Cornwallis Academy
Ambitions for All

SMILE
SUCCESSFUL | MOTIVATED | INSPIRED | LEARNING | EXCITED & ENGAGED

Year 13 Biology

Topic Title: Module 11

Learning Objectives

Photosynthetic Light-Dependent Reactions: Map chemiosmotic ATP synthesis and photolysis across thylakoid membranes.

• Light-Independent Calvin Cycle: Track carbon fixation via RuBisCO, GP reduction, and TP regeneration.

• Respiratory Pathways: Detail glycolysis, the Link reaction, Krebs cycle, and oxidative phosphorylation across mitochondrial domains.

• Biomass Energy Transfer Efficiency: Quantify net primary productivity (NPP = GPP - R) and energy transfer coefficients across trophic levels.

• Nutrient Cycle Microhabitats: Model nitrogen fixation, nitrification, denitrification, and phosphorus mineralization loops.

What previous knowledge is required?

Year 12 Cell Ultrastructure: Mitochondrial and chloroplast compartmentalization from Module 3.

• ATP Biochemical Energetics: Role of ATP as the universal energy currency from Module 2.

How will this term's content help with future learning?

• Global Climate Feedbacks: Predicting ecosystem carbon sinks and nitrogen run-off impacts in environmental science.

- • Metabolic Engineering: Optimizing microbial fermentation and artificial photosynthesis for bioenergy production.

Common Misconceptions

• Dark Reaction Nighttime Assumptions: Believing the light-independent reactions only occur at night, ignoring their absolute dependence on daytime ATP/NADPH.

• Energy Destruction: Assuming lost biomass energy disappears from existence rather than being dissipated as metabolic heat.

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National Curriculum / Specification

• Sections 3.5.1 (Photosynthesis), 3.5.2 (Respiration), 3.5.3 (Energy Transfer), and 3.5.4 (Nutrient Cycles).

• Practical Connections: Required Practical 7 (Chromatography of photosynthetic pigments) and Required Practical 8 (Dehydrogenase activity in yeast using DCPIP).

Topic Title: Module 12

Learning Objectives

• Plant Growth Factor Tropisms: Detail indoleacetic acid (IAA) distribution causing phototropisms and gravitropisms.

• Reflex Arc Architectures: Map rapid involuntary pathways spanning sensory, intermediate, and motor neurons.

• Autonomic Cardiovascular Control: Profile baroreceptor and chemoreceptor modulation of heart rate via the medulla oblongata.

• Sensory Receptor Transduction: Analyse pacinian corpuscles as mechanical transducers generating generator potentials.

What previous knowledge is required?

Year 12 Plasma Membrane Permeability: Stretch-mediated sodium channels and voltage gating from Module 7.

• Cardiac Cycle Kinetics: Myogenic stimulation networks from Module 10.

How will this term's content help with future learning?

• Neurotrauma Clinical Pathology: Diagnostics of reflex impairment and autonomic dysfunction in medical fields.

• Plant Biosecurity: Formulating synthetic auxin herbicides to manipulate agricultural weed populations.

Common Misconceptions

• Brain Reflex Control: Believing conscious brain decisions are required for a reflex arc to complete.

• Receptor Action Potentials: Assuming receptors directly generate action potentials rather than localized generator potentials.

National Curriculum / Specification

• Sections 3.6.1.1 (Survival and Response) and 3.6.1.2 (Nervous Control of Heart Rate).

• Practical Connections: Choice chamber experiments tracking animal taxes/kineses, and measuring root/shoot responses to directional stimuli.

Topic Title: Module 13

Learning Objectives

Action Potential Kinetics: Map resting potentials, depolarisation thresholds, and repolarisation phases via ion channels.

• Saltatory Conduction Mechanics: Evaluate the role of myelin sheaths and nodes of Ranvier in accelerating impulse propagation.

• Synaptic Transmission Cascades: Track neurotransmitter release, postsynaptic receptor binding, and acetylcholinesterase breakdown.

• Spatial and Temporal Summation: Analyse how sub-threshold postsynaptic potentials combine to trigger or inhibit action potentials.

