Year 13 Biology – Control of Gene Expression

West Kirby Grammar School

Learning about this topic is important because: Although every cell in an organism contains the same DNA, different genes are switched on or off to produce specialised cells with different functions. Understanding how gene expression is controlled explains how organisms develop, how cells become specialised and how genetic variation can influence phenotype. This topic also explores how advances in biotechnology, such as genome sequencing, genetic engineering and gene therapy, are transforming medicine, agriculture and scientific research.

This builds on (form GCSE): At GCSE, you learned that DNA carries genetic information, genes determine characteristics, and proteins are made using the genetic code. In this topic, you build on that knowledge by studying how gene expression is regulated, how mutations affect gene function, and how cells become specialised despite containing the same DNA. You will also investigate modern genetic technologies, including genome sequencing, recombinant DNA technology, gene editing and gene therapy, and evaluate their applications in medicine, agriculture and biotechnology.

This leads to: Final unit in A level specification – may lead to further studies at degree level on biochemistry, biology, medicine and bioscience degree

We will learn about:

- Gene mutations
- Cancer
- Stem cells
- Regulation of Transcription
- Epigenetics
- Genome projects
- Recombinant DNA technology
- In vivo and In vitro cloning
- Gene analysis

We will develop/practise skills including:

Throughout this topic, you will develop skills in analysing and interpreting biological data, evaluating scientific evidence, and applying knowledge to unfamiliar contexts. You will strengthen your understanding of molecular and genetic processes by interpreting DNA sequences, genetic data and experimental results, and by constructing clear, evidence-based explanations using precise scientific terminology. Mathematical skills include calculating percentages, ratios, probabilities and magnification, interpreting graphs and statistical data, and using logarithmic scales in the analysis of DNA sequencing and molecular techniques. Interpreting PCR and DNA sequencing results, and evaluating the reliability, validity and limitations of experimental methods.

Keyword Definition

Epigenetics	The study of heritable changes in gene expression that occur without changes to the DNA base sequence.
Epigenome	The complete pattern of chemical modifications to DNA and histones that regulates gene expression.
Methylation	The addition of methyl groups to DNA, reducing or preventing transcription of a gene.

You could learn more about this topic by doing the following

READ

- **AQA A-level Biology Student Book (Oxford University Press) – Topic 8 chapters on gene expression and biotechnology.**
- **Save My Exams – Comprehensive notes on gene expression, epigenetics, genetic engineering and genome sequencing.**
- **Physics & Maths Tutor (PMT) – Revision notes, past paper questions and mark schemes for Topic 8.**
- **Biological Sciences Review magazine – Articles on CRISPR, gene therapy, personalised medicine and genomics.**

WATCH

- **Cognito A-Level Biology (YouTube) – Videos covering gene expression, PCR, electrophoresis, genetic engineering and genome sequencing.**

Year 13 Biology – Control of Gene Expression

West Kirby Grammar School

Acetylation	The addition of acetyl groups to histone proteins, making DNA less tightly coiled and increasing transcription.
Transcription factor	A protein that binds to DNA and controls the rate of transcription by promoting or inhibiting RNA polymerase binding.
Recombinant DNA	DNA that has been formed by joining DNA from two different sources.
Restriction endonuclease	An enzyme that cuts DNA at specific recognition sequences, often producing sticky ends.
DNA ligase	An enzyme that joins DNA fragments together by catalysing the formation of phosphodiester bonds.
Polymerase Chain Reaction (PCR)	A technique used to amplify a specific DNA sequence, producing millions of copies.
Genome sequencing	The process of determining the complete sequence of bases in an organism's DNA.

