Unit 2: Working in the Science Industry

Unit code: H/502/5539

QCF Level 3: BTEC National

Credit value: 10

Guided learning hours: 60

Aim and purpose

The aim of this unit is to enable learners to gain the knowledge and skills that an employee in the science industry needs to be an effective, efficient and safe member of a team. Learners will know communication practices, how laboratories are designed, how information is stored in laboratory information management (LIMS) and how to work safely in a scientific workplace.

Unit introduction

The understanding and skills of laboratory science technicians and other professionals who work in a variety of places and scientific disciplines contribute to find solutions to many scientific challenges society faces. The knowledge, understanding and skills of laboratory technicians contribute to the success or failure of organisation in which they work.

Laboratory technicians and other scientists need to have a good understanding of specialist laboratories and each laboratory has individual requirements and generic procedures and practices. An understanding of safety regulations, quality systems and the application of Laboratory Information Management Systems (LIMS) is essential. The combination of these procedures, systems and regulations gives an appreciation of how to run an efficient, effective and safe laboratory. This unit is crucial in underpinning the training of science laboratory technicians.

The unit starts by exploring the essential procedures and practices found in all laboratories. This is supported by an investigation of specialist laboratories. They are examined on their different individual requirements in terms of efficiency, effectiveness and safety.

Learners will also gain an appreciation of how scientific data and records are kept in a modern laboratory information system.

Finally, the unit provides essential insight into how laboratories are organised today in the light of up-to-date safe working practices and safety regulations.

This unit enables learners to consider what it is like to work in the science industry. Whilst aimed at science technicians/junior practitioner level, it is suitable for all learners who are interested in a career in science.

Learning outcomes

On completion of this unit a learner should:

1 Know how procedures are followed and communicated in the scientific workplace

2 Be able to design a scientific laboratory

3 Know about laboratory information management systems

4 Be able to demonstrate safe working practices in the scientific workplace.

Unit content

1 Know how procedures are followed and communicated in the scientific workplace

Procedures: handling of materials; store management, eg chemical, biological; ordering procedures; calibration of equipment, eg pH meters, graduated pipettes; maintaining equipment, eg burettes and Bunsen burners; collection/transport of substances and equipment for disposal; use of centrifuges; instrumentation techniques, eg colorimeter, electrophoresis; dessicators and vacuum storage; handling and disposal of radioactive substances; handling and use of glassware; handling of solvents and poisons; use of ovens; operation of the fume cupboard; transfer of materials; carrying out tests

Communicating practices: lines of authority and accountability to and from other personnel; working as a team; organisation of the laboratory (weekly, daily, etc); routines (work schedules, briefings); reporting of results; scientific terminology

2 Be able to design a scientific laboratory

Design features of a laboratory: services; furniture; access; safety equipment, eg fume cupboard; storage; workspace; efficiency; effectiveness

Specialist laboratories: biological, eg microbiological laboratories; chemical; physical sciences; research facilities

Safety requirements of laboratory design: materials; radioactive substances; specialist equipment; health and safety requirements; waste disposal; toxic and flammable substances storage; specific safety equipment and clothing; security

3 Know about laboratory information management systems

Scientific data storage: COSHH records; scientific data; scientific apparatus records; waste disposal records; health and safety checks; training records; quality assurance data; report records; specification levels; sample throughput and management; security, Data Protection Act

Workplace records: stock records; work schedules; servicing dates and contracts; laboratory test data; specimen records; test records; calibration records; validation data; standard operating procedures; information and communication technology (ICT), eg laboratory information management systems (LIMS)

4 Be able to demonstrate safe working practices in the scientific workplace

Definitions: risk; hazards, eg harmful, toxic, flammable, oxidising agent, reaction with water to give flammable gas

Risk assessment: need for; carried out for every practical activity; minimisation of risk; action to be taken when incidents occur

Sources of information: CLEAPSS hazcards, manufacturer's data sheets, MSDS

Safe working practices: use of fume cupboards; storage of chemicals and test samples; waste disposal; incident and accident procedures; risk assessments; COSHH register; good housekeeping, eg safe handling of pathogens; protective equipment, eg laboratory coat, protective gloves, goggles, visor, protective shoes, protective glasses

Regulations and legislation: COSHH regulations; HSE inspectors; UKAS assessments; international standards relating to good laboratory practice and quality of service, eg quality standards (BS EN ISO/IEC 17025, GLP/GMP/GCP, BS EN ISO 9001); compliance regulations, eg FDA/MHRA/EMEA

Assessment and grading criteria

In order to pass this unit, the evidence that the learner presents for assessment needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria for a pass grade describe the level of achievement required to pass this unit.

