The Association for Science Education
Promoting Excellence in Science Teaching and Learning
ASE Health & Safety Group

Topic 14: Living Organisms

This *Topic* (dated April 2017) is an updated version of *Topic 14*, which appeared in the 3rd edition of *Topics in Safety* (ASE, 2001). Most changes are within section 14.4 and the Appendices.

14.1 Introduction

Ask science teachers or students what is meant by the term 'biology' and it would be surprising if they did not respond "the study of living things", or something similar. And yet, in many schools, investigations involving *living* organisms, especially animals and microorganisms, are relatively rarely encountered. Practical biology is often reduced to simple enzyme studies or activities with seeds, seedlings or adult flowering plants. Students rarely have the opportunity to experience first hand the behaviour, growth and physiology of an extensive range of organisms. Even practical activities involving the students themselves as the subjects of investigation are often restricted or absent. Without a wide variety of living organisms occupying a central role in the science curriculum, it is impossible to teach biology properly.

Several reasons are often cited for the absence of living organisms in biology teaching. These include, with varying degrees of justification:

- limited finances and reduced amounts of technician support, especially during holiday periods,
- moral objections to keeping animals in captivity,
- difficulties in ensuring the welfare and humane treatment of animals in the laboratory,
- legal restrictions on experiments involving animals, as stipulated by the *Animals (Scientific Procedures) Act* (but note that this defines 'animals' only as *vertebrates* and *cephalopods*),
- prohibitions on the collection of animals and plants from the wild, as controlled by the *Wildlife and Countryside Act* (but note, it is only endangered species, not common organisms, that are fully protected), and
- restrictions caused by health and safety considerations.

This collection of *Topics in Safety* is not the vehicle for a discussion of the first five issues listed above. However, teachers and technicians often report that, on grounds of health or safety, activities involving the keeping or using of living organisms have been abandoned. However, there is often little real justification for such curtailments. Many of the widely-held beliefs of health and safety restrictions are complete myths. Even when there is legitimate concern for health or safety, the adoption of simple precautions can often permit an activity to take place. Nevertheless, some of the restrictions in biology teaching may have been elevated to the status of a ban by an employer, most often a Local Authority but sometimes a governing body of, for example, an academy, independent school or FE college. Such official instructions not to keep a particular organism or carry out a specified procedure must be obeyed, though they *should* be challenged if they are thought to be unreasonable.

So, what are the health and safety fears that have contributed to an impoverishment of biology teaching in many schools and how many of such fears are justified?

14.2 Hazards: real or imagined?

Listed below are the main concerns for health and safety in biology teaching.

- Infectious diseases from humans, animals, animal organs and microbiological cultures.
- Infestation by parasites.

- Allergies caused by animals, plants, spores or chemicals.
- Physiological or mental stress from investigations on pupils.
- Hazardous substances in plants, seeds or biological reagents.
- Animal bites, scratches, stings etc.

14.3 Risk assessment

Faced with such a catalogue of possible hazards, as outlined above, a common response of some teachers is to abandon a planned activity or observation in order to ensure the health and safety of pupils and/or staff. Employers, mindful of their statutory duties to ensure a healthy and safe working environment, may go further and issue instructions restricting the keeping of certain organisms or the performance of specified activities. However, the observation that an organism may cause harm in some way should not in itself be sufficient reason to 'ban' it or restrict an activity involving it. What is required is a systematic assessment of the risk that harm will occur, together with a consideration of the seriousness of the consequences. Such an approach may identify situations in which it would be unwise to proceed with the intended activity or the need to restrict it in some way. However, in the majority of cases, the risk assessment will reveal that, by adopting simple precautions, if necessary, the risk of harm occurring can be reduced to zero or an acceptably low level. Elimination of risks by banning an organism or activity is very often unnecessary and unrealistic; no aspect of life can be completely free of risk and a balanced approach to risks in biology teaching should be the only sensible strategy to consider.

The following section provides guidance on the hazards of using organisms and biological materials to help in risk assessment. Guidance on the hazards of microbiology and DNA technology can be found in Topics 15 and 16.

