Education & Skills Funding Agency

Science content in the T Level Technical Qualification in Science

The Science pathway is from the Health and Science route

This document refers to the Science content from section B2 Further Science concepts and the Occupational Specialisms in the T Level Technical Qualification in Science, (Level 3) (delivered by NCFE) (603/6989/9)

The table below maps this Science content to that of the BTEC National Extended Diploma in Applied Science and the GCE AS and A level subject content for biology, chemistry, and physics.

All the T Level Science content in section B2 is mandatory. BTEC offers a mandatory and optional content structure. BTEC optional content is shown in red type.

Science in the Occupational Specialisms

Science content outlined for the T Level in section 3 relates to the Occupational Specialisms, one of which must be selected by students. Science content in section 3 can either be a development/extension of Science concepts from section B1 or B2 or new concepts which are relevant only to that Occupational Specialism.

Assessment in T Levels

T level students will need to undertake a variety of assessment types such as those that take place in Higher Education for Health-related courses including examinations, controlled assessments, and Objective Structured Clinical Examinations.

T Level Core assessment is an externally set written exam(s) and an employer set project: both sets of exams assess students' knowledge, understanding and application of contexts, theories and principles relating to the core content in the specification The written exams assess route and pathway knowledge through 'unseen' examination (which samples content), meaning breadth can be assessed at appropriate level 3 depth, whilst limiting the overall duration of assessment. The written exam structure will provide students with relevant exam and revision skills for HE. The employer set project is a more substantial project-based assessment set by employers through the awarding organisation and will develop their critical thinking and problem-solving skills. The project will draw upon knowledge and understanding from across the core content synoptically and will allow learners to effectively respond to a 'brief'. All science elements are assessed.

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The occupational specialism components (**Section 3** below) are also externally assessed through synoptic assignments, except for the observation element, which takes place in a controlled environment is internally marked by providers and externally moderated.

BTEC assessment is external, internal, and synoptic. External and internal assessment is linked to a specific unit.

Science		
Specification content areas	Specification content by unit	Specification content by section
T Level[1]	**BTEC in Applied Science[2]**	**A Level[3]**
1. B2 Further Science (mandatory)		
Classification of Biological molecules • Molecular structures and functions of • Proteins • Carbohydrates • Lipids • Nucleic acid **Enzyme and protein structure** • Role of DNA bases in the production of amino acid chains • Process of protein synthesis • properties of enzymes • enzymes as catalysts **Cell Cycle** • Mitosis and meiosis in nuclear division within cells • Stages of mitosis, chromosome behaviour and cellular structure • Process of meiosis and gamete production	**Biological Molecules and Metabolic Pathways (Unit 10-O)** • Structure and function of water, carbohydrates, proteins and nucleic acids, lipids • Causes and effects of disruption to biochemical processes (e.g. cystic fibrosis) • Respiration, production and role of ATP • Photosynthesis **Unit 11: Genetics and Genetic Engineering (Unit 11 -O)** • Nucleic acids • Basis of genetic code • Protein synthesis • Cell division and its role in variation • Cell Cycle • Cellular activities including stages • Chromosome position at division • Stages of mitosis; plants and animals • Stages of meiosis in gamete production • Slide preparation	**Biological Molecules** • Biological molecules are often polymers and are based on a small number of chemical elements • Role and function of nucleic acids (DNA and RNA), carbohydrates, proteins, lipids, inorganic ions and water. • Sequence of bases in the DNA molecule determines the structure of proteins, including enzymes • Enzymes as catalysts • ATP as a source of energy for biological processes **Cells** • Cell theory • Prokaryotic and eukaryotic cells and their structure and ultrastructure • Division of multicellular organisms cells into tissues/organs/systems • The cell cycle and copying of genetic information • Mitosis and meiosis/gene copies

[1] T Level Technical Qualification in Health and Science: Science (qualhub.co.uk)
[2] BTEC Level 3 National Extended Diploma in Applied Science
[3] GCE AS and A level subject content for biology, chemistry, physics and psychology

- Differences between mitosis and meiosis

Cellular respiration

- Glucose breakdown to produce ATP
- ATP as a source of energy for biological processes
- Energy production from proteins, lipids and carbohydrates