Assessment and grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	**To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:**	**To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:**
P1 outline procedures in the scientific workplace [IE1,2]	**M1** explain why procedures and practices are followed in the scientific workplace	**D1** analyse why laboratory procedures and practices must be clearly communicated
P2 identify how information is communicated in the scientific workplace [IE1,2]	**M2** explain how information is communicated in the scientific workplace	
P3 design a scientific laboratory, identifying its individual key features [CT1,3,4, EP3,4]	**M3** justify key features in the non-specialist and specialist laboratory	**D2** analyse why good laboratory design is important for efficiency, effectiveness and safety
P4 describe the procedure for storing scientific information in a laboratory information management system [RL4,5]	**M4** explain the processes involved in storing information in a scientific workplace	**D3** discuss the advantages gained by keeping data and records on a laboratory management information system
P5 demonstrate safe working practices in a scientific workplace. [TW1, SM2,3]	**M5** explain the need for current regulations and legislation in safe working practices.	**D4** evaluate the regulation of safe working practices in a scientific workplace.

PLTS: This summary references where applicable, in the square brackets, the elements of the personal, learning and thinking skills applicable in the pass criteria. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.

Key	IE – independent enquirers	RL – reflective learners	SM – self-managers
	CT – creative thinkers	TW – team workers	EP – effective participators

Essential guidance for tutors

Delivery

A visit to a state-of-the-art laboratory is strongly recommended. If this is not possible for all learners, then tutors are strongly advised to take any opportunity to visit one themselves. This would give tutors an appreciation of the differences between industrial laboratories and centre-based laboratories to enable them to deliver the unit better. Differences include the clear demarcation of 'clean' and 'contaminated' areas and the separate space for computers, desks etc.

The unit should be delivered so that learners are enthused, motivated and stimulated by performing experiments and following procedures in the laboratory.

Varied and interesting experiments or exercises can teach the proper use of laboratory equipment. Key laboratory skills can be developed through concentrating on a practical teaching approach.

Tutors should stress the importance of health and safety regulations in all practical work. Learners should be encouraged to risk assess each practical exercise that they undertake.

The use of industrial visits, virtual visits using organisations' websites and either video or DVD recording of industrial sites will enlighten the learners about laboratory organisation in a range of scientific workplaces or laboratories.

Learning outcome 1 covers the wide range of procedures undertaken in laboratories. A number of class worksheets could be used to deliver the information required to cover the course content. Worksheets would allow learners to record information in their own words whilst including any relevant scientific terms. Communication of detailed/technical or sensitive information needs to be outlined and assessed. Industrial visits and guest speakers would be useful.

Learning outcome 2 should be delivered in a way that makes learners fully aware of how the environment in which they find themselves affects their effectiveness, efficiency, safety and security. Well-designed specialist laboratories promote their own efficiency and effectiveness for their intended use and purpose. These factors together promote safety for everyone, and security for staff and information.

Learning outcome 3 highlights the purpose of a laboratory to produce results from scientific investigations and procedures as well as running efficiently. It should make learners aware that these results have to be recorded and stored for future reference. Modern laboratories all employ laboratory information management systems (LIMS) to record this information, and have security systems in place to protect it. The day–to-day running of a laboratory requires information on stocks, staff and work patterns which also needs to be stored.

Learning outcome 4 addresses the need for safe practice when performing procedures and experiments in the laboratory. Learners should be made aware of all current legislation and regulations.

As a very large amount of information needs to be conveyed to learners, worksheets for discussion and completion in class can be useful to cover the pass criteria. The merit and distinction criteria can be achieved using vocationally-based assignments which the learner researches and completes with less help from the tutor.

Studying blood and other bodily substances is not a banned activity (unless an employer has provided written instructions restricting the activity). A risk assessment **must** be carried out.

Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments.

The outline learning plan demonstrates one way in planning the delivery and assessment of this unit.

Topic and suggested assignments/activities and/assessment
Introduction to unit and programme of learning and assessment.
Work covering the many procedures and practices carried out in a variety of laboratory settings. Tutor explanation of unfamiliar terms, words and concepts. Learner's discussion in class or research/fact finding in groups or individually as required. Visiting speakers or visits could enhance the research carried out into procedure and practices carried out in industry.
Assignment 1 – Work in the Science Industry (P1, P2, M1, M2, D1) Individual research, planning and completion time
Work covering laboratory design and its implications. Tutor explanation of unfamiliar terms, words and concepts. Learner discussion in class or research/fact finding in groups or individually as required. Visiting speakers or visits could enhance the research carried out into design of laboratories in industry.
Assignment 2 – Designing a Laboratory (P3, M3, D2) Learners familiarise themselves with a laboratory in which they are working by drawing a plan showing the important items of equipment and services. Learners research the type of laboratory that they may work in eventually and design a laboratory to include the type of equipment etc that will be there or use the laboratory they are familiar with as long as it is a specialist laboratory. Individual research, planning and completion time.
Work covering the storage of common types of laboratory information and data. Tutor explanation of unfamiliar terms, words and concepts. Learner discussion in class or research/fact finding in groups or individually as required. Visiting speakers could enhance the research carried out into laboratory management information systems.
Assignment 3 – Data Storage (P4, M4, D3) Learners research the ways of storing data in a laboratory setting including the use of computers, their advantages and disadvantages, and investigate. Individual research, planning and completion time.
Worksheets covering safe working practices employed in the workplace. Tutor explanation of unfamiliar terms, words and concepts. Learner discussion in class or research/fact finding in groups or individually as required.
Assignment 4 – Legislation in the Laboratory (P5, M5, D4) Learners investigate the types of legislation in place in the workplace, the reasons for it and the ways that it is internally and externally enforced. Individual research, planning and completion time.
Review of unit and assessment.

