

2 Working in the science industry

You might know already which branch of science you are most interested in, or perhaps you are using this course to find out about the different branches of science and the hundreds of careers that could be open to you. You may even change your mind as you come across the different aspects of this fascinating subject.

This unit gives you the chance to explore what happens in many science workplaces. Some of the procedures are used in all science workplaces, while others are much more specialised. This unit will familiarise you with the skills and knowledge that an employee in the science industry needs to have to be an effective, efficient and safe member of a team.

Learning outcomes

After completing this unit you 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.

Assessment and grading criteria

This table shows you what you must do in order to achieve a pass, merit or distinction grade, and where you can find activities in this book to help you.

To achieve a pass grade the evidence must show that you are able to:	To achieve a merit grade the evidence must show that, in addition to the pass criteria, you are able to:	To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, you are able to:
P1 outline procedures in the scientific workplace See Assessment activity 2.1	M1 explain why procedures and practices are followed in the scientific workplace See Assessment activity 2.1	D1 analyse why laboratory procedures and practices must be clearly communicated See Assessment activity 2.1
P2 identify how information is communicated in the scientific workplace See Assessment activity 2.1	M2 explain how information is communicated in the scientific workplace See Assessment activity 2.1	
P3 design a scientific laboratory, identifying its individual key features See Assessment activity 2.2	M3 justify key features in the non-specialist and specialist laboratory See Assessment activity 2.2	D2 analyse why good laboratory design is important for efficiency, effectiveness and safety See Assessment activity 2.2
P4 describe the procedure for storing scientific information in a laboratory information management system See Assessment activity 2.3	M4 explain the processes involved in storing information in a scientific workplace See Assessment activity 2.3	D3 discuss the advantages gained by keeping data and records on a laboratory information management system See Assessment activity 2.3
P5 demonstrate safe working practices in a scientific workplace See Assessment activity 2.4	M5 explain the need for current regulations and legislation in safe working practices See Assessment activity 2.4	D4 evaluate the regulation of safe working practices in a scientific workplace See Assessment activity 2.4

How you will be assessed

Your assessment could be in the form of:

- a table showing procedures and practices in a scientific workplace
- a leaflet detailing the importance of communication in a scientific workplace
- a design plan for your own laboratory
- an article on laboratory safety.



Stephen, 18 years old

The information in this unit helped me to decide that I wanted to be a technician in education, perhaps in a college or university.

The unit covered all aspects of the work in general but also looked at the specialist tasks used in some types of laboratory. Although, at that stage, I was not sure what some of the information might be used for, I did the tasks and assignments as well as I could.

I finished the course with some good grades and started looking for work. There was a technician job in a college of a London university advertised. I applied for the job and was asked to go for an interview.

When I went for the interview a lot of the questions that I was asked had been covered in 'Working in the science industry' and this made me comfortable answering the questions. I was told afterwards that I had shown a good understanding of the work and organisational aspects and that had got me the job. I've a lot to learn so I hope to go on to do a degree part time and to get promotion.



Catalyst

Where is science in the workplace?

Write down any six organisations that you know of and then think about whether they use science to carry out their work.

Get into small groups and compare what you have written with others in the group.

What conclusions have you come to about science in the workplace?

You should have included all types of workplace which involve computers in your list as well as science as it is understood by most people.

2.1 Procedures and practices

In this section:

P1 M1 D1 P2 M2

Key terms

Science environment – any location where science is carried out as part of the day-to-day routine.

Procedure – method of conducting the business.

Practice – established method used regularly.

Calibration – checking that the equipment is working to a set standard.

Hierarchy – a number of people arranged in order of rank.

Whatever type of science you go into, either straight from this course or after higher education, there will be a number of **procedures** that are found in all parts of the **science environment**.

In any laboratory it is important to have:

- knowledge of equipment
- ability to use equipment
- ability to keep equipment in good working order
- knowledge of laboratory procedures
- communication skills and information on how people work.

Knowledge of equipment

You may already be familiar with different pieces of equipment that you have used in science. Some of these pieces of equipment might be new to you.

Equipment	Use
centrifuge	separates solids and liquids, particles of different sizes or liquids of different densities
microscope	optical instrument used for magnifying very small things so that they are visible to the naked eye
balance	measures the mass of objects, powder or liquids
pH meter	measures the pH of a liquid
oven	heats substances, often to high temperatures

Equipment	Use
incubator	maintains objects or substances at a particular temperature, often human body temperature
fume cupboard	protects the operator and others from hazardous fumes and powders
graduated pipette	measures liquids for use
heating mantle	a source of heat when a naked flame could be dangerous
burette	graduated glass tube with a tap at one end used to perform titrations
Bunsen burner	a source of heat where a naked flame is required or where it would not be dangerous
desiccator	a vessel containing a substance that attracts moisture so keeping the contents drier than in the open atmosphere
oscilloscope	used to measure voltage and frequency in electric circuits

Activity 2.1A

Think about the science you are most interested in and find out about some of the equipment that is used there. Make bullet point notes on what the equipment is and what it is used for.

Glassware

Glassware is commonly used in science. You are probably already familiar with some of the glassware which is used in most scientific workplaces. Why do you think glass is used so much?

The glassware used in science is not the same as the borosilicate glass used at home. There are several different types of glass used in science and it is important to ensure that the correct type of glassware is used, and is kept in good condition. Glassware is expensive and chips and cracks can be repaired. Borosilicate glass is soft and can be melted easily using a Bunsen burner. You may be familiar with the name Pyrex®. This type of glass is stronger, particularly when subject to sudden changes of temperature, and does not melt easily. It requires

additional oxygen to make the flame hot enough to melt it. This is important to know if your job is to mend or make safe cracked or chipped glassware.

Activity 2.1B

Complete the following sentences:

When finding broken glassware you should...

When heating glassware you should...

When moving hot glassware you should...

When washing glassware you should...

When storing glassware you should...

Maintenance of equipment

It is very important that equipment is kept in good, safe working order as other people using it could be put in danger and results produced from work using the equipment could be wrong. For example, broken or wrongly **calibrated** pH meters can give incorrect results, making the results useless. In a research laboratory this could lead to wrong conclusions, wasted time and wasted resources. Broken or damaged wires on equipment can cause electric shock or fire.

To make sure that this does not happen all scientists and technicians look for faults all the time. This could be as simple as chipped or cracked glassware or it could mean looking out for problems with pieces

of sophisticated equipment, or being aware of their maintenance schedules. Some types of equipment will draw the user's attention to a problem with warning lights but others will need to be carefully watched.

Modern equipment, for example high specification spectrophotometers, is so sophisticated that only the manufacturers and their specially trained technicians can perform maintenance and servicing on them. Other pieces of equipment can be maintained, serviced and calibrated by trained technical staff in the laboratory. When equipment is being cleaned the power should be switched off to prevent electric shock and the manufacturers' instructions should be followed.

Calibration, maintenance and servicing can, in some cases, be carried out by the laboratory technical staff and appropriate records should be kept of the work done and dates.

If the maintenance, calibration and servicing has to be carried out by specialist personnel from the manufacturer, either because the equipment is very technical or the laboratory staff have not been trained to do it, a contract will be set up with the manufacturer. The contract will state how often the maintenance will be carried out and what will be done. This will have a cost implication for the laboratory. This type of maintenance and calibration will be required for the validation of the data produced by the laboratory and, perhaps, for the laboratory to be allowed to do particular work.

