure depends on force and area, as shown by sharp knives and snowshoes. Water pressure increases with depth.
12	**Energy and Machines**	1	**Forms of Energy**	Kinetic, gravitational potential, elastic, chemical, thermal, light, sound, electrical and nuclear energy, with examples.
		2	**Energy Transformations and Conservation**	Energy changes form but is never created or destroyed. Transformation chains (a torch: chemical → electrical → light and heat) and wasted energy.
		3	**Levers, Pulleys and Gears**	Pivot, effort and load in levers, and how pulleys and gears give mechanical advantage by trading force for distance.
		4	**Energy Resources and Electricity Generation**	Fossil fuels, solar, wind, hydroelectric, geothermal and biomass energy compared by availability, cost and environmental impact.
13	**Heat and Thermal Energy**	1	**Temperature and Thermal Energy**	Temperature measures how hot something is, while thermal energy depends on both temperature and amount of material. Heat flows from hot to cold.
		2	**Conduction**	Heat passes through solids as vibrating particles pass energy on. Metals are good conductors, while insulators reduce heat flow.
		3	**Convection**	Warm liquids and gases rise and cooler ones sink, forming convection currents, as seen in room heating and sea breezes.
		4	**Radiation**	Heat travels as infrared radiation without needing particles, as from the Sun. Dark, dull surfaces absorb and emit more radiation than light, shiny ones.
		5	**Thermal Expansion**	Materials expand when heated and contract when cooled. Applications include expansion gaps in railways and bridges, and liquid thermometers.
14	**Light**	1	**Properties of Light**	Light travels in straight lines at about 300,000 km/s, much faster than sound, which is why lightning is seen before thunder is heard.
		2	**Reflection**	The law of reflection (angle of incidence equals angle of reflection), and regular reflection from mirrors compared with diffuse reflection from rough surfaces.

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		3	**Refraction**	Light bends when it passes between materials of different densities, making a pencil in water look bent. Lenses use refraction.
		4	**Dispersion and Colour**	A prism splits white light into a spectrum of colours. Objects appear coloured because they reflect some colours and absorb others.
15	**Sound**	1	**Sound Waves**	Sound travels as vibrations passed through a medium. It moves fastest in solids and slowest in gases, and cannot travel through a vacuum.
		2	**Frequency, Amplitude, Pitch and Loudness**	Higher frequency (hertz) gives higher pitch and larger amplitude gives louder sound, measured in decibels.
		3	**Hearing Range and Uses of Sound**	Humans hear roughly 20–20,000 Hz. Echoes, sonar and ultrasound are used by bats and dolphins and in medicine.
16	**Magnetism and Electricity**	1	**Magnetic Fields**	Field lines shown with iron filings and plotting compasses, field strength near the poles, and Earth's magnetic field.
		2	**Electromagnets**	A current-carrying coil becomes a magnet. Strength increases with more turns, more current or an iron core. Uses include cranes, bells and door locks.
		3	**Static Electricity**	Rubbing transfers charge, like charges repel and unlike charges attract, and lightning is a large static discharge.
		4	**Electric Circuits and Components**	Cells, switches, bulbs, buzzers and resistors drawn with standard circuit symbols. Current flows only in a closed circuit.
		5	**Series and Parallel Circuits**	Comparing bulb brightness and the effect of a break in series and parallel circuits, and why homes are wired in parallel.
		6	**Electrical Energy and Safety**	Power ratings of appliances, fuses, circuit breakers and earthing as safety devices, and saving electricity.
17	**Earth's Structure, Rocks and Soil**	1	**Structure of the Earth**	The crust (continental and oceanic), mantle, and outer and inner core, and an introduction to tectonic plates.
		2	**Rock Types**	Igneous rocks form from cooled magma (granite, basalt), sedimentary rocks from compressed layers (sandstone, limestone) and metamorphic rocks from heat and pressure (marble, slate).
		3	**The Rock Cycle**	How weathering, erosion, deposition, compaction, heat, pressure, melting and cooling continuously change rocks from one type to another.
		4	**Weathering and Erosion**	Physical (freeze–thaw), chemical (acid rain) and biological (plant roots) weathering, and erosion and deposition by water, wind and ice.