Pathogens

- Pathogen definition
- Bacteria, fungi, prions, protists viruses

Formulae and Equations

- Balancing equations; group 1 metals with water and oxygen, transition metals with oxygen and strong acids
- Empirical formula and molecular mass
- Isotope and isotopic mass
- Moles in reactions and concentrations

Kinetic Changes

- Factors affecting the rates of chemical reactions
- Calculating rate of reaction
- Activation energy
- Action of catalysts
- Catalysts in industrial reactions
- Maxwell Boltzmann distribution of molecular energies

Analytical Techniques

- Chromatography and applications
- Calculation of rF value
- Acid-base titrations

Diseases and Infections (Unit 12-O)

- Pathogens and infectious diseases
- Pathogens
- Bacteria, parasites, viruses, fungus, protozoa
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Periodicity and Properties of elements (Unit 1-M)

- Electronic structure of atoms
- Ionic, covalent and metallic bonding
- Intermolecular forces
- Balancing equations
- Quantities used in chemical reactions

Industrial Chemical Reactions (Unit 18-O)

- Enthalpy changes
- Entropy and Gibbs energy, equilibrium constant
- Rate of reaction (collision theory)
- Chemical equilibrium

Practical Scientific Procedures and Techniques (Unit 2-M)

- Undertake titration and colorimetry to determine the concentration of solutions
- Calculation of Rf value
- Preparation and standardisation of solutions using titration
- practical application of colorimetry techniques
- Undertake chromatographic techniques to identify components in mixtures

Fluids in motion (Unit 5-M)

- fluid flow patterns, streamline and turbulent flow
- viscosity, viscous drag
- non-Newtonian fluid flow
- rate of fluid flow and pressure
- Bernoulli's principle

Energy for Biological Processes

- In cellular respiration, glycolysis takes place in the cytoplasm and the remaining steps in the mitochondria
- ATP synthesis is associated with the electron transfer chain in the membranes of mitochondria and chloroplasts

Formulae, equations and amounts of substance

empirical and molecular formulae

- Balanced chemical equations
- Avogadro constant and the amount of substance (mole)
- relative atomic mass and relative isotopic mass
- calculation of reacting masses, mole concentrations, volumes of gases, per cent
- yields and atom economies
- Atomic structure
- Bonding and structure

Kinetics

- Collision theory
- Effect of temperature changes on rate of reaction, Boltzmann distribution
- Role of catalysts in providing alternative routes of lower activation energy
- Determination and use of rate equations
- Orders of reactions

Modern analytical techniques

- Use of mass spectrometry, infrared spectroscopy, nuclear magnetic resonance spectroscopy and chromatography in analysis, including techniques for the elucidation of structure

Gas Laws • Boyle's Law (P1V1 = P2V2) • Charles's Law (V1T2 = V2T1) • the Pressure Law (P1/T1 = P2/T2) • Kelvin temperature scale • Gas storage • **Pressure/fluid/viscosity** • Definitions of pressure, density, fluid and viscosity • Properties of Newtonian and non-Newtonian fluids • hydrostatic pressure in a liquid/depth change • volumetric and mass flow rates • steady and turbulent flow • coefficient of viscosity		
2. Science in the Occupational Specialisms **NB students study ONE Occupational Specialism in addition to core science and further science.**		
2 a. Technical: Laboratory Sciences **Atomic structure** • Definitions of orbital and nucleus • Electron arrangement • Electron arrangement links to the periodic table/reactivity • Relative atomic mass and relative molecular mass • Apply the mole and Avogadro's constant • Calculations for acid-base titrations • Relationship between volume of a gas and the number of moles **Molecular structure and bonding** • Different types of bonds, ionic, metallic, and	**Periodicity and Properties of elements (Unit 1-M)** • Electronic structure of atoms • Ionic, covalent, and metallic bonding • Intermolecular forces • Periodic table, elements and groups **Applications of Organic Chemistry (Unit 14-O)** • Structures, reactions, uses and properties of non-carbonyl compounds: halogenalkanes, alcohols, amines • Structures, reactions, uses and properties of carbonyl compounds: aldehydes, ketones, carboxylic acids, esters, acyl chlorides, amides • Structures, reactions, uses and properties of benzene Structures, reactions, uses and properties of monosubstituted benzene compounds	**Formulae, equations and amounts of substance** **empirical and molecular formulae** • Balanced chemical equations • Avogadro constant and the amount of substance (mole) • relative atomic mass and relative isotopic mass • calculation of reacting masses, mole concentrations, volumes of gases, per cent • yields and atom economies • Atomic structure • Bonding and structure • **Organic Chemistry** • Functional groups. Structural isomers and stereoisomers