Equipment	Maintenance required
microscope	General cleaning, taking particular care to use lens tissues on the objectives and eye pieces. Immersion oil can cause a particular problem if left to dry.
pH meter and electrode	These should be rinsed clean and stored with the protective cap to prevent drying out. The machine itself should be calibrated using standard solutions of known pH.
spectrophotometer	Spillage must be avoided but if it does occur the machine should be switched off before cleaning can take place. The light path in the machine should be cleaned, as should the carriage which holds the cuvettes with the test solutions inside.
centrifuge	The inside, including buckets, must be cleaned regularly to prevent the build up of spilt material and dust which may be hazardous to the user and the machine. Seals around lids may need changing at times.
burette	Burettes will need regular cleaning and checking of the glass body, tap and spout. Normal cleaning procedures will be sufficient in most cases. The tap should be taken apart, cleaned, checked for damage, greased and reassembled. The spout will need checking for damage as a break or chip will affect the accuracy of the amount of liquid dispensed.
Bunsen or similar type of burner	Burners will have a gas tube which must be checked for cracks or breaks that could cause a gas leak. Any connections should be checked for leakage which could cause explosions. The moving parts, such as the collar, should be freely moving to allow the air content to be easily controlled. If there is a possibility of drips falling down the chimney of the burner this should be checked for blockages.

Equipment	Maintenance required
fume cupboard	Used to protect the worker and other staff from potentially hazardous substances such as chemicals, fumes or microorganisms. It works like an extractor fan pulling air from inside the laboratory into the fume cupboard, across the work area then up a chimney and outside into the atmosphere. Maintenance is required on the motor and filters to ensure that air is moving fast enough to remove any dangerous substances. The movement of air can be checked by the technical staff using a basic piece of equipment. If further work is required a specialist company may need to be called in.
oscilloscope	Used to measure the value of ac voltages and to make measurements so that their frequencies can be calculated. Modern instruments are very reliable but in situations where a high level of accuracy is needed their calibration should be checked routinely. This could usually be carried out by technical staff in the workplace but if adjustments are needed then a specialist would be required.



Sophisticated equipment needs specialist maintenance.

Moving equipment

Sometimes you will need to move equipment, either for maintenance or for disposal. When equipment is to be moved for maintenance purposes the maker's instructions should be followed to prevent damage. Moving within the laboratory might just mean providing access for the maintenance engineer to be able to work on the equipment or gathering the pieces of equipment together in one place for the engineer to work on them. If this is the case then good manual handling techniques should be used to prevent injury to staff and damage to the equipment.

For example, training can be organised for staff who might be required to lift or move equipment or stock. This could involve the best way to lift using a straight back and bent knees or the use of ladders, etc. for accessing higher level shelves. Technicians should also be aware of the fact that equipment can be very heavy and, as well as needing more than one person to move it, there might be a need to use a trolley or wheels.

When a piece of equipment has become obsolete, due to age and/or damage, it should be disposed of in a suitable way.

Some companies will buy old but working equipment for resale to organisations who can still use it. For example, obsolete blood testing equipment can be sold by an NHS trust and bought by colleges for training.

Activity 2.1C

List reasons why equipment must be maintained.

If equipment is to be disposed of there are several procedures that need to be observed. Some analysers, for example, contain hazardous substances such as mercury, radioactive material or gases. Local council disposal regulations should be followed before disposal can take place. Mercury should be drained and collected for disposal. Radioactive sources can be sent to the relevant authorities for safe disposal. Gases, such as refrigeration gases, can be removed by an authorised organisation.

Laboratory procedures and practices

Depending on what type of work the laboratory is carrying out the procedures and **practices** in use will be different. However, some procedures will be carried out in some form in all laboratories. These procedures and practices could be documented in a Laboratory Information Management system (see section 2.3, p.19).

Standard Operating Procedures (SOP) are in place in many laboratories. These are documented procedures that are carried out regularly as part of the routine and could cover many different aspects of the work. For example, how tests are carried out, the procedures for handling the chemicals or samples involved and the disposal of samples or waste. This could also cover the way different pieces of equipment must be used and maintained, including the correct solutions for use in them.

A typical standard operating procedure

At the start of the day:

- Switch on the analyser. Allow machine to run its initial set up procedure.
- Check internal standards have been met by consulting the screen or print out. Address any problems that have been highlighted.
- Check any solutions required for the running of the equipment. Replace or refill as required.
- During the day monitor the correct running of the machine and the level of solutions.

At the end of the day:

- Clean and shut down the machine according to the manufacturer's instruction.
- Switch off or leave safe.

Store management and ordering

In all laboratories there will be one or more stores of chemicals and equipment. A procedure which must always be under strict control (see below) is the ordering, storage and use of these day-to-day requirements. The senior technician or laboratory manager is likely to be in control of ordering, and will have to manage a budget. Normal procedures will include:

- stock rotation – using the oldest chemicals first to make sure they do not become too old; some chemicals can become dangerous if kept too long
- correct storage procedures – taking into account any special storage requirements
- how stock is ordered and moved for immediate use.

Orders may be placed automatically on a regular basis for chemicals or equipment, called consumables, or stock may be ordered as and when it becomes necessary. The senior technician or scientist will probably be the person who has the authority to place orders, but they will need to be told when stocks become low. The order will need to be authorised and this might include agreement from the finance department of the company.

In industry, stocks from the supplier will usually be delivered in large quantities, even by road tanker. The chemicals could automatically be taken from the storage place for direct industrial use. It will be the responsibility of the technicians or store person to deliver what is required for use in the laboratory. In some laboratories a system using bar codes and a bar code reader is used to control stock, a bit like on the shelves of a supermarket.

There are various categories of materials that may be used in the laboratory. Some can be bought normally while others might need a special licence to be bought.

Material	Storage requirements
flammable material: large quantities and explosive material	Stored in a special brick-built store usually away from the main building with a roof that can detach in case of an explosion rather than blowing out walls.
flammable material: small quantities for immediate use	Stored in a metal flammables cabinet.
drugs and poisons	Stored in a locked cupboard.
dry chemicals	Stored in a cool dry place.
biological materials: bacteria, plants and animals, including clinical test samples	Live material will need to be stored correctly so that it stays viable. This might involve keeping it cool or warm, in the dark or light.
radioactive materials	Store in a locked metal cupboard away from where flammable materials are stored. Removal from the cupboard and details of use should be recorded in a log book.

Transfer of materials

It is important that, as a technician or scientist, you know how materials should be transferred from place to place and what quantity is safe to carry. Flammable, biological and radioactive materials are commonly moved around and need special handling. When materials are ordered from a supplier, the supplier will be responsible for delivering them safely to the laboratory. Once they arrive, a technician will be responsible for the safe handling of any hazardous material.

Dry chemicals should be kept in a suitable container if taken from their original container and relevant labelling should be transferred as well. You may need to use a fume cupboard to prevent dust particles contaminating the surrounding area and other workers. Wet chemicals must be carried in a bottle carrier in a suitable container.

Biological material, such as living organisms, must be treated with care to keep them in good condition and, in the case of animals, to prevent suffering.

In general, if substances are heavy and are to be transferred from the store to the area of use they must be carried on a trolley whenever possible.

Disposal of waste

In every science laboratory there will be some form of waste produced and it must be disposed of safely.

Waste	What it might include
chemical	waste from school laboratories waste from manufacturing
clinical	waste from hospital wards and clinics sharps bins waste test samples from hospital laboratories waste reagents from testing in hospital laboratories waste from veterinary surgeries
pharmaceutical	waste from pharmaceutical manufacturers out of date drugs from local pharmacies and chemist shops
biohazardous	waste from research laboratories samples from patients
radioactive	waste from hospitals waste from the energy industry

Options for disposal

Some non-toxic, non-polluting waste products can be flushed away into the drain in the laboratory using water, while others must be disposed of by mixing with other chemicals to make them safe (for example, sodium carbonate added to acids).

Disposal of waste may involve storing it until it can be disposed of. This could pose a problem as large amounts of mixed waste can create a new hazard, e.g. carcinogens or mutagens.

The storage of waste material will be specific to each laboratory and local regulations will detail what needs to be done. The technicians in charge will have detailed knowledge of substances in use in the laboratory and the requirements for their safe disposal.

Some waste must be taken away for expert disposal. Some can be taken away, cleaned and recycled, such as mercury. If this forms part of your job you will be trained in which process you should use. A technician will need to label and log all waste products ready for collection. Disposal of large quantities of waste must only be

carried out by a reputable company, a registered waste carrier, to prevent illegal fly tipping of potentially dangerous substances into the environment.