- **SnapRevise A-Level Biology (YouTube) – Detailed AQA-specific explanations of Topic 8.**
- **Miss Estruch (YouTube) – Exam-focused lessons and worked examples.**
- **Amoeba Sisters (YouTube) – Accessible introductions to gene regulation, biotechnology and genetic engineering.**
- **HHMI BioInteractive (YouTube) – Short animations explaining PCR, DNA sequencing, CRISPR and modern genetics.**

🎧 **LISTEN**

- **The Naked Scientists Podcast – Episodes on genetics, gene editing, genomics and personalised medicine.**
- **BBC Inside Science – Features on CRISPR, genome sequencing and advances in medical genetics.**
- **Nature Podcast – Current research into gene expression, biotechnology and molecular biology.**
- **Genetics Unzipped – A podcast dedicated to genetics, covering gene regulation, genetic engineering, inherited disease and the latest discoveries.**
- **The Royal Institution Podcast – Talks exploring DNA, genetic technologies and their ethical implications.**

Your teacher will assess your knowledge & understanding throughout the topic by looking at your work, questioning, discussion and giving you feedback in lots of different ways. The key pieces of work in this topic are:

- CPAC assessed required practical work
- Unit 8 Part 1 assessment
- Unit 8 Part 2 assessment
- Series of smaller knowledge assessments

Year 13 Biology – Energy and Ecosystems

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Year 13 Biology – Energy and Ecosystems

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Learning about this topic is important because: In communities, the biological molecules produced by photosynthesis are consumed by other organisms, including animals, bacteria, and fungi. Some of these are used as respiratory substrates by these consumers. Photosynthesis and respiration are not 100% efficient. The transfer of biomass and its stored chemical energy in a community from one organism to a consumer is also not 100% efficient.

This builds on: The study of photosynthesis and respiration at GCSE and A-level, enzymes, it will also build on prior learning from biological molecules at A-level and the ecology unit of work at GCSE.

This leads to: the study of photosynthesis and respiration, build on the learning of population biology, and further studies beyond A-level in environmental biology related courses.

We will learn about:

- Energy and ecosystems – including primary and net production, efficiency of energy transfer and measurement of biomass.
- Nutrient cycles – the nitrogen and phosphorus cycles, with a specific focus on the role of microorganisms, use of fertilisers and environmental issues.

We will develop/practise skills including:

- Calculating gross primary production and to derive the appropriate units.
- Students could carry out investigations to find the dry mass of plant samples or the energy released by samples of plant biomass.
- To calculate: the net productivity of producers or consumers from given data, the efficiency of energy transfers within ecosystems and percentage yields.
- Appreciate the ways in which production is affected by farming practices designed to increase the efficiency of energy transfer.
- Devise investigations into the effect of named minerals on plant growth.

Some of the vocabulary that we will use includes:

Biomass, calorimetry, gross primary production, net primary production, consumers, chemical energy, primary and secondary productivity, microorganisms, saprobionts, mycorrhizae, ammonification, nitrification, nitrogen fixation and denitrification, natural and artificial fertilisers, leaching and eutrophication.

You could learn more about this topic by:

Read: https://www.theguardian.com/environment/2022/jun/27/using-far-less-chemical-fertiliser-still-produces-high-crop-yields-study

Watch: https://www.youtube.com/watch?v=2ifo_UXJnS8

All videos in the Miss Estruch series for this unit are excellent preparation / consolidation resources.

Listen: https://defrafarming.blog.gov.uk/2023/02/27/farming-podcast-next-steps-for-environmental-land-management/

Your teacher will assess your knowledge & understanding throughout the topic by looking at your work, questioning, discussion and giving you feedback in lots of different ways. The key pieces of work in this topic are:

- CPAC assessed required practical work
- Recall assessment for nitrogen and phosphorus cycles
- Calculations of efficiency transfer and percentage yields
- Energy and Ecosystems Assessment
- Seneca Assignments

Year 13 Biology – Organisms respond to changes in their internal and external environments

Learning about this topic is important because: Living organisms must detect and respond to changes in their internal and external environments in order to survive. Homeostasis maintains stable internal conditions through the coordinated actions of receptors, the nervous system, hormones and effectors. These communication systems regulate essential processes such as blood glucose concentration, water potential and body temperature. Understanding how organisms respond to change provides insight into normal physiological function, the causes of disease and the development of effective medical treatments.

