Investigative biology		
Key area	**Depth of knowledge required**	**Suggested learning activities**
Random, systematic and stratified sampling	In random sampling, members of the population have an equal chance of being selected. In systematic sampling, members of a population are selected at regular intervals. In stratified sampling, the population is divided into categories that are then sampled proportionally.	In ecological studies, use random numbers to select quadrats for sampling. Establish sample size by determining a travelling mean or the cumulative total of species in quadrats. Use line or belt transects to systematically sample an environment. Use stratified sampling to sample habitats that are not uniform, using a standard formula to calculate the number of samples from each area.
(d) Reliability Variation in experimental results may be due to the reliability of measurement methods and/or inherent variation in the specimens The precision and accuracy of repeated measurements	The reliability of measuring instruments or procedures can be determined by repeated measurements or readings of an individual datum point. The variation observed indicates the precision of the measurement instrument or procedure but not necessarily its accuracy.	Determine the precision of a measuring procedure by repeated measurements, and the accuracy of a measuring procedure by calibration against a known standard.

Investigative biology		
Key area	**Depth of knowledge required**	**Suggested learning activities**
The natural variation in the biological material being used can be determined by measuring a sample of individuals from the population The mean of these repeated measurements will give an indication of the true value being measured The range of values is a measure of the extent of variation in the results If there is a narrow range then the variation is low Independent replication should be carried out to produce independent data sets These independent data sets should be compared to determine the reliability of the results	Overall results can only be considered reliable if they can be achieved consistently.	
(e) Presentation of data Discrete and continuous variables give rise to qualitative, quantitative, or ranked data	Qualitative data is subjective and descriptive. Quantitative data can be measured objectively, usually with a numerical value.	

Investigative biology		
Key area	**Depth of knowledge required**	**Suggested learning activities**
	Ranked data refers to the data transformation in which numerical values are replaced by their rank when the data are sorted from lowest to highest.	
The type of variable being investigated has consequences for any graphical display or statistical tests that may be used		
Identification and calculation of mean, median and mode		
Use of box plots to show variation within and between data sets	Median, lower quartile, upper quartile and inter-quartile range.	
Interpret error bars on graphical data		
Correlation exists if there is a relationship between two variables	Correlation is an association and does not imply causation. Causation exists if the changes in the values of the independent variable are known to cause changes to the value of the dependent variable	
Positive and negative correlations	A positive correlation exists when an increase in one variable is accompanied by an increase in the other variable.	

Investigative biology		
Key area	**Depth of knowledge required**	**Suggested learning activities**
Strong and weak correlations	A negative correlation exists when an increase in one variable is accompanied by a decrease in the other variable. Strength of correlation is proportional to spread of values from line of best fit. Correlation values are not required.	
3 Reporting and critical evaluation of biological research (a) Background information Scientific reports should contain an explanatory title, an abstract including aims and findings, an introduction explaining the purpose and context of the study including the use of several sources, supporting statements, citations, and references	Background information should be clear, relevant and unambiguous. A title should provide a succinct explanation of the study. An abstract should outline the aims and findings of the study. An aim must link the independent and dependent variables. The introduction should provide any information required to support: choices of method, results, and discussion. An introduction should explain why the study has been carried out and place the study in the context of existing understanding. Key points should be summarised and supporting and	

Investigative biology		
Key area	**Depth of knowledge required**	**Suggested learning activities**
	contradictory information identified. Several sources should be selected to support statements, and citations and references should be in a standard form. Decisions regarding basic selection of study methods and organisms should be covered, as should the aims and hypotheses.	
(b) Reporting and evaluating experimental design A method section should contain sufficient information to allow another investigator to repeat the work Experimental design should address the intended aim and test the hypothesis Treatment effects should be compared to controls Any confounding variables should be taken into account or standardised across treatments	The validity and reliability of the experimental design should be evaluated. An experimental design that does not address the intended aim or test the hypothesis is invalid.	

