Unit title: Laboratory Techniques for Applied Biology

Unit code: **L/601/0219**

QCF level: **4**

Credit value: **15**

Aim

This unit gives learners the opportunity to practise and be able to use skills commonly used in practical biology. These include microscopy, titration, spectroscopy, chromatography and use of aseptic technique.

Unit abstract

Learners studying applied biology have a wide range of specialisms open to them, for example biochemistry, molecular biology, physiological measurement, haematology, histopathology, oncological research, microbiology and infection control, virology, environmental science, genetics and forensic science. In this unit learners will cover a range of techniques. They will become familiar with microscopy, titrimetric, spectroscopic and chromatographic techniques, serial dilution and aseptic techniques. Learners will develop the ability to present experimental results in a variety of formats and to produce different styles of report. Learners will also learn how to assess the risks associated with particular practical techniques.

On completion of the unit, learners should have developed the flexibility to use unfamiliar techniques, by following given instructions and be able to report on, and assess, the reliability of these techniques.

Learning outcomes

On successful completion of this unit a learner will:

1 Be able to use and calibrate a light microscope to differentiate between cell types

2 Be able to use titrimetric and spectroscopic quantitative techniques

3 Be able to use chromatographic techniques for qualitative and quantitative analyses

4 Be able to use aseptic technique in microbiological procedures.

Unit content

1 Be able to use and calibrate a light microscope to differentiate between cell types

Component parts of a microscope: eyepiece; body tube; coarse adjustment; fine adjustment; stage; condenser/diaphragm; mirror; foot; objective lenses on nosepiece; lamp

View prepared slides: slides from a library eg tissue slides; slides prepared by learners eg onion cells, pond water; mount slides appropriately using clip on stage; optimise light; optimise focus and magnification; calibrate; stage micrometer; reticule; eyepiece micrometer

Produce representations: labelled drawings; calculation of magnification; digital image capture

Slide preparation: slide; coverslip; dry mounting; wet mounting; staining eg iodine; microtome

2 Be able to use titrimetric and spectroscopic quantitative techniques

Assess the risks: chemical hazards eg toxic, harmful, teratogenic; non-chemical hazards eg broken glassware; risk assessment for a titrimetric procedure; risk assessment for a spectroscopic procedure; aspects of given procedures which minimise inherent risks

Weighing and measuring equipment: balances eg top pan, analytical; volumetric equipment eg automated pipettes, graduated pipettes, syringes, burettes, volumetric flasks

Analyses using titrimetric techniques: quantitative methodology eg weighing by difference, use of appropriate glassware, accurate reading of position of meniscus, appropriate mixing of solutions; different types of pipette eg bulb, graduated, automatic; calibration of pipettes; use of primary standard solutions; acid base titration including use of pH electrode; calibration of pH electrode; redox titration eg use of potassium manganate (VII), thiosulfate/iodine

Analyses using spectroscopic techniques: using the Beer-Lambert law eg use of ultraviolet/visible spectrometer at fixed wavelength, use of colorimeter techniques eg flame emission to determine potassium content of blood, atomic absorption (AA) to determine iron concentration; technique to involve serial dilution eg Beer-Lambert determination of potassium manganate (VII) concentration, potassium by flame emission

Appropriate degree of accuracy: in quantitative determinations eg comparison with reference value with given tolerance, use of class results/statistical treatments to establish appropriate tolerance

Report: methods of producing formal laboratory reports; use of additional methods of reporting eg completion of a pro forma, oral presentation, PowerPoint presentation, writing an article

3 **Be able to use chromatographic techniques for qualitative and quantitative analyses**

Assess the risks: risk assessment eg for a paper or thin layer chromatography (TLC); risk assessment for an instrumental technique

Chromatographic separations: paper chromatography; TLC; other techniques as available eg gas chromatography (GC), high performance liquid chromatography (HPLC), electrophoresis, ion-exchange; use of locating agents eg iodine, ninhydrin, cerium sulfate

Quantitative techniques: interpretation of results from GC; HPLC; integration of peak area; composition of a mixture or concentration of a solution

Present: methods eg poster, report, written account, PowerPoint presentation slides, verbal presentation

Principles: mobile phase eg solvent, carrier gas; stationary phase eg water within paper, silica, viscous liquid on GC capillary/support; sorption mechanism eg adsorption, partition, ion-exchange; column eg GC, HPLC, ion-exchange; layer eg paper and thin layer; detection of components eg colour of components, locating agent, flame ionisation detector (FID), absorption of ultraviolet light; calculation of R_f values; retention time; features of specific techniques eg oven in GC, pump and degassing of solvents in HPLC; block diagrams of instrumental techniques

Report: formal laboratory report; other methods of reporting eg completion of a pro forma, oral presentation, PowerPoint presentation, writing an article

4 **Be able to use aseptic technique in microbiological procedures**

Guidelines: types eg instruction sheets, verbal instructions, instruction manuals

Prepare inoculated agar plates: sterile plates; pouring techniques; control plates; appropriate inoculation eg streak plates; lawn plates, environmental swabbing; incubation to determine extent of growth; appropriate labelling of plates

Minimal environmental contamination: wiping surfaces with disinfectant; use of alcohol and flaming as appropriate; pouring technique; protecting cultures from contamination

Decontamination techniques: sterilisation; use of an autoclave; disinfection; different types of disinfection; safe disposal of waste

Risks associated with microbiological experiments: hazards associated with various disinfectants eg toxicity, flammability; hazards associated with micro-organisms; aerosol formation; steps to minimise risk