Processes for disposing of waste

Chemical waste

Flammable solids:

Large amounts (or even small amounts) will require collection. Small quantities of water-reactive solids, such as calcium dicarbide, may be added carefully to a large volume of water in a fume cupboard. Metals such as sodium, lithium and calcium should be destroyed chemically before disposal via a drain with great dilution. Sodium should be dissolved in ethanol or propan-2-ol in a fume cupboard. Lithium and calcium may safely be dissolved in excess water.

Toxic chemicals:

Most of these should be stored for collection or made safe chemically if in large amounts. Small amounts (10 g or less) of toxic salts may be dissolved, diluted and flushed away.

Corrosive liquids:

These should be diluted and neutralised using sodium carbonate (for acids) or ethanoic (acetic) acid (for alkalis) before washing to waste with large amounts of water.

Water-reactive corrosives:

These should be added cautiously to a large excess of water in a bucket or bowl in a fume cupboard before washing to waste with large amounts of water.

Corrosive solids:

These should be dissolved carefully, diluted greatly and preferably neutralised with sodium carbonate as above before washing to waste.

Oxidising agents:

These should be dissolved in water and diluted greatly before washing to waste. Care should be taken that wood, paper or cloth does not become contaminated with the solution.

General chemicals:

Low-hazard inorganic chemicals may safely be disposed of via the refuse or drains but large amounts of metal compounds such as copper or zinc salts should be kept for collection. Small amounts of copper or zinc salts may be dissolved and flushed away.

Special cases

Asbestos:

Asbestos can only be collected by a carrier specifically licensed for that purpose. However, if a small amount of asbestos is found, it should be sealed in a tough plastic bag and a special collection arranged by contacting the Environmental Services department of your local council.

Mercury:

Mercury recovered from spills or otherwise considered 'dirty' could be kept and sent for purification when enough has been collected. Lime/sulfur is used to help clean up small spills of mercury and the mix contaminated with dust and small droplets of mercury from broken thermometers, etc. should be stored in a strong bottle and kept for collection by a registered waste carrier.

Clinical waste

Clinical waste is placed in special yellow plastic bags and collected separately by the refuse service for incineration. Sometimes it will need to be double bagged, i.e. putting a full bag inside another empty bag to prevent leakage. Sharps that might be contaminated with biologically hazardous material, such as used needles, are collected in special reinforced bins and are usually also taken away for incineration.

Pharmaceutical waste

Pharmaceutical waste from manufacturing and quality control processes will be treated as chemical waste. Other controls might be used for particularly dangerous drugs. Out of date or returned medicines are waste from the local pharmacy or chemist shop.

Did you know?

Old medicines should not be put into household waste or flushed down the sink or toilet but returned to your local chemist shop or pharmacy.



Radioactive waste

This waste can come from the energy industry where large amounts of radioactive material will be generated. Some medical tests require the use of very small amounts of radioactive material. This can be mixed with clinical waste and disposed of in the same way.

Regulations about waste disposal

There are many rules and regulations about waste and its disposal, for example, the Hazardous Waste Regulations 2005.

Below are outlined two quite complicated regulations that are covered by European legislation.

Trade Effluent (Prescribed Processes and Substances) Regulation 1989:

Companies who dispose of their waste into rivers and waterways need to seek the water authority's permission if they wish to dispose of chemicals such as mercury, cadmium and their compounds, tetrachloromethane and pesticides. It advises that the disposal of other substances in river water such as ammonia and metals like zinc, nickel, lead and copper is kept to a minimum.

Radioactive Substances Act 1993:

Organisations that use radioactive material, and therefore produce radioactive waste, must be registered so that their activities can be monitored.

Communication in the workplace

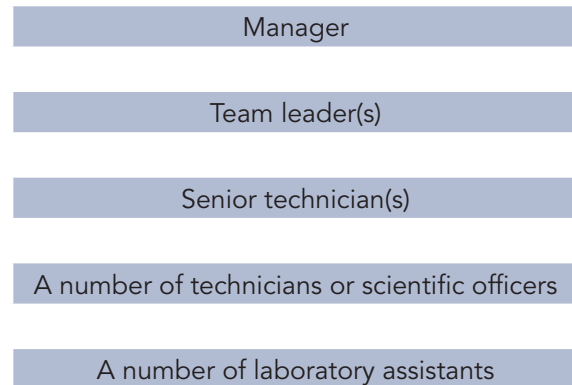
The work carried out by scientists and technicians relies heavily on the structure of the team they work in, and the way each team member acts. In most work places there is a **hierarchy**.

This means the most senior person will have various levels of personnel reporting to them. How this is organised depends on:

- how large the team is
- the particular routines that are carried out in the workplace
- whether the team is spread over a large area or different sites
- if the team is split into smaller groups carrying out a particular job or at particular times of the day or night.

No matter how people are organised, the way they communicate within their team or outside of it is crucial to the safe and smooth running of the organisation.

Type of organisational structure



Reporting of results

Results generated in a workplace will be specific to that workplace. They may be results of research performed by colleagues or results generated for the use of outside agencies. Whatever the results are they must only be communicated to those who need to know them.

Internal day-to-day results will probably be reported via the laboratory notebooks, printouts from the laboratory equipment and at team meetings. These results may be gathered together to produce a report on completion of the research.

Unless there are reasons for urgent results to be communicated directly to another person, results will normally go through an office procedure where they are written up and copied to the recipient, for example a GP. In some cases results, such as scans, can be viewed via a computer screen along with test results.

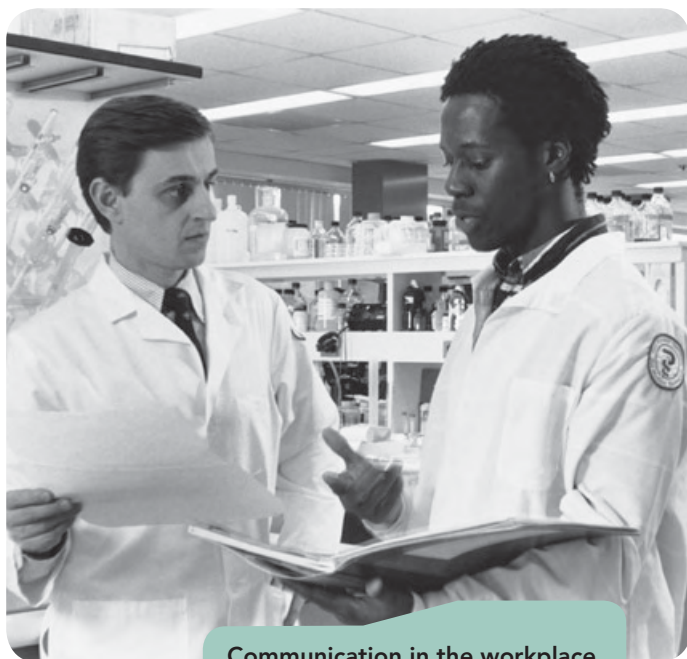
Scientific terminology

It is essential that scientific terminology is used and understood by all members of the team if effective communication is to take place. This is particularly important where research work or production is being carried out in different countries where language may cause confusion if standard terminology is not used.

Security

Keeping information secure means being sure only certain people can access it. This is important as industrial espionage can cost a company large sums of money. For example, a pharmaceutical company could lose money if a competitor reaches drug production first.

Individuals also want their personal records (e.g. medical records) kept private. A patient can be badly



Communication in the workplace.

affected if their personal clinical information is lost or reaches the wrong person. The Data Protection Act is in place to prevent personal information falling into the wrong hands.

Roles and responsibilities

It is important that each member of the team knows their role and responsibilities. This helps the team work well together but lets each member know and feel comfortable with what is expected of them.

Your place in the team

Most workplaces will give a new person a diagram showing how the team is organised. This shows the new person in the team who they should report to and also who they can go to for help or guidance. This also affects how the work is organised.

