LEVEL 3 CERTIFICATE / EXTENDED CERTIFICATE

APPLIED SCIENCE

ASC6A: Microbiology
Report on the Examination

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General

ASC6a remains a popular choice, although it does not necessarily reach the high standards seen in portfolios for the other options. Compared to ASC6b and ASC6c, there is more assessed practical work and it could be this weighting that is seen as important, or it may be that teachers and learners are more comfortable with the areas of study and levels of demand of the experimentally based content of the unit.

However, learners in some centres did find it difficult to present all the evidence, data, and outcomes of practical work systematically and in a coherent order.
It was often difficult for moderators to locate sufficient evidence that learners had actually carried out all the required practical work and/or had understood the purpose of that work. Results were often hard to locate, and, in some cases, there were no results evident at all.

P3, PO2, and most of PO3 are all based on, or connected with, practical activities. Clarity and full supporting evidence, descriptions, results/data, photographs, images, etc are very important. Parts of an overall experiment could sometimes be found separated into three different sections in different places in the portfolio.

Another issue noticed by moderators was that PO4 was often a weaker section than any other and this was a feature across a number of centres. In some cases, this appeared to be a time issue, and in others it was seemingly due to the independent nature of the expected approach, based almost solely on individual research. Overall, PO4 can generate 6 marks in all or almost 25% of the overall marks available, and this is potentially a very significant contribution to overall scores.

For all practical work, an Observation Statement or Witness Confirmation is required to support learner achievement and to provide the evidence that they have completed the experiment, followed the SP, applied the risk assessment, used aseptic technique, recorded results correctly, etc.

It is very important to note that the USF signatures of both the learner and the teacher confirm that the work submitted is the learner's own independent work. However, this was not the case in some instances where pair or group work was evident.

Overall, ASC6a had a wide range of approaches and portfolio content.

Some excellent portfolios were seen, with suitable high-level practical work which was not only complete but also logically ordered and presented. This followed through to the inclusion of good supporting evidence, data, images, etc for all experiments. High scores also reflected a consistent approach across all four POs and good levels of knowledge of the required content and approaches.

In the case of weaker scores, it was not always apparent whether all the required practical work had been completed, as the evidence of outcomes was limited or absent. In some cases, the experimental work may have been completed, but no results could be found. The levels of organisation of the portfolio and sequencing of content also tended to impact on the available credit. Weaker portfolios also demonstrated weaker research skills, content which was sometimes close to source, sometimes incomplete, and a general lack of understanding of the levels of content expected by the Unit Content and PO grid.

PO1: Identify the main groups of microorganisms in terms of their structure

P1, M1

P1 and M1 were covered well by many learners. Good portfolios had the following content for all three types of micro-organism, all based on research and with source material adapted well by the learners to target the criteria:

- Characteristic structures and features
- Labelled diagrams
- Functions of the key features
- Detailed coverage evident consistently across the three types of micro-organism

In a small number of cases, source material was not reworded satisfactorily to demonstrate the learners' own knowledge and understanding, and this could not be awarded credit.
Note: This would also contradict the signed statements by the learner and the centre regarding independent work.

P2, M2, D1

P2 should describe methods used to identify micro-organisms to include:

- Gram staining
- Light microscopy
- Electron microscopy
- Colony characteristics

Annotated diagrams and images from research will always add to the descriptions. Good portfolios always described the four techniques well, whereas weaker attempts sometimes missed out a technique completely or included very little descriptive detail.

M2 continues from P2 and explains how the techniques are used and how they provide information that allows identification of the structures of microorganisms and how they are linked. At Merit level, this requires much more than a few lines, although there were many well researched and detailed explanations evident.

To achieve M2, all the techniques covered in P2 should be considered

- How differences in structure of bacteria enable them to be identified by Gram staining
- How colony characteristics (morphology) enable microorganisms to be identified
- How light microscopy and electron microscopy are used and how their usefulness is related to resolution and magnification and the structural features of microorganisms
- In each case, good explanations will be accompanied by relevant images

D1 in the Unit Content is covered by the statement (final bullet point) "identification techniques used in biotechnological industries". Learners did not always know what was required here and typically underestimated the levels of detail expected at Distinction level.

High scoring portfolios typically included relevant industries and techniques. Including but not limited to the following:

- Food and beverage, pharmaceuticals, water, environmental, and forensics and which industries use which identification techniques and for what.

Some excellent examples of independent research seen then went on to consider if there other techniques. For example; electrophoresis based techniques, DNA sequencing or mass spectrometry.