covalent, electron organisation • Electron pair repulsion theory and the shapes of molecules • Structure and bonding related to range of properties **Organic chemistry** • IUPAC based naming of organic compounds: • straight chain alkanes and cycloalkanes • straight chain alkenes • alcohols • carboxylic acids • aldehydes and ketones • amines **Oxidation and reduction** • Oxidation, reduction, redox • standard electrode potentials to determine the direction of electron flow in electrochemical cells **Enthalpy and Entropy** • Definition of enthalpy and entropy • Gibbs equation • Stability of compounds and factors affecting reactions • Enthalpy changes **Materials science** • Properties of synthetic polymers, alloys, composites and their applications • addition polymerisation • condensation polymerisation **Metabolic pathways and bioenergetics**	• Types, structures, reactions, uses and • properties of isomers • Reactions of non-carbonyl compounds Reactions of carbonyl compounds Reactions of aromatic compounds using methylbenzene or methoxybenzene **Applications of Inorganic Chemistry (Unit 13-O)** • Oxidation and reduction reactions • Displacement reactions and electrochemical cells • Use of oxidation number • Titrimetric methods involving oxidation-reduction reactions • **Industrial Chemical Reactions (Unit 18-O)** • Enthalpy changes • Entropy and Gibbs energy, equilibrium constant • Rate of reaction (collision theory) • Chemical equilibrium **Materials Science (Unit 22-O)** • Metals and alloys • Composites • Polymers and their sources • Benefits of polymers • Limitations and environmental risks of polymers **Biological Molecules and Metabolic Pathways (Unit 10-O)** • Effect of activity on respiration in humans and factors that can affect respiratory pathways • Adenosine triphosphate (ATP) as the universal energy currency. • Stages and locations of aerobic and anaerobic respiratory pathways • Glycolysis: conversion of monosaccharides to pyruvate; production of lactic acid in	• Reactions classified as addition, elimination, substitution, oxidation, reduction, hydrolysis, addition polymerisation and condensation polymerisation • Mechanisms classified as radical substitution, electrophilic addition, nucleophilic substitution, electrophilic substitution and nucleophilic addition • Single and double covalent bonds, bond polarity and bond enthalpy as factors influencing reactivity • The structure of, and the bonding in, benzene Organic synthesis, characteristic reactions of alkanes, alkenes, halogenoalkanes, alcohols, arenes, aldehydes, ketones, carboxylic acids, esters, amines, amino acids and amides **Redox** • Oxidation states and their calculation Oxidation and reduction as electron transfer, applied to reactions of s, p and d block elements **Energetics** • Enthalpy changes • Reaction rates • Entropy **Mechanical properties of matter** • Stress, strain, Young modulus • Force-extension graphs, energy stored • **Biological Molecules** • Biological molecules are often polymers and are based on a small number of chemical elements

- Energy change in anabolic and catabolic pathways
- Aerobic respiration, glycolysis, link reaction Acetyl-Coenzyme A oxidation, Krebs cycle, electron transport chain (ETC) and oxidative phosphorylation
- Beta oxidation
- The regulation of metabolic pathways by enzymes and feedback mechanisms

Genotyping and Phenotyping

- Difference between genotype and phenotype
- Determining genotype by DNA sequencing

Ecosystems

- Definition and characteristics of ecosystems
- Habitats, populations, community, niche
- Biomass transfer
- Recycling
- Primary Succession
- Bioaccumulation
- Measurement techniques

Nanoscience and nanotechnology

- Manipulation techniques, application, risks

Electronics

- Analogue and digital signals
- Conversion

Nuclear Physics

- Properties of stable and unstable nuclei
- $E=mc^2$

Scientific Techniques

anaerobic respiration and ethanol in yeast.
- Link reaction.
- Krebs cycle:
- Electron transport chain in ATP production

Materials Science (Unit 22-O)

- Defining nanotechnology
- Uses of nanotechnology
Benefits of nanotechnology
Environmental impact and health and safety risks of nanotechnology materials