Assessment

All the pass grade criteria must be met in order for a learner to achieve this unit.

P1 learners will be expected to outline the procedures commonly used in a laboratory. It is expected that all the procedures listed in the *Unit content* will be covered. Evidence for this could take the form of class worksheets and a compiled list with accompanying short notes. For M1, learners are required to explain why procedures and practices are followed in the scientific workplace.

P2 learners should identify how information on procedures and practices is communicated to other personnel in the scientific workplace. This could take the form of scenarios and notes on the outcomes of different methods of communication. For M2, the learners should explain how scientific information is communicated in various scientific workplaces. For D1, learners should make a judgement about the importance of communicating laboratory procedures to other laboratory personnel, giving reasons and examples to support their evaluation. This could take the form of a well-structured essay.

P3 requires learners to design a laboratory and identify its key features. A familiar laboratory could be used as an example. Plans can be placed on a CD ROM or on graph paper according to the abilities of the learner and their ICT skills. For M3, written justification should be supplied for the design of individual key features. Learners must look at a specialist and non-specialist laboratory. This can be achieved by using the laboratory they are working in at present and then researching the type of laboratory that they hope to be working in when they start their careers in science. D2 requires learners to make an informed judgement on how a well-designed laboratory fulfils its effectiveness, efficiency, safety and security purposes. Learners can draw on examples from industrial visits and demonstrate their understanding in the form of a well-constructed essay.

For P4, learners must describe the procedures for storing scientific information in a laboratory information management system (LIMS). Tutors could give learners a prepared list of scientific data and ask them to decide which sets of information could be stored on a workplace record system. Due to the huge amount of material in the *Unit content*, tutors may confine themselves to choosing specific types of data or records. Tutors must acknowledge the need for security and must give some examples, but a catalogue-style presentation is not appropriate. For M4, learners must explain how scientific data and records are stored. Evidence can take the form of an essay or verbal presentation. Learners must also demonstrate an awareness of the need for security and confidentiality. D3 requires learners to discuss the advantages of keeping data and records in a LIMS. Their views should be supported by evidence. The evidence can be drawn from the course content, industrial visits or internet research. Again, tutors can help learners with the use of appropriate worksheets on any industrial visit or the visit of a guest speaker. A well-constructed essay could be used to achieve the criterion.

P5 requires learners to demonstrate safe working practices in the scientific workplace. The tutor could write specific worksheets to cover the *Unit content*. Learners should be strongly encouraged to produce presentations. M5 requires learners to submit a discussion essay, giving details and examples to support their understanding of the need for current regulations and legislation in the laboratory. Historical events can be used as examples of lack of legislation and regulation. For D4, learners must show that they understand why safe working practices are regulated in a modern laboratory. Attention should be paid to applying the most up-to-date regulations in all working practices in today's scientific environments. The learner may have to access the internet to complete this assignment. Industrial visits and/or guest speakers will help learners to understand the course content.

Programme of suggested assignments

The table below shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the assessment and grading grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Edexcel assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P1, P2, M1, M2, D1	Work in the Science Industry	Work of a technician for training organisation publicity.	Report into the work of a science technician. Assignment looking at ways to communicate in the workplace and reasons why communication is important in the workplace.
P3, M3, D2	Designing a Laboratory	Senior technician organising refurbishment of laboratory.	Plan and notes for refurbishing a science laboratory. Assignment: plan of familiar laboratory and design for new specialist laboratory.
P4, M4, D3	Data Storage	Proposals for updating storage procedures in a laboratory.	Report into the storage procedures for laboratories. Assignment: proposals for an update of an old system, advantages and disadvantages.
P5, M5, D4	Legislation in the Laboratory	Journalist writing an article on current legislation in the science industry.	Article on the legislative requirements of laboratories. Assignment: report on legislation in laboratories.

