



Key Skills – GCE AS/A Level Biology

This Appendix offers detailed guidance on the Key Skills evidence that a candidate might produce during their programme of study. It focuses on the evidence required to meet the criteria for the internally assessed Key Skills portfolio. The evidence requirements are reproduced from Part B of the QCA Key Skills specifications. For example, in producing work for assessment as evidence of C3.2 (Read and synthesise information from two extended documents about a complex subject. One of these documents should include at least one image.) A candidate is required to:

- select and read material that contains the information you need;
- identify accurately, and compare, the lines of reasoning and main points from text and images; and
- synthesise the key information in a form that is relevant to your purpose.

The Key Skills and Evidence Requirements below are quoted from Part B of the QCA Skills specifications and, as such, are addressed to the candidate. The text below the Evidence Requirements is guidance for teachers about how the specification might be used to provide teaching and learning opportunities and/or assessment opportunities for the Key Skill.

For further information, teachers should refer to QCA's Key Skills specifications (for use in programmes of study starting from September 2000).

For further information about the assessment and certification of Key Skills, teachers should contact OCR.

C3 Communication Level 3

C3.1a Contribute to a group discussion about a complex subject.

Evidence requirements

- i. Make clear and relevant contributions in a way that suits your purpose and situation.
- ii. Listen and respond sensitively to others, and develop points and ideas.
- iii. Create opportunities for others to contribute when appropriate.

Possible opportunities

These Advanced Subsidiary GCE and Advanced GCE Biology Specifications provide many opportunities for group discussion. The social and ethical implications of many topics are implicit and stated. A useful way of 'breaking the ice' with a new group is to encourage them to bring newspaper and magazine cuttings on ethical issues, discuss them with the class and construct a display for notice boards that may be empty at the start of the year.

Module 2802, Human Health and Disease

A discussion of the possible links between diet and coronary heart disease, supported by articles from popular press, journals, CD ROMs and the Internet, is possible in section 5.2.2 (f).

Module 2805, Component 01, Growth, Development and Reproduction

A discussion of contraception, in vitro fertilisation and abortion from biological and ethical viewpoints is possible in section 5.5.4 (i).

Module 2805, Component 02, Applications of Genetics

A discussion of the ethical implications of the use of AI, in vitro fertilisation and embryo transplantation in animals, and their social and ethical implications in humans, is possible in section 5.6.2 (h).

A discussion of the advantages and disadvantages of genetic screening and the need for genetic counselling, supported by leaflets distributed by the Health Education Council, is possible in section 5.6.5 (b).

Module 2805, Component 05, Mammalian Physiology and Behaviour

A discussion of the effects and implications of ageing in the locomotory, nervous and sensory systems, i.e. relating to sections 5.9.3 (i), 5.9.4 (f), and 5.9.5 (e) is possible.

C3.1b *Make a presentation about a complex subject, using at least one image to illustrate complex points.*

Evidence requirements

- i. Speak clearly and adapt your style of presentation to suit your purpose, subject, audience and situation.
- ii. Structure what you say so that the sequence of information and ideas may be easily followed.
- iii. Use a range of techniques to engage the audience, including effective use of images.

Possible opportunities

If time allows it is possible to approach any of the topics used for group discussion as a presentation.

The preparation of the task would also cover some of the skills in IT3.

Module 2801, Biology Foundation

Sections 5.1.1 (c) and (d) could be taught through the candidates themselves preparing presentations on one or two organelles. The presentations could be supported by electron micrographs and drawings on the OHP (prepared by hand or downloaded from a CD ROM or the Internet), and by using prepared handouts.

In a similar way, sections 5.1.2 (b), (c) and (d) could be presented using molecular building kits, computer generated molecules, cut and paste shapes and photocopied summaries.

Module 2805, Component 04, Microbiology and Biotechnology

Presentations on section 5.8.4 (d) could be supported by data from the food industry, companies involved in GM crops and information downloaded from the Internet.

Section 5.8.5 (f) could also be delivered as a presentation using data from food industry, companies involved in GM crops, and information downloaded from the Internet.