Work schedules or rotas will be written so that staff know when they should be working and when their days off will be. This might include working at other sites. This differs depending on the organisation. For

Case study: The importance of communication

The importance of communication in the workplace is highlighted in this fictitious case study.

In a pharmaceutical laboratory the research and development technicians had been working on a new drug. They had reached a critical stage of the work but had changed one of the chemicals in the mix. The next day, one of the technicians was due to be on holiday and the other was on day release. They left work on Tuesday evening leaving a process running that needed 12 hours to complete. Their laboratory note book, noting their findings and changes to formulation, had not been updated recently and was left on the bench.

The last person in the laboratory saw the equipment still on and turned everything off. The following day a laboratory assistant arrived to find the process apparently complete but with no information about what to do next. Not realising that the process had not been completed and results had not been documented, they cleared away the samples and equipment before asking anyone else. The senior technician was also away on a management course.

Whilst being disposed of, the chemicals were mixed with others and toxic fumes were created. These unknown fumes caused the assistant to become unconscious and, when she was found, the emergency services were called and the assistant taken to hospital. When an emergency contact number for the assistant was called, the number was found to be no longer in use. The emergency services could be given no clue as to the cause of the collapse.

Meanwhile, the R&D technician on holiday talked at length to some casual acquaintances in technical detail using technical language to impress them about what he had been doing at work.

The technician on day release returned to find a considerable amount of research lost and had to start it again. The senior technician returned to find one of their staff in hospital and the process being repeated. Shortly afterwards news on the Internet informed them that the drug was being developed by a rival company.

Who is responsible for this situation arising?

instance, if there is a continuous process running, such as a production line in a pharmaceutical company producing tablets, there may be a need for staff to work day and night in shifts. This means working for a number of hours and then having time off. This could be over an extended period.

At busy times, a day worker may need to work night shifts to keep up with the work. If cover is needed for emergencies then some qualified or experienced

people will be 'On call'. This means they could be called in to work at short notice. If handover meetings are required they will be scheduled so that team members can attend.

Holidays, time off, sickness and day release to attend training can be added to the schedules to ensure that enough people are available to cover the work and that the staff working together are qualified and experienced.

Assessment activity 2.1

P1 M1 D1 P2 M2



- 1 Produce a table listing all of the procedures and practices that you have investigated and in a second column give the reasons why they are carried out. **P1 M1**
- 2 You have been asked to produce a leaflet for trainee technicians covering communication in the scientific workplace. In the introduction say how information is communicated in the workplace. Then, in a table list the ways communication can happen in a workplace, the reasons for communication and why any communication must be clear. Finally, use case studies (real or imagined) to show how important it is that procedures and practices are communicated clearly and what might happen if they are not. Display the information as a leaflet for distribution to prospective technicians at a job fair. **D1 P2 M2**

Grading tips

In order to achieve **P1** you are only asked to list procedures and practices in the table. Don't do more than is required. For **M1** you may have to think about why these procedures and practices are carried out so make sure you understand what each one is.

For **P2**, you need to list the ways in which information is communicated in the workplace, whereas for **M2** you need to give more in-depth explanations of the points listed for **P2**.

Think about leaflets that you have picked up in the past. What attracted you to them, why did you want to read them and how did they hold your attention? Along with the information required to show that you understand why communication of procedures and practices is necessary in a scientific workplace, add in these factors to produce an interesting and informative leaflet. **D1**



PLTS

Self-manager

Completing work to standard and deadline will use your skills as a self-manager.

2.2 Laboratory design

In this section:



Key terms

Key features – anything that is vital for the work of the organisation.

Services – utilities such as gas, electricity and water. In some laboratories there might also be vacuum lines available.

At some stage in your career in a scientific workplace you might be involved in the planning, building, rebuilding or refurbishment of a laboratory.

This is a complex task requiring specialised knowledge and experience. However, practical day-to-day knowledge of the work and the workplace may prevent costly mistakes in time, money and personnel problems.

What makes a workplace scientific?

You have already investigated the use of science in the workplace and you found that science in some form or another is present in many workplaces.

In this section of the unit you will be looking at what makes a workplace really scientific.

Let's consider what you would expect to find inside a scientific workplace.

Think about laboratories that you are familiar with at school, during work experience or visits.

The **key features** of a laboratory are those that make it a scientific workplace, for example, building materials that will not be affected by substances in use in the laboratory. These could include floor, ceiling and wall coverings, such as special tiles or paint, types of specialist furniture such as benches with clear surfaces and surfaces on furniture that can withstand the types of substances in use. There will also be greater access to more **services** in the laboratory than in many other workplaces. Ventilation will be an important part of the laboratory, as there must be adequate fresh air, but this must not allow substances inside the laboratory to escape into the environment unchecked.

The services that are required in the laboratory are: water, gas, electricity and you could include in this list a vacuum line.

The furniture will depend on the work being carried out but essential pieces might include benches and stools, sinks, storage cupboards, drawers and fume cupboards.

Activity 2.2A

List the key features that you would expect to see in a laboratory. What furniture and services should be there?

Furniture

Furniture in laboratories can be free standing or fixed. It is usual for benches to be fixed because they will have services, water and waste outlets, gas and electric fitted to them and it would be dangerous if the benches were able to be moved. In some classrooms, however, modular furniture can be moved around and

Case study: Poor design

A new suite of laboratories was built as part of the General Hospital. The designs were approved and the laboratory was built. When the staff came to move in they found that the bench where the haematologists use microscopes to look at blood smears was positioned underneath the outlet to the air conditioning. They spent all day with cold air blowing down their necks and this resulted in many stiff necks and aching shoulders. The air conditioning

could not be altered, as this had an effect on several areas of the laboratory which became uncomfortably hot. The laboratory had to be rearranged so that the microscopes were located away from the outlet. This meant that urgent work was held up until the relocation was completed.

How could these problems have been prevented?

linked to fixed units to change the configuration of the teaching area. There might, in some laboratories, be requirements for teaching equipment such as whiteboards.

In some old laboratories wood is still in use for work surfaces. It is a very good material but requires continuous care to keep it in good condition. More and more synthetic surfaces are being introduced into laboratories which are easier to keep in good condition.

The surfaces in a laboratory will be different from those in your home kitchen as they have to be chemical proof as well as heat proof. Benches may have storage below them but there should be space for people to sit and work at them. Some laboratories, microbiology for instance, require that there are no gaps between separate lengths of work surface to prevent the build up of chemical substances or microorganisms.

Storage is a vital part of the laboratory. If there is not enough storage space, things that should be put away safely can get left out. This can be dangerous as they can block access and create a hazard for people moving about in the laboratory. Other hazards include paper, which could be a fire risk if left lying around the laboratory.

In all laboratories there will be safety equipment. This could include fire extinguishers, a fire blanket, safety solutions and eye wash. All laboratories will have a first aid box in the room or close by. Sometimes a safety shower will be available to wash away large spills of substances from a person's body.

There may be one or a row of fume cupboards. Fume cupboards need maintenance to make sure that they are removing the correct volume of air to protect staff both working at the cupboard and in the surrounding area. The speed of flow depends on the substance in the fume cupboard. For instance, chemicals and radioactive substances require a flow of 0.4 and 0.7 m/s. The fume cupboard acts as an extractor fan pulling air into itself, across the work space and then up a chimney to be vented into the atmosphere. It is important that air contaminated with harmful organisms or fumes is cleaned (filtered) before being released into the atmosphere. Air might also be filtered before going into the cabinet to prevent contamination of what is being worked on.

Fume cupboards can also contain gas, water and electric supplies, as well as a sink.

There are also cabinets called laminar flow cabinets. These are designed to blow cleaned air across the work surface. Any hazards being produced in the cabinet will be blown out into the laboratory and over the workers. Therefore, laminar flow cabinets should only be used for non-hazardous work.

Unit 15: See page xxx for more information on laminar flow cabinets.

Activity 2.2B

As a preparation for the assignment task make a sketch of the laboratory you are working in or that you are most familiar with.