14.4 Guidance to assist in assessing risks for biological hazards

14.4.1 Infectious diseases

Zoonoses

These are infections transmitted from animals to humans[1]. In most schools and colleges, the risk of disease transmission from the animals likely to be studied will be very low. In the majority of cases, good hygiene after direct handling of the animals will be an effective control measure. Captive-bred, laboratory small mammals which have not come into contact with wild mammals are unlikely to carry any zoonoses. In the past, it was strongly recommended that small mammals should only be obtained from accredited breeders subscribing to schemes organised by the Medical Research Council Laboratory Animals Centre and, later, the Laboratory Animals Breeders Association, to ensure a disease-free status. However, such schemes no longer exist. Small mammals (and other animals too) should therefore be obtained from as reputable a source as possible. If a local pet shop is used, choose one that evidently maintains its animals in excellent conditions.

Because of the obvious risk of transmission of unknown diseases or parasites from *wild* mammals and birds, it is not recommended that native species of these vertebrates, found dead or alive, should be brought into schools to be studied. Injured animals, found and brought in by pupils, should be handled with care and kept isolated from other animals already in the school and arrangements made for their humane euthanasia.

---

[1] For details, refer to *The Occupational Zoonoses*, Health & Safety Executive, the Stationery Office, 1993, ISBN 0118863975. Now out of print, but available from Amazon. Other information on zoonoses can be obtained from Public Health England by searching on web browsers or from https://www.gov.uk/government/collections/zoonotic-diseases-zoonoses-guidance-data-and-analysis.

Specific zoonoses have been associated with certain animals encountered in schools or during school-based activities. ***Salmonellosis*** has been linked particularly with reptiles and even healthy animals may transmit *Salmonella* bacteria. As a consequence, Public Health England has gone as far as stating that "Reptiles are not suitable as pets in schools"[2]. The validity of this statement is currently being challenged. (If you downloaded this revised Topic some time ago, check the ASE web site for updates.) *Salmonella* may also be carried by a range of other animals, both invertebrate and vertebrate (including fish, amphibians, chickens, ducks and other wild or domesticated birds). Good hygiene is vital, with hands always being washed after handling animals or contact with their enclosures. Cleaning out animal aquaria and vivaria requires particular care. Animal material, such as hearts and lungs, that is obtained from a butcher or abattoir for dissection, may be contaminated with food-poisoning bacteria including *Salmonella*. Good hygiene is therefore required during and after the handling of such items.

Psittacosis (ornithosis) is a disease caused by the microorganism *Chlamydia*, particularly associated with birds of the parrot family, including budgerigars, and again, fears of transmission to humans have generated a variety of mythical or actual bans. In fact, the disease can be found in *all* birds, exotic, caged or wild. Transmission is usually through dust from faeces and feathers. It is highly unlikely that pupils and staff are endangered by, for example, a pair of zebra finches, particularly if the birds are healthy and have been resident for some time. Those who will be more at risk in schools are the staff who are responsible for the upkeep and cleaning out of a large collection of birds, particularly in an outdoor aviary where contact is possible with reservoirs of the disease in wild birds. Control measures involve excellent hygiene and avoiding the creation of airborne dust when cleaning out the cages or aviary. If this is unavoidable, it would be prudent to wear a dust mask able to filter out the finest particles[3].

Leptospirosis (Weil's disease) is another bacterial infection, transmitted typically by rats in their urine. This disease is potentially life-threatening, though it can be treated successfully with antibiotics, particularly when diagnosed early. However, the chance that captive-bred, laboratory rats would be carriers of the disease is extremely small. Animals obtained from a reputable source in healthy condition should not be considered hazardous in this respect. However, staff and pupils involved in pond-dipping activities, mammal-trapping investigations and other aspects of fieldwork near streams and ponds may be at risk from water contaminated by rat urine carrying the bacterium. People in schools who are most at risk are those involved in canoeing and other water sports. Control measures are, however, simple. For wild animals caught in live traps or brought into school by pupils, avoid handling them without wearing gloves (which also provide some protection against bites and scratches) and wash hands thoroughly after any activities near or on natural waters. Avoid touching the face, particularly the lips, with hands that are wet (as the *Leptospira* bacterium can enter the bloodstream through mucous membranes). Open wounds should be protected with water-proof dressings. For further guidance, see CLEAPSS & SSERC publications[4].

