International Advanced Level
Subject: Biology
The need for Transferable Skills

Sources: Cognitive/Intrapersonal and Interpersonal skills adapted and taken from the NRC framework

In recent years, higher education institutions and employers have consistently highlighted the need for students to develop a range of transferable skills to enable them to respond with confidence to the demands of undergraduate study and the world of work. The Organisation for Economic Co-operation and Development (OECD) defines skills, or competencies, as 'the bundle of knowledge, attributes and capacities that can be learned and that enable individuals to successfully and consistently perform an activity or task and can be built upon and extended through learning'.

To support the design of our qualifications, the Pearson Research Team selected and evaluated seven global 21st-century skills frameworks. Following on from this process, the team identified the National Research Council's (NRC) framework as the most evidence-based and robust skills framework, and have used this as a basis for our adapted skills framework.

The framework includes cognitive, intrapersonal skills and interpersonal skills. These skills have been interpreted to ensure they are appropriate for this subject. All of the skills listed are evident or accessible in the teaching, learning and/or assessment of the qualification.

Identifying and highlighting these skills in International Advanced Level qualifications ensures that it is not only the academic and cognitive skills that are developed, but those broader elements that universities highlight as being essential for success. Skills such as self-directed study, independent research, self-awareness of own strengths and weaknesses and time-management are skills that students cannot learn from a textbook but have to be developed through the teaching and learning experience that can be provided through an international curriculum.

In the tables below, we have taken the NRC framework skills and provided definitions of how each skill can be interpreted for this subject. This will enable teachers and learners to understand examples of how they can develop each skill through an International Advanced Level qualification.

NRC framework skill	Skill interpretation in this subject	Where the skill is covered in content	Where the skill is explicitly assessed in examination	Opportunity for the skill to be developed through teaching and learning approach
Cognitive skills				
Cognitive Processes and Strategies				
Critical thinking	Use many pieces of information from different areas of the subject and synthesise the information to make judgments.	Examples in several parts of the specification including: 5.17 Understand the causes of anthropogenic climate change, including the role of greenhouse gases in the greenhouse effect. 5.20 Understand the effects of climate change (changing rainfall patterns and changes in seasonal cycles) on plants and animals (distribution of species, development and life-cycles). 6.9 Understand the roles of antigens and antibodies in the body's immune response including the involvement of plasma cells, macrophages and antigen-presenting cells. 8.4 Understand how a nerve impulse (action potential) is conducted along an axon, including changes in	SAMS Unit 4, Qu.4. SAMS Unit 4, Qu.8. SAMS Unit 4, Qu.6 (b)(ii).	Questioning for feedback in the classroom; 'quick quizzes' (for example with one word answers) and immediate feedback. Homework assignments, for example, defining terms, or researching a topic using on-line resources. Objective self-assessment questions including multiple choice, true / false, labelling a diagram, match lists and cloze passage, all with feedback on correct and incorrect responses.

		membrane permeability to sodium and potassium ions.		
Problem solving	Apply unifying patterns and themes in biology and use them in new and changing situations.	2.15 (i) Know the meaning of the terms: gene, allele, genotype, phenotype, recessive, dominant, incomplete dominance, homozygote and heterozygote. (ii) Understand patterns of inheritance, including the interpretation of genetic pedigree diagrams, in the context of monohybrid inheritance. (iii) Understand sex linkage on the X chromosome, including red-green colour blindness in humans. 3.21 Understand how some phenotypes are affected by multiple alleles for the same gene, or by polygenic inheritance, as well as the environment, and how this can give rise to phenotypes that show continuous variation. 6.19 Understand how DNA profiling is used for identification and determining genetic relationships between organisms (plants and animals).	SAMS Unit 1, Qu.6 (b)(i). SAMS Unit 1, Qu.5(d). SAMS Unit 2, Qu.1. SAMS Unit 4, Qu.5.	Students can work independently to attempt many questions relating to, for example, genetic crosses (monohybrid) and sex linkage. These should be supported with worked examples of correct answers.
Analysis	Analyse and interpret data, experimental methods and results, drawing conclusions which are consistent with evidence from experimental activities.	2.10 (i) Understand the process of DNA replication, including the role of DNA polymerase. (ii) Understand how Meselson and Stahl's classic experiment provided new data that supported the accepted theory of replication of DNA and refuted competing theories. 5.16 Understand the different types of evidence for climate change and its causes (including records of carbon dioxide levels, temperature records, pollen in peat bogs and dendrochronology), recognising correlations and causal relationships.	SAMS Unit 4, Qu.4.	Students can be given opportunities to interpret scientific data, such as the results of Meselson and Stahl's experiment and data relating to mean global temperature and levels of carbon dioxide. Experimental data relating to the effect of temperature on enzyme activity and on growth rates of organisms also provide opportunities for the development of this skill.