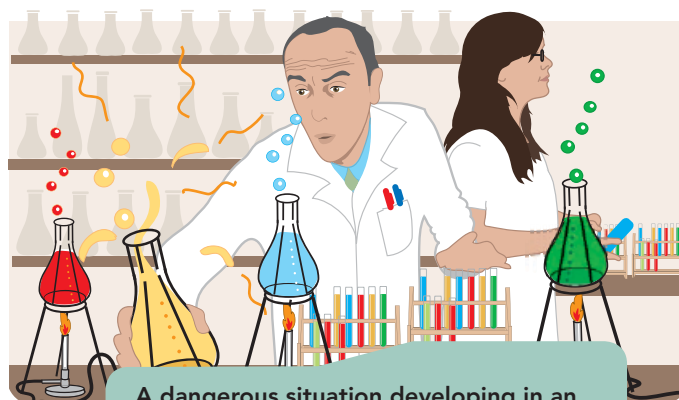
Sketch in the furniture and any large pieces of equipment and make a note of where services, exits and store rooms are located. A plan in this case is a view of the lab looking down onto it as if you were a spider on the ceiling.

Access and workspace

Have you left space for people to move around? There are rules and regulations stating how much space is required in secondary schools for movement between benches and cupboards. They are published in a document called Building Bulletin 80 Science Accommodation in Secondary Schools. This can also be found in a CLEAPSS document called G14 Designing and Planning Laboratories.

One of the biggest problems in any workplace is the lack of space for people to move around and to work. This can have dangerous consequences.

When scientists and technicians are moving around the laboratory they may need to carry samples or equipment in their hands, or move them on trolleys if



A dangerous situation developing in an overcrowded laboratory.



A modern clean and ordered laboratory.

they are heavy. If a technician is working at a laboratory bench, other people need to move past them without hitting them. If the bench space is insufficient, samples or equipment might be knocked off the bench or things could be put on the floor, which would add to the risk of tripping.

Equipment will need space around it for access should it need repair but also for air circulation to prevent overheating.

Has this made a difference to your plan? Redraw your plan if you have to make changes.

The specialist laboratory

The work that is carried out in a laboratory will influence the type of equipment that is used there. Most laboratories will have several large pieces of equipment, numerous smaller pieces and several computers linked in.

The storage required will vary, with special facilities for radioactive, flammable and toxic materials.

Medical

In a medical laboratory machines will be used to diagnose illness, as well as monitor patients' treatment. Many and varied tests can be carried out on many different types of sample. In particular, work in a microbiology laboratory is carefully controlled to prevent the spread of disease-causing microorganisms into the surrounding area. Any sample may be hazardous and so it must be treated accordingly.

Forensic

In a forensic laboratory there will be areas for checking and testing evidence. It is important that evidence

does not become contaminated as this can lead to a criminal case being thrown out of court. Different areas of the laboratory will be used for specific types of testing. Firearms, ballistic and explosives tests will be carried out in an area away from the main work area for obvious safety reasons.

Pharmaceutical

In a pharmaceutical research laboratory there will be equipment for producing and testing drugs. This could include testing and producing new drugs or testing drugs where patients have highlighted a problem, for example strange side effects. In a pharmaceutical dispensing laboratory there will be equipment for weighing and measuring out medicines and, possibly, for making pills. There will be an area for this activity and an area for actually handing over prescriptions to patients.

Preventing contamination

In some laboratories, especially the forensic and pharmaceutical labs mentioned above, there will be a definite difference between clean areas and general areas. In clean areas special protective clothing must be worn, such as suits covering the whole body, masks and shoe covers, hats and, in some cases, beard covers. This is to protect work from contamination by workers' clothes, hair and skin. In clean areas the air coming in is filtered to prevent contamination from outside. On the way into these clean areas there are lockers for clothes, supplies of the right protective clothing and bins for used protective clothing. There is often a barrier of some sort, such as a low wall or a door with labelling, to remind people that they are entering a special area.

Food science

In a food science laboratory, usually associated with large food producing companies, there will be kitchens producing new food samples or maybe improving an existing product. There will also be laboratories checking the quality of products and investigating complaints made by customers.

Physical sciences

In physical laboratories, physical tests might be carried out, for example to check the strength of a metal component. This could involve stretching a piece of metal until it breaks. Special equipment is required, as are special precautions to protect the workers.

Chemical

Chemical laboratories could be producing small amounts of chemicals for specialist work or they could be researching chemical reactions in preparation for much larger scale production in a factory situation. In each case there will be chemicals which must be stored correctly and waste chemicals which must be disposed of correctly.

The health and safety issues will be different for different types of laboratory.

Laboratory design will need to address all of the issues relating to health and safety to comply with current regulations in a new building. In an older building that is being refurbished or updated, such as a listed building, it may not be possible to comply with all of the rules and regulations.

Assessment activity 2.2

D2 P3 M3

BTEC

- Using all of the information given and work you have done in class produce a simple design for a laboratory identifying the key features that must be present to be able to call it a scientific workplace.

P3

- Your school or college laboratory will be a non-specialist laboratory as it can be used for most types of science, even though you might only carry out one of the sciences in it. If it has been designated as a microbiology suite then it will be a specialist laboratory.

Look at the facilities and equipment that are required in a specialist laboratory to carry out their work and justify the inclusion of the key features in a non-specialist and a specialist laboratory. **M3**

- You are the senior technician in a laboratory and you have been told that there is a grant available for the refurbishment of your workplace. There have been problems over the years with the increase in size and complexity of the equipment that you are using in the laboratory and the number of staff that have to be accommodated as well as the amount of work expected.

To be given the grant you have to make an application with an analysis of the changes that you want to make and how they impact on the efficiency, effectiveness and safety aspects of your

workplace. You need to write a report outlining the changes you would like to make and should cover the design and the content of the laboratory. **D2**

Grading tips

Gather together all of the information that you may have learned in class or from your own research so that you can draw a simple plan of a scientific workplace. As a practice for the assignment you might like to draw a sketch plan of the laboratory you are familiar with and mark on this plan all of the services, furniture and large pieces of equipment that are there. Add on to this all exits and other doors to preparation or store rooms and then locate safety items such as fire blankets, eyewash bottles, etc. that may be there. This will help you to attain **P3**.

Find out what different pieces of equipment are required for a named type of specialist laboratory and what they are used for to help you reach **M3**.

Putting all of the information you gathered for **M3** into a professional report that could be shown to the management of your company to encourage them to give you the grant that you require will help you reach **D2**.



PLTS

Independent enquirer, Creative thinker, Reflective learner and Self-manager

You will develop these skills by researching, creating a scenario, using several sources to reach a conclusion and completing work to standard and deadline



Functional skills

ICT

You will develop your ICT skills by finding and saving information for later use, bringing together information to suit a purpose, presentation of information

2.3 Storage and management of information in the laboratory

In this section:



Key terms

Data protection – the 1998 Data Protection Act was passed by Parliament to control the way information is handled and to give legal rights to people who have information stored about them.

In the course of work being carried out in a laboratory, large amounts of information will be produced. It has become increasingly important for data to be stored so that they can be retrieved at a later date.

Can you think of some reasons why data might be needed, possibly some time after the work has been completed?

Storage of records has changed enormously since the computer arrived in the workplace. In most



Data storage nightmare!

organisations large boxes or filing cabinets of documents have been replaced by hard drives and disks containing the vast majority of data.

Benefits of computer storage

- The amount of space required for computer storage is much smaller than the space required for paper storage.
- Computer storage is less of a fire risk than large amounts of paper.
- Computer records can be searched very quickly.
- If records have to be accessed from a number of sites, a computer system allows this without paper records having to be copied and sent to different locations. This saves time and removes the risk of them getting lost.
- Records can be updated quickly and there is less chance of technicians using out of date information.

The data that might need to be stored in a laboratory could fall into one of several categories:

- data produced from research carried out in the laboratory
- data about staffing levels
- personal data about members of staff, etc.
- data about resources/equipment.