P3 is an experimentally based criterion. The evidence that allows this to be awarded consists of the following:

- Standard procedure and risk assessment followed (both issued by the centre)
- Observation Record
- Individual learner results (eg photographic images)*
- Conclusions drawn, ie identification of the microorganisms

*Note: Weaker portfolios often failed to include evidence of outcomes and thus did not complete the experiment (which is "to identify microorganisms").

PO2: Use aseptic techniques to safely cultivate micro-organisms

PO2 is, in many ways, a precursor to PO3 and it is important that learners organise and present their work logically and in an unambiguous sequence. It does need to be clear which techniques from P5 (in PO2) are carried forward and used for M5 (in PO3). Centres should be aware of this and advise learners accordingly.

P4, M3

P4: Risk assessments are prepared by each learner for the safe cultivation of microorganisms and should include:

- Preparation of sterile growth media
- Names of microorganisms used
- Cultivation of microorganisms
- Aseptic techniques
- Safe disposal

Without specific identification of the microorganisms used and full risk assessments associated with them, the RA will be considered to have important omissions and should not be awarded. Risk Assessments in general are still a weak area for learners, this follows through to the control measures which are assessed in M3.

M3: Explanations of control measures applied can be incorporated into the RA table or considered separately. M3 should not be considered for credit if P4 is not awarded.

P5, M4, D2

P5: There should be at least two different types of microorganism used in P5 (Specification p101).

To award P5, the following are required:

- Standard procedure(s) for the preparation of the growth media
- Standard procedures for all three techniques including incubation
- Observations (images/photographs to support successful completion of the tasks)
- Evidence of following aseptic technique
- Observation record supporting the completion of all three techniques

NB: "Use aseptic techniques" is a key part of P5 and part of the marking criterion statement.

M4: This requires an explanation of the principles behind the use of growth media and each of the three techniques. This remains a weak area for many learners. It would be sensible for:

- each cultivation technique to be treated as a separate experimental account to include all the following before moving on to the next technique:
    - standard procedure and results/images (for P5)
    - all relevant material/evidence required for M4 and D2 including an explanation of the principles of the technique (for M4)

D2 requires the following:

- an evaluation of the following in each of the three cases, making reference to the results obtained
    - the effectiveness of the aseptic techniques used in each case
    - the effectiveness of the cultivation techniques in each case
    - a consideration of the results obtained
    - identification of errors or anomalies evident in the results
- justified suggestions for improvement

Evaluations and justifications are often a difficult area for many learners. This is particularly evident here where a logical, ordered approach across all three techniques and their results is necessary. Weaker portfolios were often not logical in their order or content, and omissions of key information such as results were not uncommon.

Note: D2: This placed alongside P4, M3 in the PO grid, but would be better placed with P5 and M4. D2 can be considered to be associated with either row of P and M criteria for the purpose of awarding credit.

PO3: Use practical techniques to investigate the factors that affect the growth of microorganisms

P6, M5, D3

P6:

- 10 different factors which promote/inhibit growth of microorganisms are listed in the Unit Content
- P6 requires a range to be described and portfolios should include a minimum of 5 or 6
- able learners will often describe more
- insufficient factors or lack of detail may prevent credit for P6.

M5, D3:

- M5 requires evidence of practical work investigating three factors that affect growth
- The three factors are drawn from the range considered in P6
- D3 requires learners to draw conclusions about how the factors affect growth
- Conclusions must be consistent with the recorded results

In order to then go on and provide evidence for other marking criteria in PO3, centres often combine the experiments investigating these three factors with other practical approaches. This avoids too many repeats of similar practical work.

- NB Specification p102 gives examples of approaches to this practical work, but there are alternatives.

Approaches to this work should include:

- Use of a range of cultivation techniques (these can follow on from those used for P5)
- Use at least two types of microorganism if carrying on from P5
- Use a range of counting or measuring techniques which could include/be selected from:
    - measuring clear zones
    - viable counts
    - use of a haemocytometer
    - colorimetry
    - viral plaque assay
    - and also use serial dilutions*
- Standard procedures, RAs (centre issued)
- Observation records, evidence for completion of all 3 practicals including aseptic technique
- Recorded results, images, photographic evidence

* Alternatively, serial dilutions can be used in a separate, unrelated activity. For instance with a haemocytometer based investigation as suggested in the Delivery Guidance p102 of the Specification.

Portfolio evidence was again variable across a range of centres and some was particularly difficult to follow and had omissions. Learners need sufficient direction to ensure all the evidence required for award of the various marking criteria is present.

