MARKHOR JUNIOR CONTEST

SCIENCE COURSE OUTLINE

ASPIRANT LEVEL

(Applicable to IX, X, O-Level & A-Level)

Chapter No.	Chapter Title	Topic No.	Topic Title	Concept Description
01	Scientific Methodology and Data Analysis	01	**The Nature of Scientific Knowledge**	Falsifiability, the distinction between theories and laws, how scientific paradigms change, and the roles of evidence, replication and peer review.
		02	**Experimental Design and Hypothesis Testing**	Null and alternative hypotheses, controls, randomisation, blind and double-blind designs, sample size and ethical considerations.
		03	**Accuracy, Precision, Reliability and Validity**	Distinguishing these four terms, systematic and random errors, calibration, and zero errors.
		04	**Significant Figures, Standard Form and Dimensional Analysis**	Expressing results to appropriate significant figures, scientific notation, and checking the homogeneity of equations using SI base units.
		05	**Uncertainty and Error Propagation**	Absolute, fractional and percentage uncertainties, combining uncertainties in sums and products, and using error bars on graphs.
		06	**Graphical Analysis and Linearisation**	Interpreting gradients and intercepts, and converting non-linear relationships to straight lines using reciprocal and logarithmic plots.
		07	**Statistical Reasoning**	Mean, median, range and standard deviation, the correlation coefficient, and the concept of statistical significance in experimental results.
		08	**Models, Assumptions and Conflicting Evidence**	Evaluating the assumptions and limitations of scientific models, recognising bias, and weighing conflicting studies to reach justified conclusions.
		09	**Interdisciplinary Problem-Solving and Engineering Design**	Systems thinking, optimisation, failure analysis and design trade-offs applied to real challenges such as water purification and renewable energy.
02	Cell Structure and Membranes	01	**Microscopy, Magnification and Resolution**	Light, transmission electron and scanning electron microscopes compared, the difference between magnification and resolution, and calculating actual sizes.
		02	**Eukaryotic Cell Ultrastructure**	Rough and smooth endoplasmic reticulum, Golgi apparatus, lysosomes, 80S ribosomes, mitochondria, chloroplasts and the cytoskeleton, and the protein secretion pathway.
		03	**Prokaryotic Cells and Viruses**	Prokaryotic features (70S ribosomes, circular DNA, plasmids, capsule) and virus structure and replication within host cells.

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		04	**Membrane Structure and Transport**	The fluid mosaic model, diffusion, facilitated diffusion, osmosis in terms of water potential, active transport, endocytosis and exocytosis.
03	**Biological Molecules and Enzymes**	01	**Carbohydrates**	Monosaccharides, glycosidic bonds formed by condensation and broken by hydrolysis, and how the structures of starch, glycogen and cellulose suit their functions.
		02	**Lipids**	Triglycerides and ester bonds, phospholipids, saturated and unsaturated fatty acids, and the roles of lipids in energy storage, insulation and membranes.
		03	**Proteins**	Amino acids and peptide bonds, primary to quaternary structure, bonds stabilising shape, and globular (haemoglobin) compared with fibrous (collagen) proteins.
		04	**Nucleic Acids, ATP and Water**	Nucleotide structure, differences between DNA and RNA, ATP as the energy currency, and properties of water arising from hydrogen bonding.
		05	**Enzyme Mechanism and Kinetics**	Induced-fit model, lowering of activation energy, rate graphs and Vmax, competitive and non-competitive inhibition, and immobilised enzymes.
04	**Cell Division, DNA and Protein Synthesis**	01	**The Cell Cycle and Mitosis**	Interphase and stages of mitosis, chromatids and centromeres, and cancer as uncontrolled cell division.
		02	**Meiosis and Genetic Variation**	Reduction division, crossing over, independent assortment and random fertilisation as sources of variation.
		03	**DNA Replication**	Semi-conservative replication, the roles of helicase and DNA polymerase, and the Meselson–Stahl experiment as evidence.
		04	**Protein Synthesis**	Transcription of DNA into mRNA, the triplet genetic code, translation at ribosomes by tRNA, and how mutations alter proteins.
05	**Genetics and Inheritance**	01	**Monohybrid and Dihybrid Crosses**	Genetic diagrams, test crosses, the 3:1 and 9:3:3:1 ratios, and recognising deviations from expected ratios.
		02	**Codominance, Multiple Alleles and Sex Linkage**	ABO blood groups, sex-linked conditions such as haemophilia and colour blindness, and interpreting pedigrees.
		03	**Mutations and Genetic Disorders**	Gene and chromosome mutations, sickle cell anaemia and its link to malaria resistance, Down syndrome, and how genes interact with the environment.
06	**Evolution and Biodiversity**	01	**Natural Selection and Types of Selection**	Stabilising, directional and disruptive selection, with examples including antibiotic and pesticide resistance.
		02	**Speciation**	Allopatric and sympatric speciation, and geographical, behavioural and reproductive isolating mechanisms.