This builds on (form GCSE): At GCSE, you learned that organisms respond to stimuli using the nervous and hormonal systems to maintain stable internal conditions (homeostasis). In this topic, you build on that knowledge by studying the detailed mechanisms of cell signalling, nerve impulses, synaptic transmission, muscle contraction, hormonal control and negative feedback. You will also investigate how these systems interact to coordinate responses and maintain a stable internal environment.

This leads to: Final unit in A level specification – may lead to further studies at degree level on biochemistry, biology, medicine and bioscience degree

We will learn about:

- Animal and Plant responses
- Pacinian corpuscle and human eye – receptors
- Nerve impulses
- Synapses
- Muscle contraction
- Control systems
- Blood glucose regulation
- Kidney structure
- Loop of Henle
- Osmoregulation and the use of ADH

We will develop/practise skills including:

- Throughout this topic, you will develop skills in interpreting and evaluating scientific information, analysing data and graphs, applying biological knowledge to unfamiliar contexts, and explaining complex physiological processes using precise scientific terminology. You will also strengthen your practical and mathematical skills by investigating biological responses, interpreting experimental evidence, and drawing evidence-based conclusions.
- Calculate length of contracted and relaxed sarcomeres
- Chi squared calculations when looking at maggot response to optional environment

Keyword Definition

Pacinian corpuscle	A pressure receptor that detects changes in mechanical pressure by generating a nerve impulse.
Depolarisation	A change in membrane potential caused by the opening of sodium ion channels, making the inside of a neurone less negative.

You could learn more about this topic by:

READ

- **AQA A-level Biology Student Book (Oxford University Press)** – Topic 6 chapters.
- **CGP A-Level Biology Complete Revision & Practice** – Clear summaries and exam questions.
- **Save My Exams** – Excellent notes, diagrams and exam-style questions on Topic 6.
- **Physics & Maths Tutor (PMT)** – Revision notes, past paper questions and mark schemes.

Year 13 Biology – Organisms respond to changes in their internal and external environments

Saltatory conduction	The movement of an action potential between the nodes of Ranvier in a myelinated neurone, increasing the speed of transmission.
Synaptic transmission	The process by which a nerve impulse is passed across a synapse using neurotransmitters.
Summation	The addition of excitatory and inhibitory signals at a synapse to determine whether an action potential is generated.
Neuromuscular junction	A specialised synapse between a motor neurone and a skeletal muscle fibre.
Sliding filament theory	The mechanism of muscle contraction in which actin filaments slide over myosin filaments, shortening the sarcomere.
Second messenger	An intracellular signalling molecule (such as cAMP) that relays a signal from a hormone or neurotransmitter after receptor activation.
Negative feedback loop	A regulatory mechanism in which a deviation from the normal level triggers responses that restore the set point by reducing the original change.
Osmoreceptor	A specialised receptor in the hypothalamus that detects changes in the water potential of the blood and helps regulate water balance.

- **Biological Sciences Review magazine** – Articles linking homeostasis and neuroscience to current biological research.

WATCH

- **Amoeba Sisters** (YouTube) – Excellent introductions to nervous communication and hormones.
- **Cognito** (YouTube) – A-Level videos on neurones, synapses, muscles, homeostasis and kidney function.
- **SnapRevise A-Level Biology** (YouTube) – Detailed AQA-specific explanations.
- **Miss Estruch** (YouTube) – Clear walkthroughs of AQA Biology content and exam questions.
- **Crash Course Biology** (YouTube) – Engaging videos on the nervous system, endocrine system and homeostasis.