C3.2 Read and synthesise information from two extended documents that deal with a complex subject. One of these documents should include at least one image.

Evidence requirements

- i. Select and read material that contains the information you need.
- ii. Identify accurately, and compare, the lines of reasoning and main points from texts and images.
- iii. Synthesise the key information in a form that is relevant to your purpose.

Possible opportunities

There are numerous opportunities to fulfil the requirements for C3.2 when preparing the material for group discussion or presentation in relation to C3.1a and or C3.1b. In addition the following topics provide opportunity to make class notes by extracting relevant information from a variety of sources, or to research information to plan a practical exercise.

The preparation of the task could also cover some of the skills in IT3.

Module 2801, Biology Foundation

For section 5.1.3 (b), CD ROM's and recommended text books, plus data from a practical exercise in 5.1.3 (d), could be used to illustrate the principles of enzyme action, and also to produce a coherent written account by hand or 'desk top published' in private study time.

Module 2802, Human Health and Disease

To support teaching of section 5.2.4 (c), use could be made of experimental evidence for the link between cigarette smoking and disease and the 'Doll Study' Reference Mortality in relation to smoking : 40 years' observations on male British Doctors. Doll R, Peto R, Wheatley K et al BMJ 1995 Vol 309 pages 901 - 911.

Module 2805, Component 04, Microbiology and Biotechnology

Use of the Internet, national newspapers and scientific journals will provide a fund of information to fulfil the requirements for section 5.8.4 (d).

C3.3 Write two different types of documents about complex subjects. One piece of writing should be an extended document and include at least one image.

Evidence requirements

- i. Select and use a form and style of writing that is appropriate to your purpose and complex subject matter.
- ii. Organise relevant information clearly and coherently, using specialist vocabulary when appropriate.
- iii. Ensure your text is legible and your spelling, grammar and punctuation are accurate so your meaning is clear.

Possible opportunities

Any of the activities outlined in C3.2 could be used to produce an extended free response answer, revision notes or material for submission as a planning exercise. This could be completed in private study time. Additional suggestions are given below.

Module 2804, Central Concepts

The topics in sections 5.4.1 (j) and 5.4.2 (f) lend themselves to a planning exercise for practical assessment. Researching information for the topics and presentation of the completed work would fulfil the requirements for this unit.

The topics in sections 5.4.6 (h) and (j) would lend themselves to a free response answer, illustrated by diagrams and data, and completed in private study time.

Module 2805, Component 05, Mammalian Physiology and Behaviour

The topic in section 5.9.6 (d) would lend itself to a free response answer, illustrated by diagrams and data, and completed in private study time.

N3 Application of Number Level 3

You must:

Plan and carry through at least one substantial and complex activity that includes tasks for N3.1, N3.2 and N3.3

N3.1 Plan, and interpret information from two different types of sources, including a large data set.

Evidence requirements

- i. Plan how to obtain and use the information required to meet the purpose of your activity.
- ii. Obtain the relevant information.
- iii. Choose appropriate methods for obtaining the results you need and justify your choice.

Possible opportunities

It may be possible to plan and execute a practical assignment that includes all three of the Application of Number skills, and some ideas are suggested below. However, it is more likely that the majority of practical assignments will cover only one of N3.1, N3.2 and N3.3.

Module 2801, Biology Foundation

An exercise could be set on section 5.1.1 (h), which requires the candidate to draw a Low Power microscope section of a dicotyledonous leaf eg Prunus. Using an eye piece graticule, which had previously been calibrated by the candidate, the linear dimensions of the leaf could be calculated. The candidate could also make this calculation from a photograph, the scale of which was known. Again, using the eye piece graticule, measurements could be taken of the mean width of a random sample of upper and lower epidermal cells. The collection of class data would provide a large data set for interpretation. Similar data could be obtained from a monocotyledonous leaf, such as Iris, and the data sets compared.

This exercise could also be used to fulfil the requirements for N3.2 and N3.3, providing an activity testing all three skill areas.