Cryptosporidiosis is caused by a protozoan which can be found in the faeces of many animal species, particularly those of cattle and sheep. It usually causes little more than diarrhoea and flu-like symptoms in healthy individuals but can be much more serious in those with compromised immune systems. It is most commonly transmitted by drinking contaminated water supplies but, as with Weil's disease, those coming into contact with natural waters, particularly in recreational water

---

2 This statement is included in the 2014 publication, *Guidance on Infection Control in Schools and other Childcare Settings*.https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/522337/Guidance_on_infection_control_in_schools.pdf.

3 Purchase dust masks which meet the requirements of the European standard EN149 which are marked FFP3S or FFP3SL. These will filter out airborne spores, bacteria, enzymes and other fine dusts, provided they fit well against the face.

4 PS001, *Pond dipping and Weil's disease*, CLEAPSS, March 1996; *Materials of Living Origin - Educational Uses: a Code of Practice,* SSERC, 2012.

sports, may also be at risk. Control measures are as for Weil's disease. There have been reported transmissions to children following farm visits, emphasising again the need for good hygiene after handling animals such as lambs and calves and ensuring that no food is consumed during the visit. Agricultural colleges plus the few schools that still maintain a rural studies department and keep sheep and cattle will already be aware of the need for such hygiene.

Spongiform encephalopathy in its most notorious bovine form (BSE) is thought to be transmitted by the consumption of an infectious protein, or prion, from cattle. This may have originated from a similar spongiform encephalopathy in sheep, causing a condition called scrapie that has been known about for several hundred years. In humans, the most well-known symptoms of spongiform encephalopathy are found in Creutzfeld-Jakob disease (CJD). The risk of transmission of BSE etc in science activities is virtually non-existent but this has not prevented a great deal of speculation and concern about the use, for dissection or other purposes, of any tissues from cattle or sheep. If there is a risk, it is in handling organs mainly of the central nervous system of infected animals: the brain, spinal cord and eyes. Of these tissues, only the eyes are regularly used for dissection purposes. Even government education departments admitted that the risk of transmission by handling such materials was "remote and theoretical"[5] but nevertheless recommended that the dissection of eyes from cattle should cease.

Since the first appearance of BSE, there has been much legislation to prevent the possibility of infectious prions (or other agents) entering the human food chain, including the *Specified Risk Material Regulations* and the *Animal By-Products Regulations.* These have controlled the supply from abattoirs of infective nervous tissues from cattle, sheep and goats[6]. The consequence of this is that, for educational purposes, abattoirs and butchers are now permitted to remove eyes from young cattle, sheep and goats, fit for human consumption. However, schools may find that some sources are still reluctant to supply eyes from these animals, of any age. There are no such legislative restrictions on the supply of eyes from pigs or other animals slaughtered for food, such as deer[7], llamas or ostriches. (Supplies can, however, be difficult to obtain because pig's eyes are not so easy to remove or few animals of other types are slaughtered.) If eyes (of any animal) are dissected, the normal control measures of good hygiene must always be observed.

Lyme disease is a bacterial infection, transmitted to humans by ticks which are located on ground vegetation. The reservoir of the bacteria is likely to be deer and wild rodents. In the context of science education, the disease is only likely to be of significance for those involved in field work in areas of woodland, bracken and long grass. Control measures primarily involve avoidance of exposure to ticks by ensuring that the skin is covered. Long sleeves and long trousers should always be worn when working in potentially hazardous areas. Clothing and the body should be inspected for ticks afterwards. (Schools on trips to Germany or other European destinations should note that ticks carrying a virus causing a serious form of encephalitis might be encountered in forested areas. Control measures as for Lyme disease are required. Advice can be sought from foreign authorities before trips commence.)