LISTEN

- **The Naked Scientists Podcast** – Episodes on the brain, nerves, hormones and human physiology.
- **BBC Inside Science** – Current research into neuroscience, endocrinology and human health.
- **The Nature Podcast** – Discussions of new discoveries in physiology and medical biology.
- **The Infinite Monkey Cage** – Accessible episodes on the brain, sleep, hormones and medicine.
- **Huberman Lab Podcast** (selected episodes) – In-depth discussions on the nervous system, vision, stress and sleep (best for extending understanding beyond the specification).

Your teacher will assess your knowledge & understanding throughout the topic by looking at your work, questioning, discussion and giving you feedback in lots of different ways. The key pieces of work in this topic are:

Year 13 Biology – Organisms respond to changes in their internal and external environments

- CPAC assessed required practical work
- Unit 6 Part 1 assessment
- Unit 6 Part 2 assessment
- Series of smaller knowledge assessments

Y13 Populations in Ecosystems

Learning about this topic is important because: Ecosystems support all life on Earth and understanding how they function helps us to appreciate the complex relationships between organisms and their environment. Studying ecosystems enables students to understand biodiversity, conservation and sustainability, as well as the challenges involved in balancing human needs with environmental protection. This unit develops students as informed citizens who can evaluate evidence relating to conservation issues and make reasoned judgements about managing natural resources for future generations.

This builds on: Students have encountered related concepts through Biology, Geography and PSHE, including:

- Food chains, food webs and energy transfer
- Adaptations of organisms to their environments
- Biodiversity and classification
- Human impacts on ecosystems
- Environmental sustainability and climate change
- Sampling techniques and data collection

They have also begun to develop an understanding of how living organisms interact with one another and with their environment.

This leads to: This unit supports further study of:

- Ecology and environmental science
- Conservation biology and biodiversity management
- Geography topics relating to sustainability and ecosystems
- Scientific research and fieldwork techniques
- Environmental policy and resource management

It also supports progression into careers involving conservation, environmental science, ecology, agriculture, forestry, sustainability, geography and wildlife management.

We will learn:

- What ecosystems, communities, habitats and niches are
- How abiotic and biotic factors influence populations
- How carrying capacity affects population size
- The effects of interspecific and intraspecific competition
- The role of predation in regulating populations
- How population size can be estimated using quadrats and transects
- How the mark-release-recapture method is used and the assumptions it relies upon
- How succession occurs from pioneer species to climax communities
- How organisms modify their environment during succession
- How biodiversity changes throughout succession
- Why habitats and species require conservation and management

We will develop/practise skills including:

- Scientific enquiry and investigation skills
- Data collection through ecological sampling techniques
- Mathematical skills when estimating population size
- Analysis and interpretation of ecological data
- Evaluation of scientific evidence and conservation strategies
- Critical thinking when considering conflicting viewpoints
- Communication and discussion of environmental issues
- Extended reasoning and judgement skills when evaluating conservation decisions

Y13 Populations in Ecosystems

• The challenges involved in balancing conservation with human need	
Some of the vocabulary that we will use includes: Community, niche, population, carrying capacity, abiotic factor, biotic factor, biodiversity, quadrat, succession, pioneer species, climax community, interspecific competition, intraspecific competition.	**You could learn more about this topic by:** • Visiting local nature reserves and observing ecosystems • Following environmental and conservation news stories • Watching documentaries about ecosystems and biodiversity • Researching conservation projects in the UK and globally • Investigating species recovery programmes • Exploring citizen science projects that monitor wildlife populations • Reading about ecological fieldwork techniques and environmental management
Your teacher will assess your knowledge & understanding throughout the topic by looking at your work, questioning, discussion and giving you feedback in lots of different ways. The key pieces of work in this topic are": • CPAC assessed required practical work • Homework questions on populations, spearman's rank, mark release and recapture, sampling techniques, succession • Assessment 1 – Populations in ecosystems	