The exercise used for IT3.2, relating to section 5.1.3 (d), could also be used for this skill. The practical exercise to measure the activity of catalase at different substrate concentrations will generate data that can be supplemented from the class and other previous experiments in order to provide a suitably large data set.

The exercise could also be used to fulfil the requirements for N3.2 and N3.3, thereby covering all three skill areas.

Module 2804, Central Concepts

Sections 5.4.3 (a) and (b) could yield data from direct sampling which could be pooled with class data, as well as with data obtained from the Internet, by email, or from commercial software. These data could be tabulated on a spread sheet.

This exercise could also be used to satisfy the requirements for N3.2 and N3.3, providing an activity which covers all three skill areas.

The exercise could also be used to test IT3.1 and IT3.2.

Module 2805, Component 03, Environmental Biology

Section 5.7.1 (f) could yield data from direct sampling which could be pooled with class data as well as with data obtained from the Internet, by email or from commercial software. These data could then be tabulated on a spread sheet.

This exercise could also be used to fulfil the requirements for N3.2 and N3.3, providing an activity covering all three skill areas.

N3.2 *Carry out multi-stage calculations to do with:*

- (a) amounts and sizes;
- (b) scales and proportion;
- (c) handling statistics;
- (d) rearranging and using formulae.

You should work with a large data set on at least one occasion.

Evidence requirements

- (i) Carry out calculations to appropriate levels of accuracy, clearly showing your methods.

- (ii) Check methods and results to help ensure errors are found and corrected.

Possible opportunities

All the practical activities described for N3.1 could be extended to include the use of the calculations listed for N3.2. The collection, processing and analysis of data is implicit in the majority of practical exercises.

Module 2801, Biology Foundation

The use of the microscope to measure the dimensions of leaf epidermal cells described above (from section 5.1.1) requires the candidate to determine amounts, scales and proportions. It is necessary to rearrange formulae in order to calibrate the graticule. The upper and lower epidermis cell dimensions in the monocotyledonous and dicotyledonous leaves can be compared statistically.

The practical planned in N3.1, for section 5.1.3, will yield data for statistical analysis.

Module 2803, Component 01, Transport

A practical exercise could be set, relating to sections 5.3.3 (c) and (k), to determine the distribution of stomata on the upper and lower surfaces of a dicotyledonous leaf. This would require the candidate to use formulae to calculate the density per unit area, as well as the carrying out of a statistical test to determine significance. The candidate could also be asked to draw a stomata to a given magnification, using a formula, and to make an estimate of size before drawing.

Module 2804, Central Concepts

Section 5.4.3 (b) requires the candidate to judge the size of the sampling area and to collect random samples of biotic and abiotic data. The data could be processed using formulae and analysed statistically.

Module 2805, Component 01, Growth, Development and Reproduction

Practical exercises on growth, relating to sections 5.5.1 (b), (c), (d) and (e), require the use of sizes, proportion, formulae and statistical analysis.

These exercises could also be used to satisfy the requirements for N3.3.

Module 2805, Component 02, Applications of Genetics

The use of the chi square test for genetic ratios is required in section 5.6.1 (i).

Module 2805, Component 03, Environmental Biology

Section 5.7.1 (f) will yield data which can be collected and entered on a spread sheet. The data could be analysed statistically by calculator, or by computer.

N3.3 *Interpret results of your calculations, present your findings and justify your methods. You must use at least one graph, one chart and one diagram.*

Evidence requirements

- i. Select appropriate methods of presentation and justify your choice.
- ii. Present your findings effectively.
- iii. Explain how the results of your calculations relate to the purpose of your activity.

Possible opportunities

The Biology specification provides many opportunities for evidence of these skills.

Module 2801, Biology Foundation

The use of the microscope, relating to section 5.1.1 (h), to measure the dimensions of leaf epidermal cells, which is described above, will yield drawings and data which provide information for interpretation, both quantitatively, using tabulated and statistical data, and qualitatively using the observation and drawings of the material provided.