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		5	**Soil Formation and Conservation**	Soil forms from weathered rock and humus in layers (horizons). Erosion is reduced by terracing, tree planting and windbreaks.
		6	**Fossils**	How fossils form in sedimentary rock and what they reveal about past life and environments.
18	**Water, Atmosphere and Climate**	1	**The Water Cycle in Depth**	Evaporation, transpiration, condensation, precipitation, infiltration and runoff, driven by the Sun's energy.
		2	**Water Resources**	Surface water and groundwater (aquifers). Only a small fraction of Earth's water is fresh and accessible, so it must be managed carefully.
		3	**Earth's Atmosphere**	Composition (about 78% nitrogen, 21% oxygen) and layers: troposphere (weather), stratosphere (ozone layer), mesosphere, thermosphere and exosphere.
		4	**Air Pressure and Wind**	Air pressure decreases with altitude, is measured with a barometer, and wind moves from high to low pressure.
		5	**Climate Zones**	Tropical, arid, temperate and polar zones, and how latitude, altitude and distance from the sea shape climate.
		6	**Natural Hazards**	Earthquakes and volcanoes at plate boundaries, tsunamis, cyclones and floods, and how they are monitored and prepared for.
19	**Earth, Moon and Space**	1	**Rotation, Revolution and Time**	Earth's rotation gives day and night, and its orbit takes about 365¼ days, which explains leap years. Introduction to time zones.
		2	**Causes of Seasons**	Earth's axis is tilted about 23.5°, changing the angle of sunlight and day length. The two hemispheres have opposite seasons.
		3	**Moon Phases and Eclipses**	Phases explained by the positions of the Sun, Earth and Moon, and how solar and lunar eclipses occur.
		4	**Planets and Their Characteristics**	Rocky inner planets and giant outer planets, notable features of each, and dwarf planets and the asteroid belt.
		5	**The Sun and Stars**	The Sun as a star releasing energy through nuclear fusion. Stars differ in size, colour and temperature, distances are measured in light-years, and constellations appear to move across the sky.
		6	**Space Exploration and Satellites**	Natural and artificial satellites and their uses (communication, navigation, weather forecasting), telescopes, space probes and space stations.
20	**Ecosystems and Energy Flow**	1	**Biotic and Abiotic Factors**	How living factors and non-living factors (light, temperature, water, soil) affect where organisms live and how many survive.

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		2	**Food Chains and Food Webs**	Producers, primary, secondary and tertiary consumers, and decomposers, and how interconnected food chains form food webs.
		3	**Energy Flow and Energy Pyramids**	Only about 10% of energy passes to the next level, which explains why food chains are short and top predators are few.
		4	**Interactions Between Organisms**	Predator–prey relationships, competition for resources, and mutualism, such as bees and flowering plants.
		5	**Biodiversity**	The variety of species in an ecosystem, why biodiversity increases stability, and biodiversity hotspots.
21	**Environmental Challenges and Sustainability**	1	**Air, Water, Land and Noise Pollution**	Sources and effects of each type of pollution, including smog, acid rain and water contamination, and prevention measures.
		2	**Waste Management**	Landfill, incineration, composting and recycling, the problem of plastic pollution, and the Reduce, Reuse, Recycle approach.
		3	**Deforestation and Habitat Loss**	Causes of deforestation and its effects on biodiversity, soil erosion and the carbon balance.
		4	**The Greenhouse Effect and Global Warming**	Greenhouse gases such as carbon dioxide and methane trap heat. Burning fossil fuels strengthens this natural effect and raises global temperatures.
		5	**Climate Change and Its Effects**	Melting glaciers, rising sea levels and more extreme weather, and actions that reduce climate change.
		6	**Conservation and Sustainable Living**	Protecting endangered species such as the markhor through national parks and wildlife laws, and using resources sustainably.

CURRICULUM SUMMARY

- **Total Chapters:** 21
- **Total Topics:** 113
- **Life Science Coverage:** 31 topics (Chapters 02–06): cells, plant processes, classification, variation and inheritance, human organ systems, microorganisms and disease.
- **Physical Science Coverage:** 32 topics (Chapters 07, 11–16): particle model, density, forces, pressure, energy, machines, heat transfer, light, sound, magnetism and electricity.
- **Chemistry Foundations Coverage:** 15 topics (Chapters 08–10): atoms, elements, compounds, symbols and formulas, solutions, separation, chemical reactions, conservation of mass, acids, bases and pH.
- **Earth and Space Science Coverage:** 18 topics (Chapters 17–19): Earth's structure, the rock cycle, weathering, fossils, the atmosphere, climate zones, natural hazards, seasons, eclipses, planets, stars and satellites.
- **Environmental Science Coverage:** 11 topics (Chapters 20–21): biotic and abiotic factors, food webs, energy pyramids, biodiversity, pollution, deforestation, the greenhouse effect, climate change and conservation.
- **Scientific Investigation and STEM Thinking Coverage:** 6 topics (Chapter 01): the scientific method, hypotheses and variables, fair testing, SI measurement, graphing and evaluating evidence.
- **Overall Academic Focus:** The outline centres on mechanisms and systems: how and why processes happen, supported by hypothesis-led investigation, data interpretation and an introduction to chemistry.

ACADEMIC PROGRESSION

Beginner Level explained what things do: plant part functions, states of matter, pushes and pulls, and the Sun, Moon and planets. Learner Level explains the mechanisms behind them: photosynthesis and transport in plants, the particle model and changes of state, balanced and unbalanced forces, and Earth's rotation, tilt and orbit. It also opens new fields, including cells, introductory chemistry, heat transfer and climate science, and moves investigation from simple fair tests to hypotheses and variables. This prepares students for Elementary Level, where cell biology, chemical reactions, energy and Earth systems are studied with greater quantitative and analytical depth.