Investigative biology		
Key area	**Depth of knowledge required**	**Suggested learning activities**
The validity of an experiment may be compromised when factors other than the independent variable influence the value of the dependent variable The effect of selection bias and sample size on representative sampling	Selection bias is the selection of a sample in a non-random way, so that the sample is not representative of the whole population. Selection bias may have prevented a representative sample being selected. Sample size may not be sufficient to decide without bias whether the change to the independent variable has caused an effect in the dependent variable.	
(c) Data analysis The appropriate use of graphs, mean, median, mode, standard deviation and range in interpreting data Statistical tests are used to determine whether the differences between the means are likely or unlikely to have occurred by chance	In results, data should be presented in a clear, logical manner suitable for analysis. Consideration should be given to the validity of outliers and anomalous results. Knowledge of specific statistical tests is not required.	Explore error bars showing standard deviation, standard errors, or range. These could be used in project work, where appropriate.

Investigative biology		
Key area	**Depth of knowledge required**	**Suggested learning activities**
A statistically significant result is one that is unlikely to be due to chance alone Error bars indicate the variability of data around a mean If the treatment mean differs from the control mean sufficiently for their error bars not to overlap, this indicates that the difference may be significant		
(d) Evaluating results and conclusions Conclusions should refer to the aim, the results and the hypothesis The validity and reliability of the experimental design should be taken into account Consideration should be given as to whether the results can be attributed to correlation or causation Evaluation of conclusions should also refer to existing knowledge and the results of other investigations	Meaningful scientific discussion would include consideration of findings in the context of existing knowledge and the results of other investigations. Scientific writing should reveal an awareness of the contribution of scientific research to	

Investigative biology		
Key area	**Depth of knowledge required**	**Suggested learning activities**
	increasing scientific knowledge, and to the social, economic and industrial life of the community.	

Preparing for course assessment

Each course has additional time, which may be used at the discretion of teachers and/or lecturers, to enable candidates to prepare for course assessment. This time may be used at various points throughout the course for consolidation and support. It may also be used towards the end of the course for further integration, revision and preparation.

Throughout the course, teachers and/or lecturers should find opportunities:

- for identifying particular aspects of work that need reinforcement and support
- to practise skills of scientific inquiry and investigation to prepare for the project
- to practise question paper techniques

Developing skills for learning, skills for life and skills for work

Teachers and/or lecturers should identify opportunities throughout the course for candidates to develop skills for learning, skills for life and skills for work.

Candidates should be aware of the skills they are developing and teachers and/or lecturers can provide advice on opportunities to practise and improve them.

SQA does not formally assess skills for learning, skills for life and skills for work.

There may also be opportunities to develop additional skills depending on the approach centres use to deliver the course. This is for individual teachers and lecturers to manage.

The following skills for learning, skills for life and skills for work are significantly developed.

Literacy

Writing means the ability to create texts that communicate ideas, opinions and information, to meet a purpose and within a context. In this context, 'texts' are defined as word-based materials (sometimes with supporting images) that are written, printed, Braille or displayed on screen. These are technically accurate for the purpose, audience and context.

Reading means the ability to understand and interpret ideas, opinions and information presented in texts, for a purpose and within a context. It includes handling information to make reasoned and informed decisions.

1.1 Reading

Candidates understand and interpret a variety of scientific texts.

1.2 Writing

Candidates develop and use skills to effectively communicate key areas of biology, make informed decisions and describe, clearly, biological issues in various media forms.

Candidates have the opportunity to communicate applied knowledge and understanding throughout the course, with an emphasis on applications and environmental, ethical and social impacts.

There are opportunities to develop the literacy skills of listening and reading when gathering and processing information in biology.

Numeracy

Numeracy is the ability to use numbers in order to solve problems by counting, doing calculations, measuring, and understanding graphs and charts. It is also the ability to understand the results. Candidates have opportunities to extract, process and interpret information presented in numerous formats, including tabular and graphical. Practical work provides opportunities to develop time and measurement skills.

2.1 Number processes

Number processes means solving problems arising in everyday life through carrying out calculations, when dealing with data and results from experiments/investigations and everyday class work, making informed decisions based on the results of these calculations, and understanding these results.

2.2 Money, time and measurement

Candidates use their understanding of time and measurement to solve problems and handle data in a variety of biology contexts, including practical and investigative.

2.3 Information handling

Information handling means being able to gather and interpret biological data in tables, charts and other graphical displays to draw sensible conclusions throughout the course. It involves interpreting the data and considering its reliability in making reasoned deductions and informed decisions. It also involves an awareness and understanding of the chance of events happening.