The results of the practical, relating to section 5.1.3 (d), planned in N3.1 and analysed for N3.2 above, can be plotted on a graph to show the mean rate of reaction against substrate concentration. The standard deviation can also be shown on this graph.

Preparation of a slide of a longitudinal section of an onion root tip, relating to section 5.1.6 (d), will provide an opportunity to measure the dimensions of cells in the zones of division, elongation and differentiation. The data collected in this way can then be pooled by the class and scattergrams drawn.

Module 2804, Central Concepts

The data obtained in sections 5.4.3 (a) and (b) require interpretation by the candidate, both quantitatively and qualitatively. Graphs of population growth could be plotted.

Module 2805, Component 01, Growth, Development and Reproduction

Practical exercises on growth, such as those in sections 5.5.1 (b), (c), (d) and (e), require the use of tabulated data, charts and graphs in order to analyse the results.

Module 2805, Component 03, Environmental Biology

The data obtained in section 5.7.1 (a), (c) and (f) require interpretation by the candidate, both quantitatively and qualitatively. Graphs and charts could be produced to illustrate the interpretation.

Module 2805, Component 04, Microbiology and Biotechnology

Practical work relating to sections 5.8.2 (b) and (f) would lend itself to an investigation of the growth of bacteria in different growth media. Bacterial growth could be monitored on plates by measuring the colony sizes at regular intervals, and the results could be plotted on a graph or bar chart. The results could then be analysed statistically.

IT3 IT Level 3

You must:

Plan and carry through at least one substantial activity that includes tasks for IT3.1, IT3.2 and IT3.3.

IT 3.1 *Plan, and use different sources to search for, and select, information required for two different purposes.*

Evidence requirements

- i. Plan how to obtain and use the information required to meet the purpose of your activity.
- ii. Choose appropriate sources and techniques for finding information and carry out effective searches.
- iii. Make selections based on judgements of relevance and quality.

Possible opportunities

These will arise during planning exercises for the Practical Skills. Alternatively, there will be opportunities in accessing information for evidence relating to C3, when a wide variety of IT skills and resources can be used, such as searching the Internet, or making use of CD-ROMs and other software.

Module 2801, Biology Foundation

Section 5.1.1 could be used to develop an independent learning exercise, designed to access the information in the section by using the facilities available in the Centre.

These would include the library, journals and audiovisual sources, but would also require the candidate to access a wide variety of IT resources. These might include CD-ROMs, such as Encarta and Body Works, as well as CD-ROM copies of journals, such as New Scientist and national newspapers, such as the science section of The Times. This type of exercise would not only help to familiarise candidates with available IT resources and their potential, but would also require the candidate to select what is relevant from a large amount of information.

This type of exercise would also incorporate some of the skills from C3.

Module 2802, Human Health and Disease

IT resources could be used to search for, and access, relevant health statistics from a variety of international sources. These data could then be used to illustrate the relevance of such statistics.

Such an exercise could also be presented to satisfy the requirements for IT3.3.

IT 3.2 Explore, develop, and exchange information and derive new information to meet two different purposes.

Evidence requirements

- i. Enter and bring together information in a consistent form, using automated routines where appropriate.
- ii. Create and use appropriate structures and procedures to explore and develop information and derive new information.
- iii. Use effective methods of exchanging information to support your purpose.

Possible opportunities

The specification provides limited opportunity to access the requirements of IT3.2, although automated routines are used relatively frequently in practical exercises. However, the exchange of data via the Internet and email can be seen as an extension of the normal pooling of class data.

Module 2801, Biology Foundation

Spread sheets, and statistics programmes within them, could be used to analyse the data from a practical investigation involving enzymes (5.1.3 (c) and (d)). For instance, data from an investigation into the effect of substrate concentration on catalase activity could then be converted to a graph. Additional data could be obtained from previous spread sheets from other candidates.

Such an exercise could also be used for Application of Number N3.1, N3.2 and N3.3.

For section 5.1.7 (c), data could be obtained from other investigations via the Internet or email. Such data could be compared, analysed statistically, and converted into charts and graphs using a spreadsheet.