All types of data will need careful management if they are to be kept safe, secure and be available at a later date.

Did you know?



In health-related organisations information stored from different outbreaks of disease such as 'flu (influenza) could help to prevent pandemics.

Many thousands of people died from 'flu in Britain following the First World War in 1919. Scientists have been trying to compare this virus with those that have caused the disease in subsequent years, going as far as trying to get lung tissue from people who died and were buried at the time. If records had been available this could have been easier. However, DNA information on the virus was not known at that time.

Data storage

Type of data	Reason to keep data	Who should record it, have access and be able to make changes
COSHH records	to ensure awareness of health and safety issues with substances being used in the organisation (see section 2.4, p.22 for more information on COSHH)	stores technicians and whoever is involved in ordering, storing and use of the substances
scientific data	in any scientific workplace it is vital to be able to safely store and then retrieve scientific data generated by that workplace and also data from other sources (scientific literature, for example)	heads of department, deputies, and those working in the laboratories
scientific apparatus	data such as date of purchase, maintenance data and schedules for maintenance	heads of department, deputies and those involved in the schedules
waste disposal	to show what and how much waste is produced and how it is disposed of	stores technicians and those involved in disposal; heads of department may need to authorise costs of disposal
health and safety checks	to show that health and safety is being monitored and to hold accident reports if necessary	heads of department, health and safety officers and possibly others who have special responsibilities
training records	to know the level of training or qualification of members of staff, and to keep and maintain a record of training required and completed by staff	training officer, heads of department, supervisors, human resource department and individual members of staff
quality assurance	to be able to show that quality procedures are being carried out (for audit purposes)	head of department, quality officers and those with special responsibility
report records	reports following tests for GPs or hospital records, or for use in developing new medicines, etc.	office support personnel will usually be responsible for recording results, with access needed by clinical staff (in a clinical environment); report records in this setting wouldn't usually be subject to change by anyone
specification levels	this could be the level at which the organisation is allowed to work, for example the danger levels of microorganisms in use	the head of department and organisation management
sample throughput	this gives information about the number of samples going through processes in the laboratory in a given time and could be an indicator of the efficiency and effectiveness of the organisation	head of department and deputies, organisation management
management	this could cover the management hierarchy and their roles	organisation management and human resources department
security	different types of laboratory might need different levels of security depending on the work being carried out	head of department, security staff, health and safety officer and all staff

With more organisations using computers to store and process personal information, there is a danger that the information could be misused or get into the wrong hands.

- Who could access this information?
- How accurate is the information?
- Could it be easily copied?

Activity 2.3A

When an organisation keeps certain types of records they will have to comply with the Data Protection Act.

What does this cover and how might it be relevant in the science laboratory?

Use the website detailed below to produce a summary.

ICO – Data Protection Act

- Is it possible to store information about a person without the individual's knowledge or permission?
- Is a record kept of any changes made to information?

How might the storage of data be different on a computerised system and a manual system?

Look again at the list of the different types of data that might be stored and consider how a computer system might be used to store the same information. Think about the benefits of using a computer compared with a manual system.

Many laboratories have bought a Laboratory Information Management System (LIMS) which is like an electronic filing cabinet. The system allows

laboratories to input data in the form that they need in order to use it and they can customise the system so that they can input information relevant to their organisation.

The LIMS can store text and graphical documents and can use the data to produce relevant information such as investigation results. It can also be used to monitor good laboratory practice by, for example, monitoring sample collection, testing, quality assurance and outgoing results.

The system can alert the laboratory of incoming samples so that when they are received into the laboratory they can be bar coded and devices can be used to generate labels for quick error-free processing. A hand-held device can be used to enter the samples onto the LIMS. The sample can then be put through the testing procedure with minimal work for the technical staff.

The LIMS can also be used to monitor stock levels so that ingredients or products do not fall below safe levels for the company to continue working.

Depending on the organisation and how sophisticated the LIMS is, much of the laboratory documentation can be taken over by the system.

Assessment activity 2.3

D3 P4 M4

BTEC

- 1 You run a small biomedical laboratory. Your main work comes from clinics run by local GPs. You have to be ready for the samples to arrive as you need to send back results quickly or your laboratory will not get paid. Using the information given above describe the processes required for the information to be put onto the LIMS and results to be sent. **P4**
- 2 Explain the different processes involved in storing information. Why are these processes necessary? **M4**
- 3 You are the senior technician in an expanding laboratory. You have been using a manual system for holding information and data but you now believe it is time to update and you have been looking into the use of LIMS.
Research a LIMS and using this information produce a presentation to give to the management of your company to encourage them to give you the funds to buy and run this system. **D3**

Grading tips

For **P4** put yourself in the place of the person in charge in the scientific workplace and suggest what type of procedures could be used.

For **M4** show a process that you would follow to store various types of information. Think about who should have access.

For **D3** the scenario gives you the opportunity to research a real LIMS and you could use the information made available by the companies who produce a LIMS in your presentation. Remember not to copy the website, but you can use some of the information as quotes as long as you don't forget to show your sources.

2.4 Safe working practices in the laboratory

In this section:

D4 **P5** **M5**

Key terms

Risk – a situation involving exposure to danger.

Risk assessment – an investigation of the risks involved with a certain procedure and whether there is a safer alternative.

Laws – a collection of rules according to which a country is governed.

Regulations – rules or orders.

Carcinogen – an agent or substance that has been suspected of causing or increasing the risk of cancer.

Mutagen – an agent such as a chemical, ultraviolet light or a radioactive element that can induce or increase the risk of genetic mutation in an organism.

Teratogen – a drug or other substance capable of interfering with the development of the fetus (unborn child), therefore causing birth defects.

You have already seen in the laboratory there are practices and procedures that are carried out on a regular basis as the work of the laboratory requires. These will have been built up over a period of time, changed and perhaps changed again as equipment and techniques have evolved. They will have been assessed for their **risks** each time a change has occurred.

The practical work that you carry out in school or college will have been assessed, using a **risk assessment**, to see if it is safe for you to carry out with the level of knowledge and experience you have at the moment. This may have been done by a member of the technical team before the practical requirements are prepared for the class. The aim of the assessment is to minimise the risks. However, accidents can still happen, even in the most safety conscious workplace.

As part of your scientific practical work in class you will have produced your own risk assessment before commencing your work.

Labelling

It is important that common hazard labels are recognised and used when handling chemicals and other substances.

Tankers carrying toxic chemicals have large labels on the side giving details of the substance being carried and the way to deal with it in case of accident or spillage.

When substances are transferred from their original container and put into smaller containers for laboratory use, all labelling must be carried over, including the substance name and its hazard if it has one. Orange sticky labels are available for putting on containers with labels stating the content of the container.



Common hazard labels found in the laboratory.



Hazard sign on a tanker carrying hazardous chemicals.

Activity 2.4A

Look at the hazard labels shown on page 20. The hazard labels shown are:

- Toxic
- Oxidising
- Extremely flammable
- Harmful
- Very toxic
- Corrosive
- Highly flammable
- Irritant
- Dangerous to the environment
- Explosive.

Draw the symbol, add the correct label and explain what the symbol means in more detail. Give a chemical example for each category.

Sources of information

The data required for the labelling of substances can be taken from several sources of information.

In schools and colleges, CLEAPSS hazcards will give the potential hazards, as well as information for the technical staff who might be using more concentrated chemicals to prepare dilute solutions for the class.

In the workplace, chemical manufacturers will produce data sheets giving all of the relevant information for their products' use. These can be found on websites for the manufacturers or suppliers or alternatively on

discs that the manufacturer supplies that can be also used for ordering supplies.

Hazard data sheets will give details such as what to avoid when using the substance, exposure limits and any specific hazards, such as the substance being a **carcinogen**, a **teratogen** or a **mutagen**.

Safe working practices

A lot of the procedures and practices that were investigated in section 2.1 of this unit will have health and safety implications.

Risks can be minimised by using personal protective equipment (PPE) and/or other pieces of equipment such as fume cupboards or laminar flow cabinets, as well as ensuring that staff use safe procedures when handling substances.



