

Content Summary (areas common to most or all curricula)

DNA

- Location of DNA in cell, basic structure of chromosomes (including comparison of eukaryotic and bacterial cells), DNA – double helix, complementary base pairs
- Genes are short stretches of DNA, encode proteins (triplet code, amino acid sequence), control characteristics of organism
- Unique nature of an individual's DNA, similarities in sequence within species and between closely related organisms
- DNA sequence can be used to identify organisms, investigate relatedness and also distinguish between strains and individuals of the same species
- Variation in populations due to variation in genes, can be generated by sexual reproduction and mutation (the workshop will focus on mutation in bacteria, will mention horizontal gene transfer via plasmids)
- Mutations can be spontaneous or induced; positive, negative or neutral

Evolution

- Theory of evolution by natural selection – Darwin and later revisions to accommodate discovery of inheritance mechanism/ DNA
- Genetic mutation combined with environmental change can lead to relatively rapid changes in species, sometimes leading to new species (specific example – emergence of antibiotic resistance in bacteria)
- Closely related species share a relatively recent common ancestor
- Evidence for evolution from fossil record, DNA research and emergence of drug resistant micro-organisms – evolution is ongoing
- Organisms can be classified according to their DNA, *evolutionary trees*

Enzymes

- Enzymes as biological catalysts
- Restriction enzymes – recognise specific sequences in DNA and cut into fragments, usually leaving 'sticky ends'

Infection and Immunity

- Some microorganisms can cause disease and are known as pathogens
- Bacteria cause damage by reproducing rapidly inside the human body
- The immune system recognises foreign organisms and mounts an immune response
- White blood cells recognise, engulf and destroy bacteria and some white blood cells produce antibodies that recognise antigens on the surface of bacteria
- Pathogens have strategies to evade the immune response, these change (evolve) over time to match changes in our immune system
- Once the immune system has produced antibodies against a pathogen these can be quickly made again in the future, giving the organism immunity against future infections
- Vaccination uses parts of a pathogen or inactivated whole pathogen to trigger the immune system and create immunity
- Antibiotics are designed to kill bacteria but many pathogens evolve antibiotic resistance

Practical techniques

- Use of micropipettes to accurately measure small volumes
- Restriction enzyme digest - enzymes as biological catalysts, specificity of cutting sites, 'sticky ends'
- Gel electrophoresis and DNA staining – parallels with DNA fingerprinting/profiling

Hands-on activities

- Restriction enzymes and genetic engineering – an activity to investigate how restriction enzymes cut DNA to leave 'sticky ends' and how they can be used in genetic engineering to insert DNA from one organism into another
- Bacterial growth and evolution – a game which illustrates factors affecting bacterial growth and the effects of mutations on bacterial populations

Curriculum links

GCSE/ Standard Grade/ BTEC Level 2

AQA GCSE Biology

Unit B1.1 Keeping Healthy B1.1.2 How our bodies defend themselves against infectious diseases
Unit B1.7 Genetic variation and its control B1.7.1 Why organisms are different B1.7.2 Reproduction
Unit B1.8 Evolution B1.8.1 Evolution
Unit B2.5 Proteins B2.5.2 Enzymes
Unit B2.7 Cell division and inheritance B2.7.2 Genetic variation
Unit B2.8 Speciation B2.8.1 Old and new species

Edexcel GCSE Biology

Unit B1 Influences on life Topic 1: Classification, variation and inheritance Topic 3: Problems of, and solutions to a changing environment
Unit B2 The components of life Topic 1: The building blocks of cells
Unit B3 Using biology Topic 1: Control Systems Topic 3: Biotechnology

OCR GCSE Biology A (21st century science suite)

Module B1 You and your genes B1.1 What are genes and how do they affect the way that organisms develop?
Module B2 Keeping Healthy B2.1 How do our bodies resist infection? B2.2 What are vaccines and antibiotics and how do they work?
Module B3 Life on earth B3.2 How has life on Earth evolved?
Module B4 The processes of life B4.1 How do chemical reactions take place in living things?
Module B5 Growth and development B5.3 How do genes control growth and development within the cell?
Module B7 Further Biology B7.5 New technologies

OCR GCSE Biology B (Gateway science suite)

Module B1 Understanding organisms

Item B1c: Staying healthy
Item B1h: Variation and inheritance

Module B2 Understanding our environment

Item B2a: Classification
Item B2f: Natural selection

Module B3 Living and growing

Item B3a: Molecules of life
Item B3b: Proteins and mutations
Item B3g: New genes for old