Links to National Occupational Standards, other BTEC units, other BTEC qualifications and other relevant units and qualifications

This unit forms part of the BTEC Applied Science sector suite. This unit has particular links with the following units in the Applied Science suite:

Level 1	Level 2	Level 3
Scientific Toolkit (FLT)	Science and the World of Work	Scientific Investigation
	Working in a Science-based Organisation	Scientific Practical Techniques
		Informatics for Science
		Using Science in the Workplace
		Microbiological Techniques
		Biomedical Science Techniques
		Chemical Laboratory Techniques

Essential resources

Tutors delivering this unit will ideally have had some industrial experience as a technician or scientist. Knowledge of contemporary methods and regulations is essential in teaching this unit.

Learners should have access to the internet, a library or a learning resource centre. Visits to industrial laboratories would enable learners to talk to technical staff in a scientific environment. If industrial visits are not possible then visits from the organisations are strongly encouraged.

The use of as much technical equipment as possible related to standard laboratory practices is encouraged.

Learners should have a hardback laboratory notebook recording all laboratory practical work.

Employer engagement and vocational contexts

This unit should be contextualised to suit the range of learners, especially if they are on day release from a local employer. It would be advantageous in this case to draw on the expertise and knowledge of the employer, perhaps having experts come in to give some relevant input.

It would be beneficial for centres to visit the STEMNET website **www.stemnet.org.uk** or Future Morph **www.futuremorph.org** for more ideas about vocational contexts.

Indicative reading for learners

Textbooks

Foale S, Hocking S, Llewellyn R, Musa I, Patrick E, Rhodes P and Sorensen J – *BTEC Level 3 in Applied Science Student Book* (Pearson, 2010) ISBN 9781846906800

Atkinson C and Mariotte J – *The Prep Room Organiser* (Association for Science Education, 2003) ISBN 9780863572838

Journals

CLEAPSS publications

Laboratory News

New Scientist

Websites

www.ase.org.uk	The Association for Science Education
www.explorer.bio-rad.com	Bio Rad science education
www.genetics.gsk.com/virtual.htm	GlaxoSmithKline virtual tour of genetics laboratories
www.hhmi.org/biointeractive/vlabs	Howard Hughes Medical Institute virtual laboratory tours
www.infomat.net/infomat/rd_staffroom/rd l /database/cleapps	CLEAPSS
www.iob.org.uk	The Institute of Biology
www.iop.org.uk	The Institute of Physics
www.istonline.org.uk	Institute of Science Technology: Laboratory Handbook
www.mhra.gov.uk	Medicines and Healthcare products Regulatory Agency
www.mond.org	Society of Chemical Industry
www.rsc.org	The Royal Society of Chemistry
www.scienceconsortium.co.uk	The Science Consortium
www.sciencelearningcentres.org.uk	Science Learning Centre, London
www.sep.org.uk	Science Enhancement Programme
www.york.ac.uk/org/ciec	Chemical Industry Education Centre (CIEC)

Delivery of personal, learning and thinking skills

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the pass assessment criteria of this unit.

Skill	When learners are ...
Independent enquirers	[IE1,2] using researching skills to obtain the information needed
Creative thinkers	[CT1,3,4] putting themselves into the role required for the assignment
Reflective learners	[RL4,5] using several sources to reach a conclusion
Team workers	[TW1] working together in research, practical and presentation work
Self-managers	[SM2,3] completing the work to the required standard and to deadline
Effective participators	[EP3,4] adding ideas at planning and discussion stages; working on research, practical and presentation work.

Although PLTS are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are ...
Independent enquirers	[IE3] researching further on parts of the topics of particular interest to the learner
Reflective learners	[RL5,6] making sense of the information in a wider context
Self-managers	[SM5,7] not becoming sidetracked by topics of particular interest
Effective participators	[EP6] achieving wider knowledge than the *Unit content*.

Functional Skills – Level 2

Skill	When learners are ...
ICT – Use ICT systems	
Select, interact with and use ICT systems independently for a complex task to meet a variety of needs	finding website information, selecting appropriate texts and saving them and using a reference system to acknowledge their research information
Manage information storage to enable efficient retrieval	saving information from different sources for later use
Follow and understand the need for safety and security practices	aware of individuals' and organisations' needs for safety and security
ICT – Find and select information	
Select and use a variety of sources of information independently for a complex task	using internet sources to research information
ICT – Develop, present and communicate information	
Enter, develop and format information independently to suit its meaning and purpose including: • text and tables • images • numbers • records	using internet sources to research information on therapies and treatments displaying results in appropriate format, presenting reports and data displaying results in appropriate format, presenting conclusions and suggestions for improvement
Bring together information to suit content and purpose	researching information and producing reports, posters, leaflets
Present information in ways that are fit for purpose and audience	producing reports, posters, leaflets
Evaluate the selection and use of ICT tools and facilities used to present information	selecting the best media for use in presentation
English	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	taking part in discussions presenting information on a researched topic
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	researching from multiple sources
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	completing the written work for the assessment.