		5.21 Understand the effect of temperature on the rate of enzyme activity and its impact on plants, animals and microorganisms, to include Q10. 6.20 Understand how to determine the time of death of a mammal by examining the extent of decomposition, stage of succession, forensic entomology, body temperature and degree of muscle contraction.	SAMS Unit 4, Qu.7.	
Reasoning	Evaluate evidence related to biology and then bring it together to form a conclusion.	2.7 (i) Understand the mechanism of action and the specificity of enzymes in terms of their three-dimensional structure. (ii) Understand that enzymes are biological catalysts that reduce activation energy. (iii) Know that there are intracellular enzymes catalysing reactions inside cells and extracellular enzymes catalysing reactions outside of cells. 3.18 Understand how cells become specialised through differential gene expression, producing active mRNA leading to the synthesis of proteins which in turn control cell processes or determine cell structure in animals and plants. 3.21 Understand how some phenotypes are affected by multiple alleles for the same gene, or by polygenic inheritance, as well as the environment, and how this can give rise to phenotypes that show continuous variation. 4.7 Understand how the uses of plant fibres and starch may contribute to sustainability, including plant-based products to replace oil-based plastics.	SAMS Unit 1, Qu.2(b). SAMS Unit 2, Qu.1.	Students can use questions from recent past papers to reinforce the principles underlying these concepts in biology. Interpretation of data relating to discontinuous and continuous variables, such as ABO blood groups in humans and the mass of individual beans in a sample, will also help students to develop their mathematical and graphical skills.
Interpretation	Select, organise and present relevant information clearly and logically using appropriate vocabulary, definitions and conventions.	5.26 Understand how reforestation and the use of sustainable resources, including biofuels, are examples of the effective management of the conflict between human needs and conservation.		Students can work individually to research topics such as reforestation and the use of sustainable resources, DNA profiling, muscles and movement, and plant growth

		6.19 Understand how DNA profiling is used for identification and determining genetic relationships between organisms (plants and animals). 7.9 Know the way in which muscles, tendons, the skeleton and ligaments interact to enable movement, including antagonistic muscle pairs, extensors and flexors. 8.11 Understand how phytochrome, auxin (IAA) and gibberellin bring about responses in plants, including their effects on transcription.	SAMS Unit 4, Qu.5(b). SAMS Unit 5, Qu.4(a).	regulators, and then write short, illustrated report on each topic.
Decision making	Evaluate data, experimental methods and results, drawing conclusions that are consistent with evidence from secondary sources and other experimental activities. Suggest possible improvements and further investigations to extend an investigation.	Topic 2 RECOMMENDED ADDITIONAL PRACTICAL Investigate tissue water potentials using plant tissue and graded concentrations of a solute. 8.12 CORE PRACTICAL 18 Investigate the production of amylase in germinating cereal grains.	SAMS Unit 3, Qu.3. SAMS Unit 6, Qu.3.	Critical evaluation of results from core practicals, including gathering class data, identification of anomalies and discussion of improvements and possible further investigations related to each practical activity.
Adaptive learning	Understand unifying patterns and themes in biology and apply them in new and possibly unfamiliar contexts.	2.2 (i) Know the structure and properties of cell membranes. (ii) Understand how models such as the fluid mosaic model of membrane structure are interpretations of data used to develop scientific explanations of the structure and properties of cell membranes. 2.14 (i) Understand how errors in DNA replication can give rise to mutations. (ii) Know that some mutations will give rise to cancer or genetic disorders, but that many mutations will have no observable effect. 4.21 Be able to evaluate the methods used by zoos and seed banks in the conservation of endangered species and their genetic diversity, including scientific research, captive breeding	SAMS Unit 1, Qu.1. SAMS Unit 1, Qu.6(b). SAMS Unit 2, Qu.4.	Students will find it helpful to look at various sample questions related to these topics to gain confidence in answering questions of this type, to ensure that they are able to apply their knowledge and understanding of the topics in a new context.