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		03	**Classification and Phylogenetics**	The taxonomic hierarchy, the three-domain system, cladograms and molecular evidence for evolutionary relationships.
		04	**Measuring Biodiversity**	Species richness and evenness, calculating Simpson's diversity index, and genetic diversity within populations.
07	**Plant Biology**	01	**Light-Dependent and Light-Independent Reactions**	Photolysis of water, production of ATP and NADPH in thylakoids, the Calvin cycle with rubisco, and analysis of limiting factors.
		02	**Water Transport in Plants**	Water potential gradients, the cohesion–tension mechanism, apoplast and symplast pathways, and adaptations of xerophytes.
		03	**Translocation and Mineral Nutrition**	The mass flow hypothesis from source to sink, and the roles of nitrogen, phosphorus, potassium and magnesium in plant growth.
		04	**Plant Growth Regulators**	Auxins, gibberellins, abscisic acid (stomatal closure) and ethene, and their commercial applications.
08	**Cellular Respiration**	01	**Stages of Aerobic Respiration**	Glycolysis, the link reaction, the Krebs cycle and oxidative phosphorylation, with their locations and ATP yields.
		02	**Anaerobic Respiration and Respiratory Quotient**	Lactate and ethanol fermentation, calculating respiratory quotients, and measuring respiration rate with respirometers.
09	**Human Nutrition and Gas Exchange**	01	**Digestion and Absorption Mechanisms**	Enzymes along the gut, co-transport of glucose and amino acids, micelles in fat absorption, and adaptations of villi and microvilli.
		02	**Ventilation and Gas Exchange**	Mechanics of ventilation, factors in Fick's law affecting diffusion rate, and interpreting spirometer traces.
		03	**Oxygen Transport and Haemoglobin**	Oxygen dissociation curves, the Bohr effect, fetal haemoglobin and adaptation to high altitude.
10	**Circulation and Cardiovascular Health**	01	**The Cardiac Cycle and Its Control**	Pressure and volume changes, the roles of the SAN, AVN and Purkinje fibres, and interpreting ECG traces.
		02	**Blood Vessels, Tissue Fluid and Cardiac Output**	Structure–function of vessels, formation and return of tissue fluid, and cardiac output = stroke volume × heart rate.
		03	**Cardiovascular Disease and Risk Analysis**	Atherosclerosis and its consequences, risk factors, and interpreting epidemiological data on heart disease.
11	**Homeostasis and Excretion**	01	**Principles of Homeostasis**	Receptors, coordinators and effectors, negative feedback, and examples of positive feedback.