Module 2804, Central Concepts

Planning an investigation on the production of carbon dioxide by yeast in section 5.4.1 (j) could involve the use of data loggers, spread sheets and the use of secondary data obtained via the Internet or email. The primary data could be downloaded into the computer, processed and presented.

In sections 5.4.4 (f) and (j), the Internet and email could be used to add to primary data on genetic crosses. Spreadsheets could then be used to record and to analyse the data statistically. The Internet could also be used to access the Human Genome Project.

This latter exercise would also incorporate some of the skills in C3.

Module 2805, Component 03, Environmental Biology

Data loggers could be used when covering sections 5.7.1 (a), (c) and (f). Computer programs could be used to process the data collected. These data could be compared with secondary data obtained via the Internet or email.

This type of activity could also be used to fulfil the requirements for Application of Number, N3.1, N3.2 and N3.3.

IT3.3 *Present information from different sources for two different purposes and audiences. Your work must include at least one example of text, one example of images and one example of numbers.*

Evidence requirements

- i. Develop the structure and content of your presentation using the views of others, where appropriate, to guide refinements.
- ii. Present information effectively, using a format and style that suits your purpose and audience.
- iii. Ensure your work is accurate and makes sense.

Possible opportunities

Most practical investigations involve the production of a report using text, the processing of data and occasionally the use of drawings and images.

Preparatory work for discussion and presentation in C3.1 also includes these skills. A presentation making more use of IT could be achieved through the use of Microsoft 'PowerPoint' to present the topic on a screen, or on a large screen television.

Module 2801, Biology Foundation

Sections 5.1.1 (c) and (d) could be taught by each candidate preparing a presentation on one or two organelles (to fulfil the requirements for C3.1(b), whilst at the same time completing the requirement for IT3.3 by including images and text from the Internet or from CD ROM.

Sections 5.1.2 (b), (c) and (d) could be presented by the candidate to satisfy the requirements for C3.1b, whilst at the same time completing the requirement for IT3.3 by including images and text from the Internet or from CD ROM.

Module 2802, Human Health and Disease

In teaching section 5.2.1 (d), health statistics from a variety of sources could be presented on screen or on large screen television, using text, data and images from the Microsoft 'PowerPoint' programme.

These data could also be accessed from IT sources to satisfy the requirements for IT3.1.

WO3 Working with Others Level 3

You must :

Provide at least one substantial example of meeting the standard for WO3.1, WO3.2 and WO3.3, (you must show you can work in one-to-one and group situations).

WO3.1 Plan complex work with others, agreeing objectives, responsibilities and working arrangements.

Evidence requirements

- (i) Agree realistic objectives for working together and what needs to be done to achieve them.

- (ii) Exchange information, based on appropriate evidence, to help agree responsibilities.
- (iii) Agree suitable working arrangements with those involved.

Possible opportunities

The suggestions outlined to cover Key Skill C3.1b could also be used to access WO3.1, WO3.2 and WO3.3 as they require the group to work together to produce a coherent and logical presentation of the whole topic. Regular meetings between the subgroups and the whole group to check on progress ensures both monitoring and an exchange of information to improve the final presentation. Records of these meetings should be kept, identifying ways in which the group worked well together and ways in which cooperative working could be improved in the future. These records could be in the form of logs kept by the participants, audio-visual tape recordings or minutes of the meetings concerned.

Module 2801, Biology Foundation

Section 5.1.1 (c) and (d) on cell structure could be taught by each candidate (or group of candidates) preparing a presentation on one or two organelles. This could be supported by electron micrographs and drawings obtained from published sources, CD ROMs or Web Sites. The candidate could also prepare duplicated notes to support the talk.

The candidate could use molecular building kits, computer-generated molecules, cut and paste shapes and photocopied summaries to give a presentations on biological molecules listed in Section 5.1.2 (b), (c) and (d). This topic provides a valuable opportunity for candidates with good spatial ability to teach on a one-to-one basis those who find the topic more difficult.