What previous knowledge is required?

• Year 12 Active Transport Systems: Sodium-potassium pump operations from Module 7.

• Proteomic Architecture: G-protein coupled receptors and channel shapes from Module 2.

How will this term's content help with future learning?

Neuropharmacological Targeting: Design of specialized drugs targeting synaptic clefts for psychiatric therapies.

• Neuromorphic Computing: Utilising biological neural summation models to build advanced artificial intelligence systems.

Common Misconceptions

• Variable Impulse Amplitude: Believing stronger stimuli produce larger action potentials rather than a higher frequency of identical pulses.

• Bidirectional Synaptic Flow: Expecting impulses to travel backward across synapses, missing the exclusive localization of neurotransmitter receptors.

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• Section 3.6.2 (Nervous Coordination) and 3.6.3 (Skeletal Muscles as Effectors).

• Practical Connections: Using oscilloscopes or virtual simulations to measure axon conduction velocities, and tracking myofibril sliding filament kinetics.

Topic Title: Module 14

Learning Objectives

• Negative Feedback Control: Model the core principles of deviation detection, corrective mechanisms, and set-point restoration.

• Glycemia Hormonal Regulation: Detail the competitive loops of insulin, glucagon, and adrenaline via the second messenger model.

• Nephron Osmoregulation: Map ultrafiltration in Bowman's capsule and counter-current multiplication in the Loop of Henle.

• ADH Aquaporin Recruitment: Track how antidiuretic hormone triggers distal tubule and collecting duct water reabsorption.

What previous knowledge is required?

• Year 12 Osmotic Gradients: Water potential dynamics and selective permeability from Module 7.

• Enzyme Kinetics: Temperature and pH denaturing conditions from Module 2.

How will this term's content help with future learning?

• Endocrinology and Diabetology: Formulating therapeutic strategies for Type 1 and Type 2 diabetes management.

• Renal Medicine Pathways: Managing chronic kidney disease and configuring artificial haemodialysis machines.

Common Misconceptions

Homeostatic Absolute Flatlines: Assuming internal body conditions remain perfectly static rather than fluctuating around a dynamic equilibrium.

• Active Water Transport: Believing aquaporins actively pump water molecules rather than facilitating passive down-gradient osmosis.

National Curriculum / Specification

• Section 3.6.4 (Homeostasis).

• Practical Connections: Required Practical 11 (Production of a dilution series of a glucose solution and using colorimetry to find unknown concentrations), and urinalysis profiling.

Topic Title: Module 15

Learning Objectives

- **Triplet Codon Specifications:** Map the universal, non-overlapping, and degenerate nature of the linear triplet code within gene loci.
- **Eukaryotic Genomic Topography:** Discriminate between coding exons and non-coding introns, tracking the removal of introns during splicing.
- **Transcription Enzyme Sub-loops:** Profile how RNA polymerase assembles complementary pre-mRNA strands along exposed DNA templates.
- **Translational Assembly Protocols:** Detail how ribosomal complexes coordinate tRNA aminoacyl actions to synthesize precise polypeptide sequences.

What previous knowledge is required?

- **Year 12 Nucleic Acid Architecture:** DNA double-helix models and hydrogen bonding parameters from Module 4.
- **Peptide Condensation Chemistry:** Peptide bond synthesis mechanics from Module 2.

How will this term's content help with future learning?

- **Epigenetic Control Systems:** Foundational knowledge for tracking how histone methylation and DNA acetylation alter gene expression without changing base sequences.
- **Recombinant Gene Technology:** Essential framework for advanced biotechnology techniques like CRISPR editing, gene splicing, and industrial insulin production.
- **Oncological Research Frameworks:** Explains how mutations in transcription factors can cause uncontrolled cell division and tumor growth.

Common Misconceptions

- **Prokaryotic Splicing Steps:** Attempting to splice prokaryotic transcripts, forgetting that bacterial DNA lacks introns and undergoes direct translation.