PPE must be suitable for the situation.

Activity 2.4B

Use the list of PPE below to say what each one might be used for in various types of laboratory.

Laboratory coat	
Protective gloves	
Goggles	
Visor	
Protective shoes	
Protective glasses	
Fume cupboard	

Regulations and legislation

As well as laboratories' own safety standards, there are many organisations that keep a check on laboratories to make sure they are maintaining the standards required for their particular scientific area and that the staff who work there are not put at risk.

The people who use the products or services supplied by the scientific workplace are also protected by other organisations, as is the environment around the workplace.

There are **laws** and **regulations** in place to monitor all types of scientific work in factories, in the field and in laboratories themselves.

Health and Safety at Work Act

This is the law that most people have heard of. It covers all aspects and areas of the workplace. It is important when investigating or using this law that you look at the most up-to-date version, as parts of it are updated to meet current standards.

All workers are made aware of this law in posters which explain the basics. The 'Health and Safety at Work' poster should be displayed somewhere in the workplace.

There are many regulations and laws that have to be obeyed in the workplace.

Some of these are made by the Health and Safety Executive (HSE). Their purpose is to 'prevent death, injury and ill health to those at work and those affected by work activities'.

Organisations with more than five employees have to produce a 'Health and Safety Policy' document. The HSE oversees this document which sets out the general approach, objectives and the management of health and safety in the business. To do this they oversee the following processes:

- 1 Writing the policy
- 2 Assessing risks
- 3 Providing facilities
- 4 Training workers
- 5 Consulting workers
- 6 Displaying Health and Safety at Work posters.

The HSE work in conjunction with many other agencies to ensure that all aspects of health and safety are covered in a common way.

The HSE have their own laboratories with scientists and technicians researching the problems seen in different types of workplace.

Health and Safety Law
What you need to know

All workers have a right to work in places where risks to their health and safety are properly controlled. Health and safety is about stopping you getting hurt at work or ill through work. Your employer is responsible for health and safety, but you must help.

What employers must do for you	What you must do	If there's a problem
1 Decide what could harm you in your job and the precautions to stop it. This is part of risk assessment.	1 Follow the training you have received when using any work items your employer has given you.	1 If you are worried about health and safety in your workplace, talk to your employer, supervisor, or health and safety representative.
2 In a way you can understand, explain how risks will be controlled and tell you who is responsible for this.	2 Take reasonable care of your own and other people's health and safety.	2 You can also look at our website for general information about health and safety at work.
3 Consult and work with you and your health and safety representative in protecting everyone from harm in the workplace.	3 Co-operate with your employer or health and safety representative.	3 If, after talking with your employer, you are still worried, phone our helpline. We can put you in touch with the local enforcing authority for health and safety and the Employment Medical Advisory Service. You don't have to give your name.
4 Free of charge, give you the health and safety training you need to do your job.	4 Tell someone (your employer, supervisor, or health and safety representative) if you think the work or inadequate precautions are putting anyone's health and safety at serious risk.	HSE helpline: 0845 345 0055 HSE website: www.hse.gov.uk
5 Free of charge, provide you with any equipment and protective clothing you need, and ensure it is properly looked after.	10 Work with any other employers or contractors sharing the workplace or providing equipment (such as agency workers), so that everyone's health and safety is protected.	Fire safety: You can get advice on fire safety from the Fire and Rescue Services or your workplace fire officer. Employment rights: Find out more about your employment rights at: www.direct.gov.uk

Your health and safety representative:
Other health and safety contacts:

HSE Health and Safety Executive

The Health and Safety at Work poster.

Did you know?

The HSE's main laboratory is set in 550 acres, with over 350 highly qualified staff.

For example, 'Health and Safety and the Healthcare Sector' is a part of the HSE where, although clients work in different areas of the health service, they all have one common aim. This is to improve patient and worker safety. They work closely with hundreds of occupational health companies providing support and a wide range of analytical services. For instance, they monitor the survival and spread of resistant microorganisms in the hospital environment.

HSE inspectors carry out visits to fact find, monitor and advise on situations concerning health and safety.

COSHH regulations 2002

COSHH stands for Control of Substances Hazardous to Health.

These regulations aim to control exposure to chemicals and protect workers' health.

COSHH research and publish data giving the amounts of chemicals or length of time workers can be exposed to chemicals before they are endangering their health.

Action to be taken when incidents do occur

However well an organisation is run, illness and accidents can still occur. This is where the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995 (RIDDOR) are used.

Employers have a legal duty to report ill health, accidents and also accidents which did not quite happen (or a near miss as it is sometimes called). As part of this procedure the employer must keep a register of all accidents and near misses so that they can look at the way they work to see if changes can be made to make the workplace safer. HSE inspectors will also need to see this documentation if an incident occurs.

Activity 2.4C

Using this government website, access the form for reporting accidents:

Health and Safety Executive - forms

Print the form and complete the details required as if you were the person who was a witness to an incident. Use your imagination and the information you have about laboratory work.

In the event of an accident, details must be logged in the organisation's accident book. On the government website of the Health and Safety Executive (HSE) there is a set of forms that can be used in the event of an accident. Further information on RIDDOR can also be found there.

Standards

As well as laws there are regulations and standards. Laws must be enforced in all workplaces, however, each type of laboratory will have laws, regulations and standards that are specific to them.

UKAS regulations – United Kingdom Accreditation Service

UKAS is 'the sole national accreditation body recognised by the government to assess, against internationally agreed standards, organisations that provide certification, testing, inspection and calibration services.

Accreditation by UKAS demonstrates the competence, impartiality and performance capability of these evaluations.'

This means that, if UKAS agree, the organisation can show that it is working to internationally agreed standards.

UKAS is a non-profit distributing company and it deals with testing, calibration laboratories, certification bodies, proficiency-testing schemes and medical laboratories.

Quality standards

Many of these standards are monitored by the British Standards Institution (BSI). Certification demonstrates to customers, competitors, suppliers, staff and investors that industry-respected practices are in use.

Many of the quality standards are prefixed by 'ISO'. Other commonly used prefixes include:

BS – this is a British standard and is mostly used in the UK

EN – this is a European standard and is used throughout Europe

ISO – this is an international standard and may be used throughout the world.

BS compliance shows that the organisation is working to the standards set by the British Standards Institution.

What is a 'standard'?

The BSI (British Standards Institution) website states that: 'A Standard is an agreed, repeatable way of doing something. It is a published document that contains a technical specification or other precise criteria designed to be used consistently, as a rule, a guideline, or a definition.

Standards help to make life simpler, and increase the reliability and the effectiveness of many goods and services we use.'

Did you know?



Standards are designed for voluntary use and do not impose any regulations. However, laws and regulations may refer to certain standards and make compliance with them compulsory.

An example is the size and shape and layout of credit cards. Standard BS EN ISO/IEC 7810:2003 defines their physical characteristics. Adhering to this standard is one of the reasons why the cards can be used worldwide.

A further example is ISO 14001. The ISO 14000 family covers issues relating to environmental management and BS EN ISO 14001 helps an organisation to:

- understand the impacts on the environment caused by its activities, and to
- achieve continual improvement of its environmental performance.

BS EN ISO IEC 17025 is a standard that deals with testing and calibration. It contains all the requirements that testing and calibration laboratories have to meet if they wish to demonstrate that they operate a quality system, are technically competent and are able to generate technically valid results.

Standards for international trade

As international science cooperation, trade, travel and communications increase, international standards are used to enable products to be traded across Europe



The BSI Certification mark is awarded to businesses demonstrating best practice in management systems, e.g. quality management (ISO 9001) or environmental management (ISO 14001). The Kitemark is awarded by BSI to products and services that have been tested against the requirements of a standard to show that they are safe and fit for purpose. The Kitemark is owned by BSI which means that only BSI can award it.

and worldwide. Standards are an important tool in removing barriers to international trade.

