LEVEL 3 EXTENDED CERTIFICATE

APPLIED SCIENCE

ASC6a: Microbiology
Report on the Examination

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General

ASC6a was the most popular choice of the three Unit 6 options available.

Some learners struggled to present all the practical work in a coherent order. As a result, moderators sometimes had difficulty working out which performance outcome was intended to be met by which set of practical procedures and results.

There was some evidence impression of some schools / colleges attempting to cover as many performance criteria with as few practical activities as they could. Whilst there is a degree of flexibility in approaches to the experiments, learners in some schools / colleges appeared to misinterpret what was required and this led to omissions or weaker areas in their accounts. In some cases, a logical approach to organising the presentation of the background science, practical techniques, standard procedures, results and analysis was missing. In others, parts of the overall experiment could be found separated into three different sections. The extraneous material in between the practical sections was sometimes relevant to the overall portfolio content, sometimes not.

Another issue was that PO4 was often a weaker section than any other and this was a feature across a number of schools / colleges. Whether this was a time issue, or because it is a more independently completed section based almost solely on individual research, is unclear. However, PO4 can generate six marks in all, and this is potentially a significant contribution to overall scores.

For all practical work, an Observation Statement is required to support learner achievement and to provide the evidence that the learner has completed the experiment, followed the standard procedure, applied the risk assessment, used aseptic technique, recorded results correctly, etc. If the learner has not provided, for instance, photographic evidence to support results (eg images of plates), then the Observation Record should do that, again supporting learner achievement and the award of marks from the assessor. Some schools / colleges did not provide much useful information, if any, to support learner achievement in this respect.

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

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

P1, M1

The requirements are clearly described in the specification content and also the performance descriptor. All three types of microorganism should be covered with the same degree of detail. Whilst akaryotes could theoretically be covered by using red blood cells as an example, page 101 of the specification does clearly indicate 'viruses'.

P1 and **M1** were covered well by many learners. Good portfolios had content for all three types, all research based and with source material adapted well by the learners in most cases. These included:

- characteristic structures and features
- labelled diagrams
- functions of the key features.

P2, M2, D1

P2 should describe methods used to identify microorganisms to include:

- Gram staining
- light microscopy
- electron microscopy
- colony characteristics.

Annotated diagrams and images from research will add to the descriptions.

M2 continues from P2 and explains how the techniques used and structures of microorganisms are linked. To achieve M2, all the techniques covered in P1 should be considered:

- How differences in structure for different types 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 the microorganism.

D1 expands on the information established in M2 and compares the use of the three techniques in biotechnological industries.

This appeared to be much more difficult for learners and they struggled to identify suitable industries in the first place, impacting on their ability to compare techniques across the different applications. Food and beverage, pharmaceuticals, water, environmental, and forensics are some areas that could be researched, but there are new applications emerging all the time.

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

- standard procedure and risk assessment followed (issued)
- Observation Record
- individual learner results (eg photographic images)
- conclusions made.

PO2: Use aseptic techniques to safely cultivate microorganisms

PO2 will probably lead directly on to aspects of study assessed in PO3 and which feature later in portfolios. It would be good practice, when learners are reviewing portfolios, to include links on the relevant pages. For instance, an indication that: 'this technique, pour plates, is later used for the investigation of the effects of temperature on bacterial growth on page'.

P4, M3

P4: Risk assessments are prepared by each learner for the safe cultivation of microorganisms and 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 risk assessment will be considered to have significant omissions and should not be awarded.

M3: Explanations of control measures taken can be incorporated into the risk assessment table, or considered separately. M3 cannot be considered for credit if P4 is not awarded.

P5, M4, D2

The choice of which three cultivation techniques to carry out is a matter for the school / college. But there must be at least two different types of microorganism used, which was not always the case in the work seen. 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
- evidence of following aseptic technique
- observation record supporting the completion of all three techniques.

Evidence for following aseptic technique was often sparse, or missing entirely, as were learner accounts of the technique itself.

M4 requires an explanation of the principles behind the use of growth media and each of the three techniques. This was not a strong area for many learners and it would be better if each cultivation technique is treated as a separate experimental account and includes all the material / evidence required for M4 and **D2** (the evaluation of effectiveness) before moving on to the next technique. With the right degree of organisation and presentation, omissions and weaker areas are less likely to result.

In some cases, there was no annotation relating to M4 in portfolios (and no evidence that it was met), but credit was given by the assessor.