Module 2802, Human Health and Disease

A model of the antigen-antibody reaction could be constructed by the candidate to illustrate Section 5.2.6 (e) on immunity. This also provides an opportunity to assist those candidates who have poor spatial ability.

Module 2805, Component 02, Applications of Genetics

The candidates could be encouraged to organise a debate on the benefits and hazards of genetically engineered organisms in agriculture as part of the coverage of Section 5.6.4 (d). This would involve the group cooperating together to research the topic and nominate speakers. Each main speech and speeches from the floor would constitute individual contributions.

WO3.2 Seek to establish and maintain cooperative working relationships over an extended period of time, agreeing changes to achieve agreed objectives.

Evidence requirements

- (i) Organise and carry out tasks so you can be effective and efficient in meeting your responsibilities and produce the quality of work required.
- (ii) Seek to establish and maintain cooperative working relationships, agreeing ways to overcome any difficulties.
- (iii) Exchange accurate information on progress of work, agreeing changes where necessary to achieve objectives.

Possible opportunities

Candidates can be assessed on this skill area whilst preparing work as outlined W03.1. The presentation of work for the group as a whole provides an obvious check as to the meeting of deadlines and cooperation within the group. Records should be kept of the progress made by the group. These can be similar to those used for WO3.1.

WO3.3 Review work with others and agree ways of improving collaborative work in the future.

Evidence requirements

- (i) Agree the extent to which work with others has been successful and the objectives have been met.
- (ii) Identify factors that have influenced the outcome.
- (iii) Agree ways of improving work with others in the future.

Possible opportunities

Candidates could be given the opportunity to provide feedback on the presentation that they have prepared. Part of this feedback could include ways in which they could help each other in similar activities in the future. Statements summarising the outcomes of the activity should be included in the reports kept by the participants. They should be encouraged to reflect on the factors that influenced the success of the group and record these and ways in which cooperative work could be improved in the future.

LP3 Learning Performance Level 3

You must :

Provide at least one substantial example of meeting the standard for LP3.1, LP3.2 and LP3.3.

Possible opportunities

Any independent learning exercise such as those outlined below provides an opportunity to assess this skill.

Study based learning

Module 2801, Biology Foundation

Sections 5.1.1 (c) and (d) on cell structure could be used to develop an independent learning exercise designed to access the information in the section by using the facilities available in the Centre. These would include books, journals and audio-visual sources, but also require the candidate to use a wide variety of IT resources. The candidate could use CD-ROMs such as Encarta and Body Works, and journals, such as New Scientist, that are available in that format. This would not only familiarise the candidate with the IT resources and their potential, but also require the candidate to select what is relevant from a large amount of information.

This exercise would also incorporate some of the skills in Key Skills units C3 and IT3.

Activity based learning

Module 2801, Biology Foundation

An exercise could be set which involved the collection, preparation and drawing of a low power plan of the transverse section of a mesophytic leaf as part of Section 5.1.1 (h). Measurements could be taken of cell dimensions on the upper and lower surface. These could be analysed statistically (Key Skill N3) and compared with data from prepared slides of xerophytic or monocotyledonous leaves.

The exercises used for planning experiments also require independent practical activity.

Module 2801, Biology Foundation

Candidates could be set the task of building a three dimensional model to illustrate transcription and translation as part of their coverage of 5.1.5 (d). The model could be designed for use by candidates who have poor spatial ability or are visually impaired.

This task could also be used to assess Key Skill PS3 and Key Skill WO3.

Module 2802, Human Health and Disease

A practical task could be set on Section 5.2.3 (j), (k) and (l) to discover the effect of exercise on the level of fitness as measured by recovery times.

Module 2804, Central Concepts

A practical task could be set on 5.4.1 (h), (j) and (m) to investigate the production of carbon dioxide by yeast.

Any form of testing together with opportunities for self evaluation by the candidate fulfil the requirements for this skill.

Although outside the scope of this specification, opportunities also exist for candidates to do individual project work for awards such as Nuffield Bursaries and Crest Awards. These too provide an opportunity to access Skill LP3.