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		02	**Thermoregulation and Blood Glucose Control**	Endotherms and ectotherms, the actions of insulin and glucagon on target cells, and the management of diabetes.
		03	**Kidney Function and Osmoregulation**	Ultrafiltration, selective reabsorption, the loop of Henle, and control of water reabsorption by ADH in the collecting duct.
12	**Nervous and Hormonal Coordination**	01	**Nerve Impulses**	Resting and action potentials, depolarisation and repolarisation, the refractory period and saltatory conduction.
		02	**Synaptic Transmission**	Release and action of neurotransmitters such as acetylcholine, summation, and the effects of drugs on synapses.
		03	**Muscle Contraction**	The sliding filament model, interaction of actin and myosin, and the roles of calcium ions and ATP.
		04	**Hormone Action and the Endocrine System**	Peptide and steroid hormones, target cell receptors, an introduction to second messengers, and the actions of adrenaline.
13	**Human Reproduction**	01	**Gametogenesis and Fertilisation**	Spermatogenesis, oogenesis and the events of fertilisation, including the acrosome reaction.
		02	**Hormonal Control of Reproduction**	Feedback control of the menstrual cycle by FSH, LH, oestrogen and progesterone, the principles of contraception, and in vitro fertilisation.
		03	**Pregnancy and Development**	Placental exchange, hormones of pregnancy such as hCG, and the main stages of embryonic development.
14	**Immunity and Infectious Disease**	01	**Pathogens and Epidemiology**	Disease caused by bacteria, viruses, fungi and protoctists, and transmission and control of cholera, tuberculosis, malaria and HIV/AIDS.
		02	**The Immune Response**	Non-specific defences, phagocytosis, T and B lymphocytes, clonal selection, antibody structure, and primary and secondary responses.
		03	**Vaccination, Antibiotics and Resistance**	Active and passive immunity, herd immunity, monoclonal antibodies, how antibiotics work and how resistance develops.
15	**Ecology and Population Biology**	01	**Population Dynamics**	J-shaped and S-shaped growth curves, carrying capacity, density-dependent and density-independent factors, and predator–prey relationships.
		02	**Productivity and Energy Transfer**	Gross and net primary productivity, and calculating efficiency of energy transfer between trophic levels.
		03	**Succession and Ecosystem Stability**	Primary and secondary succession, pioneer species and climax communities, and factors affecting ecosystem stability.

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16	**Biotechnology and Genetic Engineering**	01	**Recombinant DNA Technology**	Restriction enzymes, DNA ligase, plasmid vectors and transformation, with the production of human insulin as an example.
		02	**PCR, Gel Electrophoresis and DNA Profiling**	Amplifying DNA by PCR, separating fragments by electrophoresis, and applications in forensics and paternity testing.
		03	**Applications and Ethics of Biotechnology**	Genetically modified crops, gene therapy, an introduction to CRISPR gene editing, stem cell therapy, and the ethical and social issues they raise.
17	**Measurement and Kinematics**	01	**Physical Quantities and Units**	SI base and derived units, prefixes, homogeneity of equations, and estimating physical quantities.
		02	**Vectors: Addition and Resolution**	Adding vectors by drawing and calculation, and resolving vectors into perpendicular components.
		03	**Kinematics and Projectile Motion**	Equations of uniformly accelerated motion, motion graphs, independence of horizontal and vertical motion, and the effect of air resistance.
18	**Dynamics**	01	**Newton's Laws and Free-Body Diagrams**	Applying $\Sigma F = ma$ to connected bodies, and analysing normal reaction, tension, weight and friction with free-body diagrams.
		02	**Momentum, Impulse and Collisions**	Impulse as the area under a force–time graph, elastic and inelastic collisions, and conservation of momentum.
		03	**Equilibrium, Moments and Couples**	Torque and couples, conditions for equilibrium of coplanar forces, and centre of gravity.
		04	**Circular Motion**	Angular velocity, centripetal acceleration ($a = v^2/r$) and centripetal force in banking, loops and orbits.
19	**Work, Energy and Power**	01	**Work and Energy Conservation**	$W = Fs\cos\theta$, kinetic, gravitational and elastic potential energy, the work–energy principle and energy dissipation.
		02	**Power and Efficiency**	$P = Fv$, efficiency of engines and machines, and analysis of energy flows.
20	**Gravitation**	01	**Newton's Law of Gravitation**	$F = Gm_1m_2/r^2$, gravitational field strength $g = GM/r^2$, and gravitational field lines.
		02	**Orbits and Gravitational Potential**	Orbital speed and period, geostationary satellites, gravitational potential, and an introduction to escape velocity.
21	**Matter, Materials and Fluids**	01	**Pressure in Fluids**	$p = \rho gh$, atmospheric pressure, and measurement with manometers and barometers.
		02	**Upthrust and Archimedes' Principle**	Buoyancy calculations, conditions for floating, and applications in ships, submarines and hydrometers.