P03: Use practical techniques to investigate the factors that affect the growth of microorganisms

P6, M5, D3

The specification lists ten different factors which promote or inhibit growth of microorganisms, and **P6** requires a range to be described. Portfolios should include a minimum of five or six, although higher-attaining learners will often describe more. In some cases, weaker portfolios seen did not describe sufficient factors or detail was sparse.

M5 requires practical work investigating three factors that affect growth. The expected approaches to this work 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 to include measuring clear zones and viable counts
- use serial dilutions in one of the practical techniques*
- standard procedures, RAs (school / college issued)
- observation records, evidence for completion of all three practicals including aseptic technique
- recorded results, images, photographic evidence.

Portfolio evidence was variable across a range of schools / colleges:

- Some results were poorly presented, others were entirely absent or incomplete.
- Only two temperatures were investigated by some learners: the specification (page 102) suggests more.
- Graphs were produced based on minimal evidence (eg only two temperatures).
- Some did not report all three investigations but were incorrectly awarded credit.
- Some results were identical across all learners indicating group work, but there was no indication of individual contribution**.

* Alternatively, serial dilutions can be used in a separate, unrelated activity, for instance with a haemocytometer based investigation as suggested on page 102 of the specification.

** The Observation Record should record any use of group or pair work and the individual's contribution.

D3 follows directly on from M5 and draws conclusions concerning the effects on growth of microorganisms by the three factors investigated

P7, M6, D4, P8, M7

P7 requires the use of one suitable technique to count / measure microorganisms. This was most commonly a haemocytometer, but success rates varied with the learner's levels of understanding. Many could not follow the explanations and calculations through to a successful conclusion. However, there were some excellent explanations of the use of haemocytometers, with well explained subsequent calculations. Viable counts were also a popular choice of technique and worked well for a number of learners.

In addition to, and in combination with, serial dilutions, the following techniques may be used:

- viable counts on plates
- haemocytometer (direct counts)
- colorimetry (to measure turbidity and so an indirect count)
- measurement of clear zones
- viral plaque assay.

Schools / colleges generally avoided turbidity and preferred their learners to achieve a more directly quantitative approach. The complete determination via standard samples of known bacterial counts is probably beyond the scope of most however, and some basic colorimeters may give questionable results.

M6: Explanations of the technique used were often not sufficiently detailed, and were based on incomplete understanding of the processes involved as indicated above. It would be appropriate to record all 'raw' data, rather than just state the number of live cells. Page 102 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) was often left by the learner until all the required elements of PO3 had been completed. This included serial dilutions (**P8**) and calculations relating to the original sample (**M7**) which is entirely acceptable.

PO4: Identify the use of microorganisms in biotechnological industries

PO4 requires independent learner research, suitably referenced, and (very importantly) targeting the relevant sections of the unit content and the PO grid. This was often a weaker area for learners, and some promising earlier sections (for PO1, 2, 3) were not reinforced well by their work in PO4. Whether this was due to time constraints, insufficient research, or a lack of understanding of the specific requirements of each of the six relevant criteria was unclear, although it was probably a combination of all three in most cases.

P9, M8, D5

P9 requires descriptions of the main features of batch and continuous processes in biotechnological industry. Diagrams, examples, and reference to the scientific basis of the processes to support the descriptions should be included. It is very important here to specifically target the biotechnological industry and not to use examples such as the Haber process. Good examples will be drawn from the use of a number of different types of microorganism.

M8 needs explanations of the benefits of industrial fermenters or bioreactors, again with suitable examples to exemplify their purpose and nature. Typical benefits to be discussed might include scale, rates, cost, energy use and waste products, linked, as appropriate, to examples taken from a range of industries (see specification page 97).

This then leads into **D5** where the emphasis is on the comparison of two specific industrial processes or techniques. The microorganisms used in these two processes should be identified

P10, M9, D6

For **P10**, two different industries (chosen from those listed in the specification) are selected and the processes are described. This includes identifying / naming the microorganisms concerned.

M9 then follows on directly and the two industries discussed in P10 are considered in terms of the benefits to society of using microorganisms.

D6 can be based on a different biotechnological industry from those used in P10 and M9, but it does have to use microorganisms and it does have to involve genetic engineering. An evaluation of the use of genetic engineering – pros, cons, advantages, disadvantages, legal restrictions, public opinion and possible misconceptions etc – is required. Good accounts seen are based on significant levels of research and a systematic approach.

Mark Ranges and Award of Grades

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

Converting Marks into UMS marks

Convert raw marks into Uniform Mark Scale (UMS) marks by using the link below.
UMS conversion calculator