Standards can cover:

- quality
- environment
- sustainability
- information security and governance
- risk
- food safety
- occupational health and safety
- energy management
- testing and calibrating
- manufacturing
- services
- materials and chemicals
- building and construction
- electrotechnical matters
- protective equipment
- information and communications technology.

Good Laboratory Practice and Good Management Practice (GLP and GMP)

This is part of a quality assurance procedure which is aimed at ensuring that products are consistently manufactured to a quality appropriate to their intended use. They provide guidelines for quality control and assurance in testing laboratories.

Particular standards are required here as, unlike other goods that can be taken back if faulty, if medicines or drugs are not of good quality, they could have already caused damage to the patient before the problem is detected.

Compliance regulations

Medicine and Healthcare products Regulatory Agency (MHRA)

A government agency with responsibility for standards of safety, quality and performance. Involved with clinical trials and approval of products. Good Clinical Practice (GCP) is part of the Inspection and Standards division of MHRA.

European Medicines Agency (EMA)

Relates to medicines for human use and deals with regulation of medicines based on objective, scientific assessment of their quality, safety and efficiency.

Herbal Medicine Products (HMPC)

This is a part of the EMA that deals with herbal and traditional ingredients and products.

Food and Drug Administration (FDA) US

As many of the medicines and drugs we use are manufactured in the US by US companies, these regulations will have an impact on the medicines and drugs we can use.

Assessment activity 2.4

P5 M5 D4

BTEC

- 1 Investigate the safe working practices in a particular scientific workplace and make bullet point notes on them. **P5**
- 2 Explain the reasons why current regulations and legislation are required in the scientific workplace to ensure safe working practice. Use examples to show how things can go wrong if these regulations are not followed. Examples must be real and can be taken from the Internet, journals or the news. All sources and quotes must be acknowledged. **M5**
- 3 You are to take the role of a scientific journalist who has been given the task of writing a report for a national newspaper following accidents and allegations that health and safety are not being taken seriously in Britain's scientific workplaces. You should choose a scientific workplace and find out all of the legislation that is relevant for that workplace. **D4**

Grading tips

For **P5** you might like to look at a few health and safety documents from organisations carrying out scientific work. Don't forget to use bullet points and keep to the requirements of the task.

For **M5** give brief details of the regulation or legislation you are talking about. Think carefully about what could go wrong in a particular situation.

You will have to have an understanding of each of these types of legislation if you are going to reach **D4**. It would be useful to use headings such as 'Why is risk assessment carried out?' and then go on to explain how the organisation you are investigating is or is not doing as it should. Consider the consequences of not following regulations in your evaluation. Use your imagination. It is essential that, when considering legislation, rules and regulations, the most up to date information is used.



PLTS

Independent enquirer, Creative thinker, Reflective learner and Self-manager

You will develop these skills by researching, creating a scenario, using several sources to reach a conclusion and completing work to standard and deadline



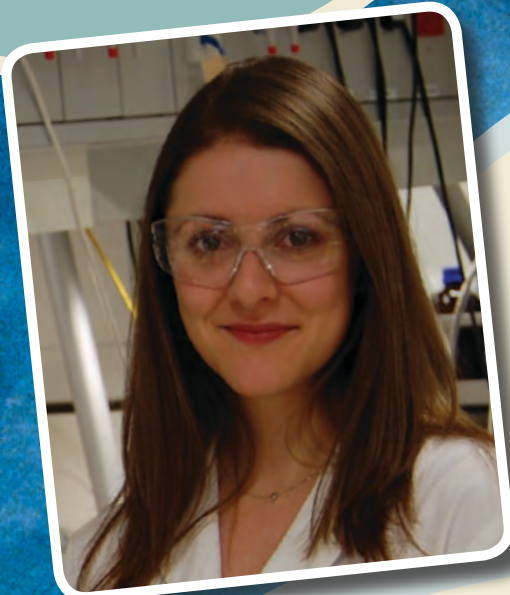
Functional skills

ICT

You will develop your ICT skills by finding and saving information for later use, bringing together information to suit a purpose, presentation of information

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I work as an analytical chemist in the Analytical Technologies group at Lilly, which is part of Discovery Chemistry. I develop analytical and purification methods using chromatography to purify compounds before they go through to biological testing. I've been at Lilly since I was 18.

On a typical day I have to check the submission system to see which samples need to be run, and talk to the chemist about their submission. Then I will either start developing a method so a sample can be purified, or I will start purifying a sample. I have to multi-task so I can get as many samples run during the day as possible, without losing any quality.

Sometimes I have meetings or courses with the rest of my department, or with external visitors, or I could be involved with projects that are to do with something other than chromatography.

The things I like best about my job include the fast pace of work, the variety, and the opportunities I have been given. I completed a chemistry degree part time through the company. Also, knowing I may contribute to a project that creates a new drug to combat a disease state is very rewarding.

Yesterday, one of the samples didn't behave as expected when I started purifying it. I realised there was a problem with the chromatography instrument. I had to work out what the problem was by checking parts of the instrument, such as the pumps, and then speak to an engineer from the instrument manufacturer to order a spare part so I could fix the fault. I needed to make sure the manufacturer had the right information so they could send the correct part and minimise downtime, and also tell the chemist that the purification of their sample would be delayed.

Think about it!

- Why is chromatography such an important part of analytical chemistry?
- Why is it important for an analytical chemist to know something about the instruments they use?

Just checking

1. Why are some procedures and practices appropriate and important in some areas and not in others?
2. Why is communication in many forms in the workplace essential for effective, efficient and safe working?
3. What has a great impact on the efficiency and safety of the people working there?
4. Do you remember which rules and regulations in the workplace are laws and which are not?
5. Who is responsible for safety in the workplace?

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Assignment tips

To get the grade you deserve in your assignments remember to do the following:

- Work on the tasks required for the pass criterion. You should be given lots of information to help with the pass tasks. If the merit and distinction work follows on, work to complete to the highest level of which you are capable. Read the information that you are given and do what is required.
- To achieve merit and distinction criteria you will be expected to do more of the work by yourself. Research is fundamental and a variety of websites and text books for the topic is essential to provide further information. Make a note of websites you have used and include them in your references section. Many sites provide valuable links which should be explored. Specific scientific sites and journals are important and can give some in-depth information for the merit and distinction grades.
- When researching websites only use information that you understand and do not just copy and paste information from specialist sites.

Some of the key information you'll need to remember includes the following:

- Specialist laboratories will have their own set of procedures and practices which they will have to observe to be allowed to continue their work.
- Communication is critical in the laboratory and between laboratories and outside agencies to allow the vital flow of information. Communication can help prevent serious breaches of health and safety rules.
- The design of the scientific workplace can have a positive or negative effect on the people who work there. Consideration of many aspects must be given to make the workplace a safe and pleasant place to work.
- Laboratory information, test results and staff information must be managed and stored correctly, safely and securely to avoid the information being lost or corrupted. Modern methods will include computer storage often using purpose-designed programmes.
- Each scientific workplace will have their own hazards and the safety rules will be designed to prevent damage to the work force, buildings and equipment and the outside environment.

For more information on ...	Visit:
Equipment in use in school and college laboratories	CLEAPSS Website. Contact your tutors for access details.
Consumables	The Association for Science Education
These websites will show up-to-date supplier websites:	Laboratory News – The Scientist’s online newspaper
	MedLab News
	Laboratorytalk
	Supplier websites
Procedures and practices	Institute of Biomedical Science
Different branches of science have their own websites outlining the work carried out by their members	Royal Society of Chemistry
	Institute of Physics
	Society of Biology
Disposal of waste	CLEAPSS website. Contact your tutors for access details.
Laboratory design	Computer packages for design
	CLEAPSS website. Contact your tutors for access details.
	CLEAPSS G14 Designing and Planning Laboratories
	The Association for Science Education
Laboratory Information Management Systems	STARLIMS
	Accelerated Technology Laboratories Inc.
Health and safety	Government websites
	Health and Safety Executive - forms
Quality control	British Standards Institution
British Standards	