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		03	**Elasticity and Material Properties**	Hooke's law, stress, strain and the Young modulus, elastic potential energy, and stress–strain curves for ductile and brittle materials.
22	**Thermal Physics**	01	**Temperature and Thermal Equilibrium**	Thermometric properties, the Kelvin scale, absolute zero, and thermal equilibrium.
		02	**Specific Heat Capacity and Latent Heat**	Calculations and experimental methods using electrical heating and the method of mixtures.
		03	**Ideal Gases and Kinetic Theory**	Boyle's, Charles's and pressure laws, $pV = nRT$, assumptions of kinetic theory, and mean kinetic energy proportional to absolute temperature.
		04	**Internal Energy and the First Law of Thermodynamics**	Internal energy as the sum of particle kinetic and potential energies, $\Delta U = Q + W$, and an introduction to heat engines.
		05	**Thermal Radiation**	Black-body radiation, emissivity, and qualitative treatment of how peak wavelength and power output depend on temperature.
23	**Oscillations and Waves**	01	**Simple Harmonic Motion**	The defining condition $a \propto -x$, periods of pendulums and mass–spring systems, energy in SHM, damping and resonance.
		02	**Properties of Progressive Waves**	Transverse and longitudinal waves, phase difference, intensity, and polarisation.
		03	**Superposition and Interference**	Coherence, path difference, Young's double-slit experiment and diffraction gratings.
		04	**Stationary Waves**	Formation of nodes and antinodes, and harmonics on strings and in air columns.
		05	**The Doppler Effect**	Frequency shifts from moving sources, with applications in speed detection, medical imaging and astronomy.
24	**Optics**	01	**Refraction and Snell's Law**	$n_1 \sin \theta_1 = n_2 \sin \theta_2$, critical angle, total internal reflection, and optical fibres in communication and endoscopy.
		02	**Lenses and Optical Instruments**	The lens formula, magnification and lens power in dioptres, telescopes and microscopes, and correction of vision.
		03	**The Electromagnetic Spectrum and Communication**	Properties of each region, uses and hazards, and principles of communication systems.
25	**Electricity**	01	**Electrostatics and Electric Fields**	Coulomb's law, electric field strength ($E = F/q$), and uniform fields between parallel plates.
		02	**Electric Potential and Capacitance**	Potential and potential difference, capacitors and $Q = CV$, energy stored, and an introduction to charging and discharging.
		03	**Current, Resistance and Resistivity**	$I = nAvq$, $R = \rho L/A$, I–V characteristics, and how resistance depends on temperature.