		programmes, reintroduction programmes and education. 5.12 Understand that the numbers and distribution of organisms in a habitat are controlled by biotic and abiotic factors.		
Executive function	Plan investigations using knowledge and understanding of experimental and investigative skills, with due regard for correct and safe laboratory procedures. Evaluate the effectiveness of an investigation in terms of accuracy, repeatability and validity.	4.9 CORE PRACTICAL 8 Determine the tensile strength of plant fibres.	SAMS Unit 3, Qu.2.	Students can work together in small groups to plan investigations, based on their knowledge and understanding of the core practical activities and recommended additional practicals. The experimental principles can be applied in a new context, for example, how to investigate the effect of treatment with an alkali on the tensile strength of plant fibres.
Creativity				
Creativity	Apply existing knowledge and understanding of biological processes to situations set in a new and possibly unfamiliar context.	Questions starting with command words such as 'suggest' and 'explain' require students to use their knowledge and understanding in an unfamiliar context. Explanations must include some elements of linked reasoning or justification.	SAMS Unit 2, Qu.2(b). SAMS Unit 4, Qu.2(b)(iii). SAMS Unit 5, Qu.3(c).	Students can work independently or in small groups to consider applications of biology. Reference should be made to questions that test this skill from the SAMS or from past papers.
Innovation	Use a novel strategy to apply existing knowledge and understanding of biological concepts in new and unfamiliar situations.	Questions which involve a critical analysis of unfamiliar data presented in tabular or graphical form.	SAMS Unit 4, Qu.4(c). SAMS Unit 5, Qu.4(c). SAMS Unit 5, Qu.6(b)(iii).	Students can work independently or in small groups to consider questions that involve analysis of data, looking for trends and patterns and supporting descriptions with suitable quantitative comments. Reference should be made to questions that test this skill from the SAMS or from past papers.

NRC framework skill	**Skill interpretation in this subject**	**Where the skill is covered in content**	**Where the skill is explicitly assessed in examination**	**Opportunity for the skill to be developed through teaching and learning approach**
Intrapersonal skills				
Intellectual openness				
Adaptability	Select and apply knowledge and understanding of scientific processes, which is not prompted or provided, to problems in biology.	5.15 Understand the stages of succession from colonisation to the formation of a climax community. 5.24 Understand how isolation reduces gene flow between populations, leading to allopatric or sympatric speciation. 6.15 Know how an understanding of the contributory causes of hospital acquired infections has led to codes of practice regarding antibiotic	SAMS Unit 4, Qu.8(c).	Students should be given opportunities to apply their knowledge in new contexts, such as observing stages of succession occurring naturally and considering factors that could explain the changes observed. Students could also research hospital codes of practice and discuss why these help to prevent infection, or codes of practice in relation to antibiotic prescription.

		prescription, and hospital practice that relate to infection prevention and control. 7.17 Understand what is meant by homeostasis and its importance in maintaining the body in a state of dynamic equilibrium during exercise, including the role of the hypothalamus and thermoregulation.	SAMS Unit 4, Qu.6(b)(iv). SAMS Unit 5, Qu.2(a).	
Personal and social responsibility	Appreciate the ethical and social issues in biology.	2.18 Be able to identify and discuss the ethical and social issues relating to genetic screening from a range of ethical viewpoints. 5.22 CORE PRACTICAL 12 Investigate the effects of temperature on the development of organisms (such as seedling growth rate or brine shrimp hatch rates), taking into account the ethical use of organisms.		Students should be given an opportunity to work in small groups to consider some of the social, ethical and moral implications of genetic screening. This could take the form of a case study, in a hypothetical situation where, for example, two parents are known to be heterozygous for a debilitating genetic disorder but are considering having a child.
Continuous learning	Plan and reflect on own learning, setting goals, meeting and reviewing them regularly.			Students could prepare weekly targets for their learning of a particular topic, then using quick self-assessment questions to review their progress.
Intellectual interest and curiosity	Identify a problem under own initiative, plan a solution and carry this out.			Many of the core practicals lend themselves to further investigations. Even if students do not carry these out practically, they should be given the opportunity to plan an investigation, with careful consideration of the variables. This will help them to develop the skills needed to cope successfully with questions on Units 3 and 6.
Work ethic/conscientiousness				
Initiative	Use knowledge of biology independently, without guided learning, to further own understanding.			Students can use ‘revision workbooks’ which can include questions from past papers to help reinforce and consolidate learning.
Self-direction	Plan and carry out investigations independently.	5.14 CORE PRACTICAL 11 Carry out a study of the ecology of a habitat, such as using quadrats and transects to determine the distribution and abundance of organisms, and measuring abiotic factors appropriate to the habitat.		There are many opportunities to develop this skill, either in a laboratory or during fieldwork. Fieldwork in particular offers suitable opportunities for students to carry out small-scale individual investigations.