LP3.1 *Agree targets and plan how these will be met over an extended period of time, using support from appropriate people.*

Evidence requirements

- (i) Seek information on ways to achieve what you want to do, and identify factors that might affect your plans.
- (ii) Use this information to agree realistic targets with appropriate people.
- (iii) Plan how you will effectively manage your time and use of support to meet targets, including alternative action for overcoming possible difficulties.

Possible opportunities

The exercises outlined above require the candidate to organise the necessary materials and equipment, such as audio-visual and IT equipment and cooperate with others to find an appropriate occasion to carry out a group activity. This will also enable the candidate to agree targets write an action plan and manage the time effectively.

LP3.2 *Take responsibility for your learning by using your plan, and seeking feedback and support from relevant sources, to help meet targets.*

Improve your performance by:

- Studying a complex subject.
- Learning through a complex practical activity.

- Further study or practical activity that involves independent learning.

Evidence requirements

- (i) Manage your time effectively to complete tasks, revising your plan as necessary.
- (ii) Seek and actively use feedback and support from relevant sources to help you meet targets.
- (iii) Select and use different ways of learning to improve your performance, adapting approaches to meet new demands.

Possible opportunities

Self learning exercises also provide ample opportunity to access this LP3.2 by monitoring the candidate's progress. Candidates should complete a log recording the different approaches they adopted, when they sought feedback and support and how they made use of it, and ways in which they revised their plan of action as they progressed.

LP3.3 *Review progress on two occasions and establish evidence of achievements including how you have used learning from other tasks to meet new demands.*

Evidence requirements

- i. Provide information on the quality of your learning and performance, including factors that have affected the outcome.
- ii. Identify targets you have met, seeking information from relevant sources to establish evidence of your achievements.
- iii. Exchange views with appropriate people to agree ways to further improve your performance.

Possible opportunities

Candidates could access this LP3.3 by discussing the assessment of their work with the teacher or another appropriate person. Performance could be assessed against targets that are set at the outset. An action plan could be devised in the light of the candidate's performance and this could be used to identify targets for future tasks. This performance review could be part of an on-going process of self review and evaluation by the candidate. Examples of work which show what the candidate has learned from studying a complex subject, such as transcription and translation, or carrying out a practical activity, such as devising a respirometer, should be kept to show evidence of achievement.

PS3 Problem Solving Level 3

You must :

Provide at least one substantial example of meeting the standard for PS3.1, PS3.2 and PS3.3.

Possible opportunities

This skill could be assessed through the Experimental Skills Components in AS and A2. In both cases this must be done in the context of a complete investigation including Planning, Implementing, Analysing and Drawing Conclusions and Evaluating Evidence and Procedures. However, as the evidence required for PS3 requires considerable feedback and support from others it may be advisable to assess the key skill on work that is used as a practice exercise and does not form part of the assessment for Unit 2803, Component 02 and/or Unit 2806, Component 02.

The following exercises could also be used to assess the Learning Performance skill.

Module 2801, Biology Foundation

Candidates could be set the task of building a three dimensional model to illustrate transcription and translation for Sections 5.1.5 (d) and (e). The model could be designed to help candidates who have poor spatial ability or are visually impaired.

This task could also be used to assess Key Skill WO3.

Module 2802, Human Health and Disease

A practical task could be set on Section 5.2.3 (j), (k) and (l) to discover the effect of exercise on the level of fitness as measured by recovery times.

Module 2804, Central Concepts

A practical task could be set on Section 5.4.1 (h), (j) and (m) to investigate the production of carbon dioxide by yeast.

For all tasks the candidate should have knowledge of the theory in the appropriate Learning Outcomes. For tasks suitable for assessing Experimental Skills, the candidate could then follow the criteria for Planning, Implementing, Analysing and Drawing Conclusions and Evaluating Evidence and Procedures as outlined in this specification, whilst at the same time selecting evidence for the Problem Solving Skills as outlined below.

PS3.1 Explore a complex problem, come up with three options for solving it and justify the option selected for taking forward.