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		04	**Circuit Analysis and Kirchhoff's Laws**	Conservation of charge and energy in circuits, series–parallel networks, potential dividers and sensor circuits.
		05	**EMF and Internal Resistance**	$E = I(R + r)$, terminal potential difference, and how internal resistance limits current and power.
26	**Magnetism and Electromagnetism**	01	**Magnetic Forces**	$F = BIL$ and $F = Bqv$, Fleming's left-hand rule, and fields around wires and solenoids.
		02	**Motors and Charged Particles in Fields**	DC motor design, deflection of charged particles in electric and magnetic fields, and an introduction to the mass spectrometer.
		03	**Electromagnetic Induction**	Magnetic flux, Faraday's law and Lenz's law, and factors affecting induced emf.
		04	**Alternating Current and Power Transmission**	Root mean square values, transformer equations, reducing I^2R losses in power transmission, and rectification.
27	**Atomic and Nuclear Physics**	01	**The Nuclear Atom**	Evidence from Rutherford scattering, nuclear notation, nucleon number and isotopes.
		02	**Radioactive Decay**	Properties of alpha, beta and gamma radiation, decay equations, half-life calculations and background radiation.
		03	**Nuclear Fission and Fusion**	Mass–energy equivalence ($E = mc^2$), an introduction to binding energy, nuclear reactors and fusion in stars.
		04	**Applications and Radiation Safety**	Medical tracers and radiotherapy, carbon dating, industrial uses, radiation dose and protection.
28	**Modern Physics and Energy Technologies**	01	**The Photoelectric Effect and Photons**	Photon energy $E = hf$, work function, threshold frequency, and wave–particle duality.
		02	**Energy Levels and Atomic Spectra**	Emission and absorption line spectra, electron energy levels, and the principles of lasers.
		03	**Semiconductors and Energy Technologies**	Diodes, LEDs and photovoltaic cells, batteries and modern energy storage technologies.
29	**Atomic Structure and Periodicity**	01	**Isotopes and Mass Spectrometry**	Calculating relative atomic mass from mass spectra and isotopic abundances.
		02	**Electron Configuration and Orbitals**	Shells, s, p and d subshells, orbital filling order, and configurations of atoms and ions.
		03	**Ionisation Energy**	Trends across periods and down groups, and successive ionisation energies as evidence for electron shells and subshells.
		04	**Periodic Trends and Group Chemistry**	Atomic radius, electronegativity and melting points across Period 3, and the chemistry of Group 2 and Group 17.

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30	**Chemical Bonding and Structure**	01	**Ionic and Metallic Bonding**	Ionic lattices, metallic bonding with delocalised electrons, and resulting physical properties.
		02	**Covalent Bonding and Molecular Shapes**	Single, double and dative covalent bonds, and VSEPR theory predicting linear, trigonal planar, tetrahedral, pyramidal and bent shapes with bond angles.
		03	**Polarity and Intermolecular Forces**	Electronegativity and bond polarity, London (van der Waals) forces, permanent dipole forces and hydrogen bonding, and their effect on boiling points.
		04	**Giant Structures and Properties**	Diamond, graphite, graphene and silicon dioxide, and predicting properties of substances from their structure.
31	**Stoichiometry and the Mole**	01	**The Mole and Avogadro's Constant**	Amount of substance, molar mass and Avogadro's constant (6.02×10^{23} mol^{-1}).
		02	**Empirical and Molecular Formulae**	Deriving formulae from percentage composition and combustion data.
		03	**Reacting Masses, Limiting Reagents and Yield**	Reacting mass calculations, identifying limiting reagents, percentage yield and atom economy.
		04	**Gas Volumes and Solution Calculations**	Molar gas volume (24 dm^3 at room temperature and pressure), concentration in mol/dm^3, and titration calculations.
		05	**Ideal and Real Gases**	Applying $pV = nRT$ in chemical calculations, and why real gases deviate from ideal behaviour at high pressure and low temperature.
32	**Chemical Energetics**	01	**Enthalpy Changes and Calorimetry**	ΔH and standard conditions, exothermic and endothermic reactions, and calculating enthalpy changes from calorimetry data.
		02	**Hess's Law**	Constructing energy cycles and using enthalpies of formation and combustion to find unknown enthalpy changes.
		03	**Bond Enthalpies**	Calculating enthalpy changes from mean bond enthalpies and understanding the limitations of this method.
33	**Reaction Kinetics and Equilibrium**	01	**Collision Theory and Catalysis**	Measuring reaction rates, the Maxwell–Boltzmann distribution, activation energy, and how catalysts work.
		02	**Rate Equations**	Order of reaction, rate constants, and deducing orders from experimental data at an introductory level.
		03	**Chemical Equilibrium**	Dynamic equilibrium, Le Chatelier's principle, and an introduction to the equilibrium constant Kc.
		04	**Industrial Equilibria**	Choosing compromise conditions of temperature, pressure and catalyst in the Haber and Contact processes.