Year 13 Biology – **Energy transfers in and between organisms**

West Kirby Grammar School

Learning about this topic is important because: Life depends on continuous transfers of energy. In photosynthesis, light is absorbed by chlorophyll and this is linked to the production of ATP. In respiration, various substances are used as respiratory substrates. The hydrolysis of these respiratory substrates is linked to the production of ATP. In both respiration and photosynthesis, ATP production occurs when protons diffuse down an electrochemical gradient through molecules of the enzyme ATP synthase, embedded in the membranes of cellular organelles. The process of photosynthesis is common in all photoautotrophic organisms and the process of respiration is common in all organisms, providing indirect evidence for evolution. In communities, the biological molecules produced by photosynthesis are consumed by other organisms, including animals, bacteria and fungi. Some of these are used as respiratory substrates by these consumers. Photosynthesis and respiration are not 100% efficient. The transfer of biomass and its stored chemical energy in a community from one organism to a consumer is also not 100% efficient.

This builds on: GCSE Respiration & photosynthesis Unit 3.1– Biological Molecules 3.1.6 ATP 3.2.3 transport across membranes Unit 3.3 – Organisms Exchange substances with their Environment

This leads to: Further studies at A-level – 3.6.1. Survival & Response 3.7.4. Populations in an Ecosystem ATP links to multiple topics e.g .muscle contraction, mass transport

We will learn about:

- Photosynthesis
- Respiration
- Energy & Ecosystems
- Nutrient Cycles

- **We will develop/practise skills including:**
- students could devise and carry out experiments to investigate the effect of named environmental variables on the rate of photosynthesis using aquatic plants, algae or immobilised algal beads.
- Students could use a redox indicator to investigate dehydrogenase activity.
- Students could be given data from which to calculate gross primary production and to derive the appropriate units.
- Students could carry out investigations to find the dry mass of plant samples or the energy released by samples of plant biomass.
- Students could be given data from which to calculate:
  • the net productivity of producers or consumers from given data
  • the efficiency of energy transfers within ecosystems.
- Students could be given data from which to calculate percentage yields.

Year 13 Biology – **Energy transfers in and between organisms**

West Kirby Grammar School

	○ Students could devise investigations into the effect of named minerals on plant growth.
Some of the vocabulary that we will use includes: Glycolysis, phosphorylation, oxidation, reduction, chemiosomotic theory, proton, redox, dehydrogenase, link reaction, krebs cycle, oxidative phosphorylation. Photoionisation, photolysis, light-dependent, light-independent, Calvin cycle, Rubisco.	**You could learn more about this topic by:** Read: Photosynthesis (A Level) — the science hive Respiration (A Level) — the science hive Ecosystems (A Level) — the science hive Energy Transfers and Nutrient Cycles AQA — the science hive Watch: All videos in the Miss Estruch series for this unit are excellent preparation / consolidation resources. PHOTOSYNTHESIS -Light Dependent Reaction:A-level Biology. Photolysis, photoionisation & chemiosmosis - YouTube Light Independent Reactions of Photosynthesis A-level (LIR The Calvin Cycle) - YouTube AQA A-Level Biology: Respiration - Learn the Entire Topic in One Video! Aerobic & Anaerobic - YouTube https://www.youtube.com/watch?v=F4QD_EkLzW NITROGEN CYCLE: A level biology AQA. Saprobionts, nitrogen-fixing, ammonification & nitrification - YouTube Listen: Biology A Level Podcasts by Seneca (senecalearning.com)

Your teacher will assess your knowledge & understanding throughout the topic by looking at your work, questioning, discussion and giving you feedback in lots of different ways. The key pieces of work in this topic are:

- CPAC assessed required practical work Investigation into the effect of a named environmental factor on the rate of photosynthesis. Investigation into the effect of temperature on the rate of respiration on yeast
- Recall assessment for energy transfers / ecosystems and nutrient cycles
- Y13 Spring Assessment – Spring Term
- Seneca Assignments