- **Amino Acid Codon Scales:** Believing each individual base specifies an amino acid, rather than strict base triplets.
- **Universal Code Absolutes:** Forgetting that 'degenerate' means multiple distinct codons can specify the exact same amino acid

National Curriculum / Specification

Section 3.4.1 (DNA, Genes, and Chromosomes) and 3.4.2 (Protein Synthesis Pathways).

Practical Connections: mRNA-tRNA sequence translation matrix mapping, codon wheel calculations, and structural comparisons of organelle vs nuclear DNA.

Topic Title: Module 16

Learning Objectives

- **Mutational Defect Categorization:** Classify base substitutions, deletions, and additions, predicting their impacts on downstream protein structure.
- **Meiotic Reduction Division:** Map homologous pair segregation and independent assortment across meiosis I and meiosis II to yield haploid gametes.
- **Crossing Over Recombination:** Track how chiasmata formation and non-sister chromatid exchange generate genetic variation.
- **Chromosomal Non-Disjunction:** Analyze errors in spindle separation that alter chromosome counts, causing conditions like Down's syndrome.

What previous knowledge is required?

- **Year 12 Mitotic Replications:** Complete tracking of standard spindle networks and checkpoint mechanics from Module 6.
- **Protein Structure Dependences:** Understanding how primary amino acid sequences dictate final tertiary folds from Module 2.

How will this term's content help with future learning?

- **Population Genetics Metrics:** Provides the foundation for tracking allele frequencies over time using the Hardy-Weinberg equilibrium principle.
- **Evolutionary Biology Frameworks:** Explains how random mutations provide the raw genetic diversity that natural selection acts upon.
- **Clinical Genetics & Counseling:** Base operating theory for diagnosing chromosomal abnormalities and assessing hereditary risks.

Common Misconceptions

- **Mutations as Conscious Actions:** Writing that organisms mutate 'in order to survive' environmental changes, rather than mutations occurring as random replication errors.
- **Mitosis vs Meiosis Recombination:** Expecting crossing over to occur during standard mitotic divisions, which would destroy genetic cloning accuracy.
- **Haploid vs Diploid Definitions:** Confusing sister chromatid counts with homologous pair definitions when determining cellular ploidy levels.

National Curriculum / Specification Section 3.4.3 (Gene Mutations and Meiotic Divisions).

Practical Connections: Preparing and observing stained gametes, calculating genetic combination frequencies (2^n), and tracking chromosomal inheritance patterns.

Topic Title: Module 17

Learning Objectives

- **Natural Selection Dynamics:** Model how random mutations generate advantageous alleles that boost reproductive success and alter population allele frequencies.
- **Selection Pressure Profiles:** Discriminate between directional selection (e.g., antibiotic resistance) and stabilizing selection (e.g., human birth weights).

- **Adaptive Classification:** Categorize anatomical alterations, physiological adaptations, and behavioral changes that improve survival in specific niches.
- **Aseptic Microbial Testing:** Design controlled experiments using aseptic techniques to measure the effectiveness of antimicrobial compounds.

What previous knowledge is required?

- **Year 12 Bacterial Proliferation:** Knowledge of prokaryotic cell walls and binary fission rates from Modules 5 and 6.
- **Meiotic Variation Drivers:** Fluency in independent assortment and recombination mechanics from Module 12

How will this term's content help with future learning?

- **Industrial Bioprocess Control:** Essential training for maintaining large-scale sterile bioreactors in the pharmaceutical and biotechnology sectors.
- **Ecosystem Conservation Models:** Explains how selective pressures drive adaptation, helping ecologists predict species responses to climate change.
- **Global Resistance Monitoring:** Groundwork for international healthcare initiatives tracking and managing multi-drug-resistant superbugs.

Common Misconceptions

- **Antibiotic-Induced Mutations:** Believing antibiotics actively cause resistance mutations, rather than selecting for pre-existing resistant alleles.
- **Individual Evolutionary Adaptation:** Writing that an individual organism evolves during its lifetime, missing that selection acts on populations over generations.
- **Dominant Allele Domination:** Assuming advantageous alleles must always be genetically dominant, confusing dominance with selective advantage.