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34	Acids, Bases and Salts	01	**Brønsted–Lowry Theory**	Acids as proton donors and bases as proton acceptors, conjugate acid–base pairs, and strong compared with weak acids.
		02	**pH and Buffer Solutions**	pH = −log[H^+], calculating the pH of strong acids and bases, and how buffers resist pH change.
		03	**Titration Curves and Salt Preparation**	Interpreting titration curves, choosing indicators, and methods for preparing pure soluble and insoluble salts.
35	Redox and Electrochemistry	01	**Oxidation States and Redox Reactions**	Assigning oxidation numbers, writing half-equations, and identifying oxidising and reducing agents.
		02	**Electrolysis**	Predicting electrode products for molten and aqueous electrolytes, and quantitative electrolysis using the Faraday constant.
		03	**Electrochemical Cells**	Standard electrode potentials, calculating cell emf, and the chemistry of batteries and fuel cells.
36	Inorganic Chemistry	01	**Metals, Extraction and Recycling**	The reactivity series, extraction of iron in the blast furnace and aluminium by electrolysis, and the benefits of recycling metals.
		02	**Non-Metals and Their Compounds**	Chemistry of nitrogen, sulfur and chlorine, and the production and uses of ammonia and sulfuric acid.
		03	**Transition Elements**	Variable oxidation states, formation of complex ions, coloured compounds and catalytic properties.
37	Organic Chemistry	01	**Nomenclature, Functional Groups and Isomerism**	Homologous series, IUPAC naming, functional groups, and structural isomerism.
		02	**Alkanes and Crude Oil**	Fractional distillation, cracking, complete and incomplete combustion, and free-radical substitution.
		03	**Alkenes and Addition Reactions**	Testing for unsaturation with bromine water, hydrogenation, hydration, and addition polymerisation.
		04	**Alcohols**	Production by fermentation and by hydration of ethene, oxidation to aldehydes and carboxylic acids, combustion and uses.
		05	**Carboxylic Acids and Esters**	Acidic reactions of carboxylic acids, esterification, and uses of esters in flavourings and solvents.
		06	**Polymers**	Addition and condensation polymers (polyesters, polyamides such as nylon), biodegradability and plastic recycling.

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38	**Chemical Analysis**	01	**Qualitative Analysis**	Identifying cations by flame tests and hydroxide precipitates, and anions (carbonate, sulfate, halides) and gases by chemical tests.
		02	**Chromatography and Instrumental Analysis**	Paper, thin-layer and gas chromatography with Rf values, and an introduction to mass spectrometry and infrared spectroscopy.
39	**Earth Systems and Geology**	01	**Earth's Formation and Internal Structure**	Accretion and differentiation of the early Earth, seismic evidence for internal layers, and the geothermal gradient.
		02	**Plate Tectonics and Geohazards**	Plate motion mechanisms, boundary processes, the logarithmic magnitude scale for earthquakes, and assessing volcanic and seismic risk.
		03	**Minerals, Rocks and Economic Geology**	Mineral identification, rock-forming processes in the rock cycle, and the formation of metal ores.
		04	**Geological Time and Earth History**	Radiometric dating, the fossil record, mass extinctions and the major divisions of geological time.
40	**Atmosphere, Oceans and Climate Systems**	01	**Atmospheric Composition and Ozone**	Atmospheric layers, ozone formation and absorption of ultraviolet light, and the chemistry of ozone depletion by CFCs.
		02	**Atmospheric Circulation and Weather Systems**	Hadley, Ferrel and polar cells, the Coriolis effect, jet streams, and tropical cyclones.
		03	**Ocean Circulation and the Global Water Cycle**	Thermohaline circulation, the El Niño–Southern Oscillation, and the oceans' role in storing heat.
		04	**Earth's Energy Balance and Climate Modelling**	Incoming and outgoing radiation, albedo, the mechanism of the greenhouse effect, climate feedbacks, and the uses and limitations of climate models.
41	**Astronomy and Cosmology**	01	**Planetary Science and Exoplanets**	Formation of the Solar System, comparative planetology, and detecting exoplanets by transit and radial velocity methods.
		02	**Stellar Properties and Distances**	Luminosity, apparent and absolute magnitude, measuring distance by parallax, spectral classes and the Hertzsprung–Russell diagram.
		03	**Stellar Evolution**	Main-sequence lifetimes, red giants, white dwarfs, neutron stars and black holes, and formation of elements in stars.
		04	**Galaxies and Cosmology**	Hubble's law and the expanding universe, evidence for the Big Bang (redshift, cosmic microwave background, element abundances), and dark matter and dark energy.
		05	**Space Exploration and Observational Astronomy**	Telescopes across the electromagnetic spectrum, satellites and space-based observatories, and major space missions.