Learning outcomes and assessment criteria

Learning outcomes On successful completion of this unit a learner will:	**Assessment criteria for pass** The learner can:
LO1 Be able to use and calibrate a light microscope to differentiate between cell types	1.1 explain the function of the component parts of a microscope 1.2 produce representations of views under different magnifications 1.3 prepare slides to meet given requirements
LO2 Be able to use titrimetric and spectroscopic quantitative techniques	2.1 assess risks inherent in quantitative procedures 2.2 routinely and accurately use weighing and measuring equipment 2.3 safely perform analyses using titrimetric techniques to an appropriate degree of accuracy 2.4 safely perform analyses using spectroscopic techniques to an appropriate degree of accuracy 2.5 report on the analyses conducted
LO3 Be able to use chromatographic techniques for qualitative and quantitative analyses	3.1 assess the risks associated with chromatographic procedures 3.2 safely carry out qualitative and quantitative chromatographic separations 3.3 interpret results from quantitative chromatographic techniques 3.4 discuss the principles of chromatographic separations and report on analyses that use chromatography
LO4 Be able to use aseptic technique in microbiological procedures	4.1 report on the risks associated with microbiological experiments 4.2 follow guidelines to safely prepare inoculated agar plates with minimal environmental contamination 4.3 safely use decontamination techniques.

Guidance

Links

This unit has particular links with the following units within this qualification:

- *Unit reference number J/601/0235: Industrial Microbiology*
- *Unit reference number F/601/0220 Analysis of Scientific Data and Information*
- *Unit reference number F/601/0217: Biochemistry of Macromolecules and Metabolic Pathways*
- *Unit reference number J/601/0218: Physiology of Cellular Systems in Animals*
- *Unit reference number K/601/0292: Chemistry for Applied Biologists*
- *Unit reference number D/601/0225: Molecular Biology and Genetics*
- *Unit reference number M/601/0231: Infectious Diseases*

Essential requirements

Delivery

Learners must know about the hazards associated with biological specimens, chemicals, non-chemical hazards, and be able to identify how given procedures minimise the associated risks. They must also learn how to undertake risk assessments for a titrimetric procedure and a spectroscopic procedure.

Learners need to be familiar with the range of procedures needed to make up solutions accurately. This may be carried out by giving learners preparatory tasks or it could be integrated into the application of techniques. Since pH is very important to many biological processes, learners must be taught how to use a pH meter accurately.

Learners must be able to use paper and thin layer chromatography. They may use these techniques to separate mixtures containing coloured substances and use locating agents to identify the position of colourless spots. R_f values must be calculated.

Centre facilities will determine which instrumental chromatographic techniques will be used. Learners must have access to infrared and ultraviolet visible spectrometers, gas chromatographs and high performance liquid chromatographs. If centres do not have these instruments, visits should be arranged so learners can use the spectroscopic techniques and see chromatographic techniques in action.

Aseptic techniques are covered in the specialist microbiology units. Centres do not need to have the facility to carry out advanced microbiology to deliver this unit. However, centres need to devise a meaningful experience for learners in an appropriate context. Learners must be given the opportunity to prepare plates which are inoculated in some way, for example sterile agar and pour plates. Alternatively, sterile plates could be purchased. Inoculation could be carried out with low hazard cultures, with organisms from foodstuffs like yogurt or with low hazard environmental swabs. Appropriate labelling must be carried out. Plates and control plates must be incubated in order to gauge how effective learners' use of aseptic technique has been. Learners must understand the principles and practice of sterilisation and disinfection and have some experience of applying them.

Assessment

Learners must record and report all results, calculations and conclusions formally. This could be achieved in a variety of formats including a formal presentation, written articles or reports.

As part of the assessment for the unit, learners must carry out at least four formal risk assessment procedures (one for a titration, one for a spectroscopic technique, one for paper or thin layer chromatography and one for an instrumental chromatography technique), and produce at least three formal reports (one for titration, one for spectroscopy, one for chromatography).

For learning outcome 1, learners could carry out research into the preparation of slides. Learners do not need to use a microtome but should know and understand its use.

For learning outcome 2, learners must be familiar with aspects of the techniques used to ensure accuracy before carrying out at least two titrations, one involving an acid-base titration and the other a redox titration. Use of primary standards must be built into these exercises. Learners are required to carry out at least two pieces of practical work based on spectroscopy. These will involve the preparation of a calibration plot – instrument readings as a function of concentration. At least one spectroscopic technique should involve the use of serial dilutions. Two formal reports must be produced for this outcome, one for titration and one for a spectroscopic technique, including assessment of the inherent risks.

For learning outcome 3, learners must be observed carrying out competent separations using paper and thin layer chromatography. Since many of these separations involve mobile phases and locating agents with significant chemical hazards, learners need to carry out at least one recorded formal risk assessment for such a procedure and one for an instrumental procedure.

Learners could carry out GC and HPLC quantitatively or be given results to interpret. At least one formal report must be produced on a chromatographic technique.

For learning outcome 4, learners must be observed carrying out practical work which, as a minimum, involves inoculation and labelling of sterile plates and observation of the incubated plates. Aspects of aseptic technique must be included in the exercise. Through their practical work, learners must also be able to show that they understand the risks associated with microbiology practicals and the principles involved in sterilisation and disinfection.

Resources

Access to practical laboratory facilities, technical support, library facilities and IT resources are essential.

Employer engagement and vocational contexts

Where learners are working in biological industry, discussion on the use of techniques should be encouraged. Visits could be arranged to local industry and to local higher education institutions to see the techniques in action. Guidance on assessment may be contextualised in relation to techniques used routinely in local industry.

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