National Curriculum / Specification

Section 3.4.4 (Genetic Diversity, Adaptation, and Selective Pressures).

Practical Connections: Required Practical 6 (Investigating antimicrobial impacts using agar plates, sterile zones, and aseptic techniques).

Topic Title: Module 18

Learning Objectives

- **Binomial Nomenclature & Taxonomy:** Organize species into non-overlapping phylogenetic hierarchies spanning domains, kingdoms, phyla, classes, orders, families, genera, and species.
- **Courtship Behavioral Metrics:** Evaluate courtship behaviors as essential pre-mating rituals that support species recognition and reproductive isolation.
- **Community Index Calculations:** Quantitatively assess biodiversity by calculating indices of diversity that account for both species richness and total individual counts.
- **Agricultural Diversity Compromises:** Analyze the impact of intensive farming practices on regional biodiversity and evaluate conservation management strategies

What previous knowledge is required?

- **Year 12 Sampling Basics:** Preliminary exposure to random field sampling and basic data averaging from early modules.

- **Proteomic Comparison Tools:** Understanding that species relationships can be tracked by comparing amino acid sequences.

How will this term's content help with future learning?

- **Ecological Field Research:** Prepares students for professional environmental monitoring, habitat management, and ecological impact assessments.
- **Phylogenetic Genomics:** Groundwork for using DNA sequencing and computer algorithms to trace deep evolutionary lineages.
- **Environmental Policy Design:** Explains how biodiversity indices guide legislation, habitat protection, and international conservation priorities.

Common Misconceptions

- **Richness equals Diversity:** Treating species richness (the count of species) as identical to true diversity, ignoring the evenness of individual counts.
- **Taxonomic Hierarchy Overlaps:** Drawing overlapping groups in taxonomic sketches, missing the strict nested nature of classification hierarchies.
- **Static Classification Systems:** Viewing taxonomic frameworks as fixed, forgetting that genetic sequencing continually reshapes classification lineages.

National Curriculum / Specification

Sections 3.4.5 (Taxonomy), 3.4.6 (Farming Impacts), and 3.8.2.1 (Diversity Measurements).

Practical Connections: Calculating indices of diversity and evaluating the ecological balance between farming and conservation.

Topic Title: Module 19

Learning Objectives

- **Molecular Phylogenetics:** Compare genetic diversity across populations by directly analyzing DNA base sequences, mRNA records, and amino acid profiles.
- **Immunological Proteomics:** Apply antibody-antigen binding assays to measure structural similarities between serum proteins of different species.
- **Random Sampling Designs:** Design rigorous field sampling protocols using randomized coordinate grids to eliminate collector bias.
- **Statistical Variance Metrics:** Quantitatively analyze population variance by computing and interpreting means and standard deviations.

What previous knowledge is required?

- **Year 12 Analytical Metallurgy:** Chromatography separation mechanics and basic assay rules from Modules 1 and 2.
- **Antigen Binding Selectivity:** Core awareness of antibody-antigen variable region fits from Module 8

How will this term's content help with future learning?

- **Epidemiological Tracking Loops:** Base operating methods for tracking viral mutations and global transmission networks using gene sequencing.
- **Conservation Genetics Networks:** Using genetic diversity data to manage breeding programs for endangered species and avoid inbreeding depression.
- **Academic Research Design:** Prepares students for writing university-level lab reports with rigorous sampling and statistical variance analysis.

Common Misconceptions

- **Phenotypic Sequencing Guarantees:** Assuming that organisms with similar outward traits must have nearly identical DNA sequences, ignoring convergent evolution.
- **Standard Deviation Overlaps:** Believing that overlapping standard deviations mean two population averages are identical, missing the true meaning of variance.
- **Bias-Free Subjective Sampling:** Assuming one can collect truly representative field samples without using randomized coordinate generators.

National Curriculum / Specification

Section 3.4.7 (Investigating Diversity) and 3.8.3 (Quantitative Variation Methods).

Practical Connections: Random field sampling with quadrats, transect line tracking, and calculating and plotting standard deviation error bars