Module B6 Beyond the microscope

Item B6a: Understanding microbes
Item B6b: Harmful microorganisms
Item B6h: Gene technology

WJEC GCSE Biology

Biology 1 Adaptation, evolution and body maintenance

1 Variety of life, adaptation and competition
3 Inheritance
4 Variation
5 Evolution

Biology 2 Cells and metabolism, digestion and respiration, biodiversity

1 Cells and cell processes

Biology 3 Transport in plants and animals, homeostasis, microorganisms and disease

5 Microorganisms and disease

CCEA GCSE Biology

Unit 1 Cells, Living Processes and Biodiversity

1.1 Cells
1.4 Enzymes and Digestion

Unit 2 Body Systems, Genetics, Microorganisms and Health

2.2 Chromosomes, genes and DNA
2.5 Applied genetics
2.6 Variation and selection
2.8 Microorganisms, Defence against Disease, Medicines and Drugs

SQA Standard Grade Biology

Topic 4 Investigating Cells

Sub-topic d: Investigating Enzymes

Topic 6 Inheritance

Sub-topic a: Variation
Sub-topic c: Genetics and Society

Topic 7 Biotechnology

Sub-topic c: Reprogramming Microbes

BTEC Level 2 Applied Science

Unit 3 Biology and our Environment

1. Be able to investigate the functioning and classification of organisms
3. Know the factors which can affect and control human health

Unit 6 Health Applications of Life Science

2. Know how preventative measures can be used to support healthy living
3. Be able to investigate how some treatments are used when illness occurs

Unit 10 The Living Body

1. Know the role of enzymes as catalysts

Unit 14 Science in Medicine

1. Be able to investigate the range of scientific procedures used in diagnosing illness
2. Be able to investigate the scientific principles of treating illness and health conditions
3. Know the factors affecting treatments

Unit 20 Biotechnology Procedures and Applications (optional unit)

1. Know how the biotechnology industry has developed
2. Know how biotechnology is used in our everyday lives
3. Be able to perform simple biotechnology procedures
4. Understand how biotechnology may help treat or cure disease

Note: There is significant overlap between the practical DNA techniques used in this workshop and those described in *Unit 13 Investigating a Crime Scene*.

A-level/Higher and Advanced Higher/ BTEC Level 3

AQA A-level Biology

Unit 1 BIOL 1 Biology and disease

- 3.1.1 Disease may be caused by infectious pathogens or may reflect the effects of lifestyle
- 3.1.6 Mammalian blood possesses a number of defensive functions

Unit 2 BIOL 2 The variety of living organisms

- 3.2.1 Living organisms vary and this variation is influenced by genetic and environmental factors
- 3.2.2 DNA is an information-carrying molecule. Its sequence of bases determines the structure of proteins, including enzymes
- 3.2.3 Similarities and differences in DNA result in genetic diversity
- 3.2.9 Originally, classification systems were based on observable features but more recent approaches draw on a wider range of evidence to clarify relationships between organisms
- 3.2.10 Adaptation and selection are major components of evolution and make a significant contribution to the diversity of living organisms

Unit 5 BIOL 5 Control in cells and in organisms

- 3.5.6 The sequence of bases in DNA determines the structure of proteins, including enzymes
- 3.5.8 Gene cloning technologies allow study and alteration of gene function in order to better understand organism function and to design new industrial and medical processes

AQA A-level Human Biology

Unit 1 HBIO 1 The body and its diseases

- 3.1.2 Enzymes – fast, specific catalysts
- 3.1.4 Microorganisms use us for food, shelter and their reproduction
- 3.1.5 How the body fights infectious disease

Unit 2 HBIO 2 Humans – their origins and adaptations

- 3.2.1 The information of life
- 3.2.3 Where we fit in the world and how we came to be here

Unit 4 HBIO 4 Bodies and cells in and out of control

- 3.4.2 Growing up, growing old and passing on your genes
- 3.4.3 The management structure of cells
- 3.4.4 New genes for old