Responsibility	Take responsibility for any errors or omissions in own work and create a plan to improve.			Constructive feedback of formative assignments gives students opportunities to take responsibility for errors or omissions and to create a plan to improve.
Perseverance	Seek new ways to continue and improve own learning, despite setbacks.			Positive and encouraging feedback on formative assignments, such as short homework activities, should help students to continue and improve their learning.
Productivity	Develop a fluency in technical vocabulary so that sophisticated answers are produced in extended answers.	Extended open-response questions require candidates to go through a logical sequence of steps, drawing together different biological concepts, link ideas, and synthesise knowledge.	SAM Paper 4, Qu.5(b)(iii). SAM Paper 5, Qu.7(c)(i).	Students should be given opportunities to practise extended open-response questions from SAMs or, where appropriate, from past papers. These questions usually have a mark allocation of 6. Class discussions of model answers and using 'mind maps' will help candidates to link together ideas and concepts related to a central theme.
Self-regulation (metacognition, forethought, reflection)	Appreciate own knowledge of biology and understand a learning task. Develop and refine a strategy over time for applications of biology to different contexts, reflect on the success or otherwise of the strategy.			Students may find it helpful to prepare a list of 'key points' for a particular topic, to review and summarise the essential information.
Ethics	Produce output with a specific moral purpose for which one is accountable.	6.4 CORE PRACTIAL 13 Investigate the rate of growth of microorganisms in a liquid culture taking into account the safe and ethical use of organisms.		Class discussion of ethical, moral or safety issues relating to any practical that involves the use of living organisms will help students to develop this skill.
Integrity	Take ownership of own work and willingly respond to questions and challenges.			Students could work independently to prepare a short presentation on a topic of their own choice and be prepared to answer questions.
Positive Core Self Evaluation				
Self-monitoring / self-evaluation / self-reinforcement	Plan and review own work as a matter of routine.			The regular use of self-assessment questions, including multiple choice, true / false, labelling diagrams, match lists and cloze passage will help students to review their work.

NRC framework skill	Skill interpretation in this subject	Where the skill is covered in content	Where the skill is explicitly assessed in examination	Opportunity for the skill to be developed through teaching and learning approach
Interpersonal skills				
Teamwork and collaboration				
Communication	Communicate a biological process or technique, either verbally or written, to peers and teachers and answer questions.			Written or verbal presentations of a specification topic of their choice give students opportunities to develop communication skills.
Collaboration	Carry out a peer review and provide supportive, constructive feedback to another.			Students can work in pairs to appraise a short piece of written work and provide helpful feedback.
Teamwork	Work collaboratively with other students in practical work so that the contribution of every student is valued and effective.			There are many opportunities for students to work together, in pairs or small groups, when carrying out core practical activities. Each student should be assigned a particular task with the group.
Co-operation	Share own resources and learning techniques with other students.			Working in small groups to discuss strategies for effective revision and learning.
Interpersonal skills	Use verbal and written communication skills in a dialogue about a topic in biology.			Written or verbal presentations of a specification topic of their choice give students opportunities to develop interpersonal skills.
Empathy / perspective taking	Support the position of another in a piece of writing or in an oral presentation.			Students may be given opportunities to work in pairs to prepare and present a short talk on a specification topic, taking it in turns to deliver separate parts of the presentation. This helps to encourage mutual support and empathy.
Negotiation	Debate an ethical topic or issue in biology, attempting to reach shared conclusions with others, compromising where appropriate using negotiation skills.	2.18 Be able to identify and discuss the ethical and social issues relating to genetic screening from a range of ethical viewpoints.		Class discussion of ethical issues in biology, such as genetic screening or the use of animals in research, gives students opportunities to reach shared conclusions.
Leadership				
Leadership	Lead others in a group activity to effectively encourage and develop learning.			Students could be given an opportunity to work in small groups to prepare a poster on a specification topic, such as ‘plant cell structure’ or ‘the polymerase chain reaction’. One student in each group takes overall responsibility for the organisation of the task.
Responsibility	Take responsibility for the outcome of a team activity, even if one is not solely responsible for the outcome.			Preparation and presentation of a poster gives students opportunities to take responsibility for the task, where each student makes a contribution.
Assertive communication	Chair a debate, allowing representations and directing the discussions to a conclusion.	8.22 Understand the risks and benefits associated with the use of genetically modified organisms.		Chairing a discussion on specific issues in biology, such as genetic screening, use of animals in research, or the benefits and risks of genetically modified organisms.

Self-presentation	Utilise a number of different opportunities to exhibit communication skills in variety of ways including written and verbal, including presenting a topic to the class.	5.25 Understand the way in which scientific conclusions about controversial issues, such as what actions should be taken to reduce climate change, or the degree to which humans are affecting climate change, can sometimes depend on who is reaching the conclusions.		Students can be given opportunities to give short, verbal accounts of their poster displays to the class and be prepared to answer questions.