Principles and applications of Science (Unit 1-M)

- Understand the applications of fibre optics in communication and analogue and digital signals: analogue-to-digital conversion, broadband

Astronomy and Space Science (Unit 16-O)

- Nuclear fusion, mass-energy conversion $E = mc^2$ and proton-proton chain

- Role and function of nucleic acids (DNA and RNA), carbohydrates, proteins, lipids, inorganic ions and water.
- Sequence of bases in the DNA molecule determines the structure of proteins, including enzymes
- Enzymes as catalysts
- ATP as a source of energy for biological processes

Ecosystems

- Ecosystems range in size from the very large to the very small
- Biomass transfers/different trophic levels
Microorganisms play a key role in recycling chemical elements
- Ecosystems are dynamic systems, usually moving from colonisation to climax communities in a process known as succession
- Dynamic equilibrium of populations is affected by a range of factors
- Humans are part of the ecological balance and their activities affect it both directly and indirectly
- Effective management of the conflict between human needs and conservation help to maintain sustainability of resources
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Quantum and Nuclear physics

- fission and fusion processes
- $E = mc^2$ applied to nuclear processes
- calculations relating mass difference to energy change

2 b. Technical: Food Sciences **Science underpinning food safety hazards and the risks associated with them** • Microbiological: bacteria, viruses, fungi - yeasts and moulds • Chemical: cleaning chemicals, natural chemicals, pesticides, food additives **Common pathogenic bacteria causing foodborne illness and disease** • Campylobacter jejuni, Bacillus cereus, Salmonella, Clostridium botulinum, Clostridium perfringens, Staphylococcus aureus, Listeria monocytogenes, Escherichia coli. • Laboratory Techniques to identify pathogens • Sampling techniques for pathogens **Composition and role of food components** • Carbohydrates, lipids, proteins, water, vitamins, minerals, enzymes, food additives, flavourings, colourings • Fermentation processes and products • Energy transfer in food technology, conduction, convection, radiation • Principles of heat processing techniques • Principles of heat removal techniques • Ambient temperature processing technologies	**Diseases and Infections (Unit 12-O**) • Pathogens and infectious diseases • Pathogens • Bacteria, parasites, viruses, fungus, protozoa **Biological Molecules and Metabolic Pathways (Unit 10-O)** • Structure and function of water, carbohydrates, proteins and nucleic acids, lipids	**Biological Molecules** • Biological molecules are often polymers and are based on a small number of chemical elements • Role and function of nucleic acids (DNA and RNA), carbohydrates, proteins, lipids, inorganic ions and water. • Sequence of bases in the DNA molecule determines the structure of proteins, including enzymes • Enzymes as catalysts • ATP as a source of energy for biological processes
2 c. Technical: Metrology Sciences **Scientific Measurement** • Calibration of measuring devices	**Science Investigation Skills (Unit 3-M)** • Select relevant measurements and the range of measurements to be recorded	**Units** • The use of SI units and their prefixes • The limitations of physical measurements

• Accuracy and standards • SI units, prefixes and conversions • Measuring temperatures, pressure, flow, electricity, chemical analysis, microscopy, • volume, mass and relevant scientific procedure and equipment	• How variables can be controlled/measured/monitored • **Practical Scientific Procedures and Techniques (Unit 2-M)** • Undertake titration and colorimetry to determine the concentration of solutions • Calculation of Rf value • Preparation and standardisation of solutions using titration • practical application of colorimetry techniques • Undertake chromatographic techniques to identify components in mixtures	
3.	**Additional content**	**Additional content**
	Organs and systems (Unit 5-M)	
	Investigative Project (Unit 6-M)	
	Contemporary Issues in Science (Unit 7-M)	
	Physiology of Human Body Systems (Unit 8-O)	
	Human Regulation and Reproduction (Unit 9-O)	
	Biomedical Science (Unit 20-O)	
	Forensic Evidence, Collection and Analysis (Unit 23-O)	
	Cryogenics and Vacuum Technology (Unit 24-O)	
	Forensic Fire Investigation Unit 25-O)	
	Forensic Traffic Collision Investigation (Unit 26-O)	
		Control Systems
		Biodiversity
		Vectors and scalars
		Mechanics
		Matter