Unit 5 HBIO 5 The air we breathe, the water we drink, the food we eat

- 3.5.1 Human impacts on evolution
- 3.5.6 People and their microorganisms

Edexcel A-level Biology

Unit 1 Lifestyle, Transport, Genes and Health

Topic 2: Genes and health

Unit 2 Development, Plants and the Environment

Topic 4: Biodiversity and natural resources

Unit 4 The Natural Environment and Species Survival

Topic 5: On the wild side

Topic 6: Infection, Immunity and forensics

OCR A-level Biology

AS Unit F212: Molecules, Biodiversity, Food and Health

Module 1: Biological Molecules

2.1.2 Nucleic Acids

2.1.3 Enzymes

Module 2: Food and Health

2.2.2 Health and Disease

Module 3: Biodiversity and Evolution

2.3.3 Evolution

A2 Unit F215: Control, Genomes and Environment

Module 1: Cellular Control and Variation

5.1.1 Cellular Control

5.1.2 Meiosis and Variation

Module 2: Biotechnology and Gene Technologies

5.2.3 Genomes and Gene Technologies

OCR A-level Human Biology

AS Unit F222: Growth, Development and Disease

Module 1: The Developing Cell

2.1.1 Mitosis as Part of the Cell Cycle

Module 3: Infectious Disease

2.3.1 Controlling the Spread of Infectious Disease

2.3.2 Acquiring Immunity

2.3.3 The Future of Infectious Disease Control

A2 Unit F225: Genetics, Control and Ageing

Module 1: Genetics in the Twenty First Century

5.1.2 Genetic Techniques

WJEC A-level Biology

BY1 : Basic Biochemistry and organisation

1.4 Biological reactions are regulated by enzymes

1.6 Nucleic acids

BY2 : Biodiversity and physiology of Body Systems

2.1 All organisms are related through their evolutionary history

BY5 : Environment, Genetics and Evolution

5.1 The genetic code and cell function

5.4 Inheritance

5.5 Variation and evolution

5.6 Applications of reproduction and genetics

WJEC A-level Human Biology

BY1 : Basic Biochemistry and organisation

- 1.4 Biological reactions are regulated by enzymes
- 1.6 Nucleic acids

HB2 : Biodiversity and physiology of Body Systems

- 2.1 All organisms are related through their evolutionary history
- 2.5 Human defence mechanisms
- 2.6 Pathogens, spread of human disease and control of infection

BY5 : Environment, Genetics and Evolution

- 5.1 The genetic code and cell function
- 5.4 Inheritance
- 5.5 Variation and evolution
- 5.6 Applications of reproduction and genetics

CCEA A-level Biology

Unit AS 1 Molecules and Cells

- 1.1 Molecules
- 1.2 Enzymes
- 1.3 DNA Technology

Unit AS 2 Organisms and Biodiversity

- 2.2 The Adaptation of Organisms
- 2.3a The variety of life

Unit A2 1 Physiology and Ecosystems

- 4.2 Immunity

Unit A2 2 Biochemistry, Genetics and Evolutionary Trends

- 5.3 DNA as the Genetic Code
- 5.4 Gene Technology
- 5.6 Mechanism of Change

SQA Higher Biology

Unit 1 Cell Biology

- d) Synthesis and release of proteins
- e) Cellular response in defence in animals and plants

Unit 2 Genetics and Adaptation

- a) Variation
- b) Selection and speciation

SQA Advanced Higher Biology

Cell and Molecular Biology

- a) Structure, function and growth of prokaryotic and eukaryotic cells
- b) Structure and function of cell components
- c) Molecular interactions in cell events
- d) Applications of DNA technology

SQA Higher Human Biology

Unit 1 Cell Function and Inheritance

- b) Protein synthesis
- e) Cellular response in defence
- f) Inheritance

BTEC Level 3 Applied Science

Unit 4 Scientific Practical Techniques

2. Be able to use scientific techniques to separate and assess purity of substances
3. Be able to use instruments/sensors for scientific investigation

Unit 9 Informatics for Science

1. Know how informatics is used in science

Unit 13 Biochemistry and Biochemical Techniques

1. Be able to investigate properties of water and biological molecules in living organisms
3. Be able to investigate the factors that affect the activities of enzymes in biological systems

Unit 15 Microbiological Techniques

3. Be able to determine the factors that influence the growth of micro-organisms

Unit 18 Genetics and Genetic Engineering

1. Understand the process of protein synthesis
4. Be able to apply basic techniques of DNA technology

Unit 21 Biomedical Science Techniques

1. Be able to investigate the structure and characteristics of major groups of organisms of medical importance
2. Understand how the body defends itself against infection

Unit 43 Diseases and Infections

1. Know the different types of diseases and infections
2. Understand the factors that can influence the development of diseases and infections
3. Be able to investigate the spread of diseases and infections
5. Understand ways in which diseases can be treated, cured or eradicated