Other zoonoses, which are only likely to be of relevance for agricultural colleges, schools with rural studies departments and those visiting farms, include ***ovine chlamydiosis***, ***ringworm*** and ***Escherichia coli*** (strain 0157). The first is a disease of sheep causing abortions. There has been concern that pregnant females coming into close contact with sheep at lambing time may be considered at risk. This risk of abortion would make it prudent before a farm visit to warn teachers and students, who are or may be pregnant, to avoid contact with ewes and lambs. Ringworm is a

---

5 As discussed in PS002, *The dissection of eyes*, CLEAPSS, July 2009. Also in *Science & Technology Bulletin* 240. *Dissecting bulls' eyes,* SSERC, Autumn 2012; http://www.sserc.org.uk/images/Bulletins/240/SSERC bul240 p11 H_S.pdf.

6 This legislative history is summarised in CLEAPSS leaflet PS002 and SSERC *Materials of Living Origin - Educational Uses: a Code of Practice* (4.5 and Appendix 7).

7 http://www.sserc.org.uk/images/Bulletins/246/SSERC_bulletin_246_p11-12.pdf.

non-life-threatening fungal skin infection which may be transmitted from infected farm animals such as cattle, sheep and pigs. Spores enter the skin through cuts and abrasions. Covering scratches and wounds with suitable dressings and practising good hygiene after contacting farm animals are obvious control measures. The 0157 strain of *E. coli* is particularly hazardous and may be passed to humans following contact with infected farm animals and their faeces. However, as with ringworm, good hygiene is an effective control measure.

Parasites

Small mammals and birds, taken from the wild, might be infested with fleas and mites which could transfer to humans or other animals in the school. It is not therefore recommended that they should be studied in schools. Care should be taken if these vertebrates are examined during field work. Items such as old bird's nests may be similarly infested. When these are brought into school (if it is known that they have not been used for some time), if autoclaving is not possible or appropriate, they should be sealed inside a plastic bag to prevent the escape of parasites. It would also be prudent to autoclave owl pellets before they are examined, in case they contain intestinal parasites or other sources of infection.

Giant African snails have been the source of some controversy in that, several years ago, government education departments warned that these animals might be carrying a parasite that could transfer to humans, causing symptoms of meningitis. It is true that, in some Asian countries to which the animal has spread, snails may be the intermediate host of a parasitic worm that infests the lungs of rats. If the snails are then used as food by humans and inadequately cooked, the parasite may survive to infest its human host. However, it seems rather unlikely that this mode of transfer will be involved with giant African snails kept and studied in schools. Furthermore, snails bred in this country (and they are prolific) cannot be infested with the parasite as its life cycle will have been disrupted. Only animals recently imported from areas where the parasitic infestation is common could be at risk of carrying the parasite. With so many snails reproducing in this country, there must now be little, if any, demand for further specimens to be imported.

Worms that infest domesticated animals such as dogs may transfer to humans in the faeces of infected animals. Illnesses produced include hydatid disease (caused by the canine tapeworm) and toxocariasis. Risks are, however, low since the host animals are unlikely to be encountered in schools, except perhaps on playing fields or when studying in local parks, and the spread of the parasite can easily be controlled by good hygiene.

Human diseases

For a full discussion, refer to section 14.4.3.

14.4.2 Allergies

For a detailed discussion of allergic reactions caused by biological materials, refer to *Topic 13*.

14.4.3 Investigations using students

Several activities which use pupils as the subject of the investigation are often thought to be banned, and indeed they may have been by some employers. Other activities are sometimes tackled in the laboratory without careful thought about the precautions that are advisable. Investigations involving pupils are invariably motivating and therefore very useful educational 'tools' and so it would be a pity if teachers were to reject them out of hand as being too hazardous to contemplate. A major concern revolves around the use of **human body fluids and cells**, typically those taken from the inside of the mouth. The fear is that if these fluids and cells are studied, diseases such as HIV or hepatitis might be transmitted from carriers to other pupils or to staff. In 1987, government education departments advised employers against the practise of taking "(human) blood and cell samples" in schools. This resulted in most education authorities instructing teachers not to take **blood samples** or **cheek cells**. However, after 1992, with the implementation of the *Management of Health & Safety at Work Regulations* which require risk assessments for all hazardous activities in the workplace not already covered by the *COSHH Regulations*, the practice of analysing

activities for their inherent hazards, and adopting suitable control measures to ensure that investigations can be conducted safely, has become widespread. At that time, the Institute of Biology (now the Royal Society of Biology), with the support of other agencies, campaigned that cheek cells can be sampled safely.