- Some results were poorly presented, others were absent or incomplete
- Insufficient range of values of factors investigated for M5, lading to poor explanations and conclusions in D3
- Graphs were produced based on minimal evidence
- Some results were identical across all learners, indicating group work, but there was no indication of individual contribution**

** The Observation Record should record any use of group or pair work and the individual's contribution. Centres should note that the signatures on the USF confirm independent work.

P7, M6, D4

P7 requires the use of one suitable technique to count/measure microorganisms. This was most commonly a haemocytometer and some good results were evident. There were some excellent explanations of the use of haemocytometers in a small number of centres, with fully explained subsequent calculations.

However, success rates varied with the learner's levels of understanding.Explanations of the technique were sometimes very difficult to follow and had omission. Diagrammatic support was sometimes weak or absent or not applied well and calculations were not explained in full and did not show understanding.

Viable counts were also a popular choice of technique and worked well for a number of centres.

It is important that centres realise that measurement of clear zones is not a technique suitable for the award of P7 (measuring micro-organisms).

In addition to serial dilutions, the following techniques may be used:

- Viable counts on plates (relatively common)
- Haemocytometer (direct counts) (a common approach)
- Colorimetry (to measure turbidity and so an indirect count) (rarely seen)
- Measurement of clear zones (common, suitable for M5, D3 but not P7)
- Viral plaque assay (rarely seen)

M6: Explanations of the technique used were often not sufficiently detailed and were based on incomplete understanding of the processes involved. For counts of colonies, it would be appropriate to record all 'raw' data, rather than just state the number of live cells. P102 of the Specification indicates that the total count should include viable and non viable cells.

D4: (Evaluation of measuring and counting techniques and suggestions for improvement)

As with last year, this was often left by learners until all the required elements of PO3 had been completed, and this included serial dilutions (P8) and calculations relating to the original sample (M7): this is entirely acceptable.

P8, M7

The evidence for P8 includes the SP for the serial dilution and any associated data. The Observation Record should confirm correct use of the SP and safe working.

The data are then used in conjunction with counting/measuring data from P7 (or from a separate experiment) to perform calculations to identify total numbers of micro-organisms. These should be clearly explained in order that the learner's knowledge and understanding of the processes involved are evident.

PO4: Identify the use of microorganisms in biotechnological industries

PO4 requires independent learner research which is suitably referenced. It is important that it is targeting the relevant sections of the Unit Content and the PO grid.

This appeared to be a weaker area for learners despite some promising earlier content for PO1, 2, 3.

P9, M8, D5

P9: Good responses to P9 included the following:

- descriptions of the main features of batch and continuous processes
- both processes are related to biotechnological industries
- avoid using inorganic processes such as Haber
- suitable diagrams and examples
- reference to the scientific basis of the processes to support the descriptions

Good examples will be drawn from the use of a number of different types of microorganism.

M8: This requires explanations of the benefits of industrial fermenters or bioreactors.
Again, suitable examples to exemplify the purpose and nature of the fermenters enable the benefits to be more easily highlighted and explained.

Typical benefits to be discussed might include; scale, rates and costs, including energy use. These can be linked, as appropriate, to examples taken from a range of industries (see Unit Content p97).

M8 then leads into D5 where the emphasis is on the comparison of two specific industrial processes or techniques. At Distinction level, the two selected processes should be researched in detail, and similarities and differences discussed. It is very important that the microorganisms used in these two processes should be identified and the part played in each case described. This was a weak area for many, and is a good example of simple omissions of clearly required content.

P10, M9, D6

P10: <u>two</u> different industries should be chosen from those listed in the Unit Content.

- Food production
- Environmental health
- Pharmaceuticals
- Forensic science
- Agriculture
- Alternative energies
- Waste water treatment.

Learners select <u>two</u> industries, research them in some detail, concentrating on:

- Naming the micro-organisms used in each case
- Describing the relevant industrial processes and techniques in each case.

This leads on directly to the content expected for M9.

M9: the same industries and micro-organisms as identified in P10 are considered further.

For each of the two industries, good portfolios will have already named the micro-organisms and, if not already present in some detail, will consider the processes in full and the outcomes or products formed. The reasons why these processes benefit society can then be explained in detail. Weaker content would not explain benefits at the levels expected for Merit.

D6: can be based on a different biotechnological industry from those used in P10 and M9, but it does have to use micro-organisms and genetic engineering.

Some key points are:

- An evaluation is needed, not just a simple statement of the process
- The biotechnological industry must clearly identified
- The background of the process and the product/outcomes are described
- The roles played by genetic engineering and the micro-organism are described
- Pros, cons, advantages, disadvantages are considered …. as are ….
- Legal restrictions, public opinion and possible misconception.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website.