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42	**Ecosystems and Conservation**	01	**Biogeochemical Cycles and Human Disruption**	The carbon, nitrogen and phosphorus cycles, and human disruption leading to eutrophication.
		02	**Conservation Strategies**	In-situ and ex-situ conservation, habitat corridors, IUCN threat categories, and community-led recovery of the markhor.
		03	**Ecosystem Services and Ecological Footprint**	Provisioning, regulating and cultural services of ecosystems, and measuring human demand with ecological footprints.
43	**Pollution, Climate Change and Sustainability**	01	**Air Pollution and Atmospheric Chemistry**	Photochemical smog, acid rain from sulfur and nitrogen oxides, particulates, and catalytic converters.
		02	**Water and Soil Pollution and Remediation**	Heavy metals, bioaccumulation and biomagnification, bioremediation and wastewater treatment.
		03	**Climate Change: Evidence and Consequences**	Instrumental records and ice-core data, attribution to human activity, sea-level rise and ocean acidification.
		04	**Climate Mitigation and Adaptation**	Carbon capture and storage, reforestation, low-carbon technologies and adaptation measures.
		05	**Energy Resources and Energy Security**	Fossil, nuclear and renewable resources, intermittency and energy storage, and balancing an energy mix.
		06	**Sustainable Technologies and the Circular Economy**	Green chemistry, life-cycle assessment, sustainable materials and the waste hierarchy.

CURRICULUM SUMMARY

- **Total Chapters:** 43
- **Total Unique Topics:** 162
- **Biology:** 51 topics (Chapters 02–16)
- **Physics:** 43 topics (Chapters 17–28)
- **Chemistry:** 37 topics (Chapters 29–38)
- **Earth and Space Science:** 13 topics (Chapters 39–41)
- **Environmental Science:** 9 topics (Chapters 42–43), with further environmental content in Ecology, Chemistry and Climate chapters
- **Scientific Investigation, Data Analysis and Research Skills:** 9 topics (Chapter 01), applied throughout all quantitative chapters

ACADEMIC DEPTH AND DIFFICULTY

Aspirant is the most demanding MJC level. It requires precise scientific terminology, multi-step quantitative reasoning (stoichiometry, kinematics, circuit analysis, energetics, uncertainty propagation) and explanations at the level of molecular and cellular mechanisms. Students must interpret unfamiliar data, evaluate models and evidence, and connect ideas across disciplines, such as energy balance in climate science or redox chemistry in batteries. The depth stays below university specialist level.

PROGRESSION BEYOND PIONEER

Pioneer introduced enzymes, Punnett squares, momentum, electromagnetic induction, bonding, the mole and reaction rates. Aspirant develops these into full mechanisms and quantitative models: membrane ultrastructure and water potential, protein synthesis and DNA replication, the biochemistry of photosynthesis and respiration, and action potentials in biology; SHM, superposition, gravitational and electric fields, capacitance, Kirchhoff's laws, radioactivity and the photoelectric effect in physics; orbitals, ionisation energy, VSEPR shapes, Hess's law, equilibrium, electrode potentials and organic chemistry. Investigation advances to error propagation, linearisation and statistical significance.

ONE COMMON SYLLABUS

All students registered at MJC Aspirant Level (IX, X, O-Level and A-Level) follow exactly the same chapters and topics. There are no separate class-wise, board-wise or tiered syllabi.