Evidence requirements

- i. Explore the problem, accurately analysing its features, and agree with others on how to show success in solving it.
- ii. Select and use a variety of methods to come up with different ways of tackling the problem.
- iii. Compare the main features of each possible option, including risk factors, and justify the option you select to take forward.

Possible opportunities

At least three methods should be considered for the exercise chosen and the main features tested and compared. A plan should be drawn up that includes an idea of the different approaches to the problem, the timing involved and the apparatus to be used. A risk assessment should always be carried out as part of the exercise. The candidate should choose the best approach to solving the problem and justify that choice.

Module 2801, Biology Foundation

The candidate could investigate the structure of DNA and RNA, the events that occur during transcription and translation and the materials available for construction of the model. The candidate needs to consider three different ways in which the model could be constructed. The candidate should also consider how to test consumer response to the model.

Module 2802, Human Health and Disease

The candidate could investigate the relevant theory concerning the cardiovascular and ventilation systems and select and use appropriate equipment. A visit to a fitness suite and investigation of pulse meters and stop clocks would be helpful here. The candidate should consider three different ways of measuring aerobic fitness and justify the final choice. The candidate should also consider the form in which data should be collected and analysed statistically.

Module 2804, Central Concepts

The candidate should investigate the relevant theory concerning respiration and select and use appropriate equipment. At least three different methods for measuring carbon dioxide production in yeast under aerobic and/or anaerobic conditions should be considered. The final choice should be justified. The candidate should also consider the form in which data should be collected and analysed statistically.

PS3.2 Plan and implement at least one option for solving the problem, review progress and revise your approach as necessary.

Evidence requirements

- i. Plan how to carry out your chosen option and obtain agreement to go ahead from an appropriate person.
- ii. Implement your plan, effectively using support and feedback from others.
- iii. Review progress towards solving the problem and revise your approach as necessary.

Possible opportunities

The candidate must have all risk assessments checked and approved by the teacher before beginning any practical work. This inevitably involves approval or possible modification of the proposed method. However, it is implicit in the Internal Assessment of the Experimental Skills, that candidates should not collude or receive undue assistance from teachers. It may however, be possible to access PS3.2 by receiving feedback and support from others and not submit the exercise for Internal Assessment, but rather use it as a practice exercise. The candidate should be encouraged to carry out a pilot study and modify the method in the light of the results. The candidate should also be encouraged to keep a log book detailing discussions with the teacher and others and recording all feedback received. This would provide useful evidence for assessing.

Module 2801, Biology Foundation

Alternative materials and approaches should be considered for making the model of transcription and translation, including materials, availability, costing, and effectiveness. The choice of method should be justified in the report. A risk assessment for building the model should be completed paying attention to the use of tools and solvent-based adhesives.

Module 2802, Human Health and Disease

The candidate could investigate alternative ways in which the subject(s) could exercise, such as swimming, running, cycling or using fitness equipment such as rowing machines, treadmills or exercise bicycles. The choice of method should be justified in the report. Pilot experiments could be carried out using different methods to measure recovery times, such as pulse rates, breathing rates, oxygen consumption or carbon dioxide production. The risk assessment should pay careful attention to the health of the individuals in the sample before conducting any tests of fitness including exercise.

Module 2804, Central Concepts

The candidate could investigate alternative ways of measuring carbon dioxide production in yeast, possibly by means of pilot experiments using manometers, gas syringes or appropriate sensors and data logging equipment. The choice of method should be justified in the report.

PS3.3 *Apply agreed methods to check if the problem has been solved, describe the results and review your approach to problem solving.*

Evidence requirements

- i. Agree, with an appropriate person, methods to check if the problem has been solved.
- ii. Apply these methods accurately, draw conclusions and fully describe the results.
- iii. Review your approach to problem solving, including whether alternative methods and options might have proved more effective.

Possible opportunities

The report of the task, following the criteria for practical assessment, and marking of the exercises described above should provide evidence to access PS3.3. The report could include a record of discussions with the teacher, the laboratory assistant and other candidates, the feedback obtained and the ways in which changes have been implemented. This record would provide useful evidence for the assessment.