Thinking skills

This is the ability to develop the cognitive skills of remembering and identifying, understanding and applying. The course allows candidates to develop skills of applying, analysing and evaluating. Candidates can analyse and evaluate practical work and data by reviewing the process, identifying issues and forming valid conclusions. They can demonstrate understanding and application of key areas, and explain and interpret information and data.

5.3 Applying

Applying is the ability to use existing information to solve biological problems in different contexts, and to plan, organise and complete a task, such as the project.

5.4 Analysing and evaluating

This is the ability to solve problems in biology and make decisions that are based on available information. It may involve reviewing and evaluating relevant information and/or prior knowledge to provide an explanation and consider potential solutions. It may build on selecting and/or processing information, so is a higher-order skill.

5.5 Creating

This is the ability to design something innovative, or to further develop an existing thing by adding new dimensions or approaches. In particular, candidates can demonstrate their creativity when planning and designing biology experiments or investigations. They have the opportunity to be innovative and to make, write, say or do something new.

Candidates also have opportunities to develop the skills of working with others and citizenship.

Working with others

Learning activities provide many opportunities, in all areas of the course, for candidates to work with others. In particular, practical activities and investigations offer opportunities for group work, which is an important aspect of biology.

Citizenship

Candidates develop citizenship skills when considering the applications of biology in our lives, as well as environmental and ethical implications.

Appendix 2: question paper brief

	Marks		
Component	**Knowledge and understanding**	**Skills**	**Total**
question paper	70+/-5	30+/-5	100

Knowledge and understanding/skills	**Range of marks**
♦ demonstrating knowledge and understanding of biology by making statements, describing information, providing explanations and integrating knowledge	min 25
♦ applying knowledge and understanding of biology to new situations, interpreting information and solving problems	25 ± 5
♦ planning or designing experiments/investigations, including safety measures, to test given hypothesis or to illustrate particular effects	25–35
♦ selecting information from a variety of sources	
♦ processing information/data (using calculations and units, where appropriate)	
♦ making predictions and generalisations based on evidence/information	
♦ drawing valid conclusions and giving explanations supported by evidence/justification	
♦ identifying sources of error and suggesting improvements to experiments	

A maximum of two extended-response questions, 12–15 marks in total: ♦ One of the extended-response questions will include a choice of topic: 8–10 marks. ♦ One of the extended-response questions will not include options: 4–5 marks.
One extensive data-handling question: 7–10 marks
One large experimental design question: 5–9 marks
Grade-A marks: approximately 25%

Administrative information

Published: August 2022 (version 4.1)

History of changes

Version	Description of change	Date
2.0	Course support notes and question paper brief added as appendices.	May 2019
3.0	Course specification amended for clarification and consistency, as follows. Amendments made to course specification and column 1 of the course support notes: key area 'organisms and evolution' sub-section (b) fitness: 'number' changed to 'frequency'. Amendments made to course specification and column 1 of the course support notes: key area 'organisms and evolution' sub-section (c) sex determination: removed 'or temperature'. Column 1 of the course support notes: key area 'cells and proteins' sub-section: (f) aseptic technique and cell culture: sentence added: 'In culture, primary cell lines can divide a limited number of times, whereas tumour cells lines can perform unlimited divisions' to address an inconsistency, as the sentence appears in the course specification on page 6.	June 2020
4.0	Course specification and course support notes amended for clarification as follows. Wording amended in 'Organisms and Evolution' key area on pages 23 and 24, and page 102 (key area column) from: 'Ectoparasites are generally transmitted through direct contact or by consumption of intermediate hosts Endoparasites of the body tissue are often transmitted by vectors' to: 'Ectoparasites are generally transmitted through direct contact Endoparasites of the body tissue are often transmitted by vectors or by consumption of intermediate hosts'	April 2022

Version	Description of change	Date
4.1	Appendix 2: question paper brief: ♦ Applying knowledge range of marks updated to 25 ± 5. ♦ Bullet point on 'presenting information appropriately, in a variety of forms' removed as no longer required. ♦ 'Additional information' section updated to amend percentage of grade-A marks to 'approximately 25%'.	August 2022

Note: please check SQA's website to ensure you are using the most up-to-date version of this document.