As a result, increasing numbers of teachers and others began to question whether a widespread ban on studies of blood and cheek cells was warranted. In 1996, the DfEE changed its earlier guidance[8] for England and Wales, indicating that cheek cells *could* be sampled if the lining of the mouth is wiped with a cotton bud or other soft implement, rather than scraped, and if contaminated items are disposed of safely. Following this amendment of earlier recommendations, most employers have now altered their instructions to schools (if they had issued any), permitting cheek-cell sampling using a safe procedure[9]. Indeed, it would not be logical for employers to maintain a prohibition on cheek-cell sampling, given that the advice on which the original restrictions were made has been reversed.

The DfEE later relaxed its 1987 advice, indicating that blood samples may be taken, if permitted by the employer[10]. Several such employers now allow the taking of blood samples from students (often restricted to sixth formers), if a thorough assessment of risks has been made and that the use of a safe, sterile procedure, both for staff and for students, can be guaranteed[11].

Activities involving the study of **saliva** (typically for its amylase content) and of **urine** or **sweat** (eg, to analyse chloride ion concentrations) are also often not attempted. Sometimes this is because of the mistaken belief that there have been recommendations or instructions not to study these body fluids. Apart from in Northern Ireland, there has never been any national advice that work with these fluids should be restricted. Indeed, even the DfEE indicated that they can be investigated safely[12], if suitable precautions are taken to ensure that infections cannot be transmitted from one person to another. Nevertheless, some employers have issued instructions that these body fluids should not be investigated and these must be obeyed until the employer can be persuaded to alter its restriction. It should be noted that there have been a number of reports of staff developing allergies to commercial amylase preparations which have been used instead of saliva. Such preparations may also behave unpredictably. Further guidance on the safe study of human body fluids, is available in CLEAPSS and SSERC publications[13].

Activities involving studies of pupils' **ventilation** and **heart rates** and the influence of **exercise** are relatively frequently carried out. Perhaps because such investigations are so commonplace, they are sometimes tackled without sufficient thought about the possible adverse effects on a minority of pupils who, through peer pressures, may not readily identify themselves. What is a normal level of exercise for most people may be inappropriate for an overweight pupil or one with a medical condition. Even mild exercise might provoke an attack in those suffering from asthma. Teachers should therefore ensure that they know who all the asthmatics are in each class and should also

---

8 In Table 17.14 of *Safety in Science Education*, DfEE, HMSO, 1996.

9 Guidance on a safe procedure is given by the Institute of Biology in *Living Biology in Schools*, (Institute of Biology, 1996, ISBN 0900490322), by CLEAPSS in PS064, *Are We Allowed To…?,* CLEAPSS, October 2010 and PP033, *Staining and observing cheek epithelium (animal) cells,* CLEAPSS, September 2016, and *Materials of Living Origin - Educational Uses: a Code of Practice,* SSERC, 2012.

10 See the information in footnote reference 6.

11 Appendix 1, *Human blood sampling: recommended procedure*, provides further guidance on taking blood samples safely, including a suitable sterile procedure, which teachers will find useful if they seek their employer's approval to take blood samples from students. Further guidance is available from CLEAPSS: GL200, *Studying Blood*, CLEAPSS, October 2016.

12 See the information in footnote reference 6.

13 GL204, *Studying Human Saliva and Urine*, CLEAPSS, October 2016; *Materials of Living Origin - Educational Uses: a Code of Practice,* SSERC, 2012.

identify any pupil who has been excused from taking part in PE or sports activities for medical reasons. Before any activities involving exercise are commenced, asthmatics should be privately warned to consider using their inhalers and pupils, for whom exercise would be unwise, allowed not to take part. Teachers should, however, be sensitive in their management of these investigations. By, for example, pairing up pupils so that one performs exercise while his or her partner takes readings, it is easier to protect those for whom exercise might be unsafe, without drawing the attention of a class to pupils' disabilities. It is also important to ensure that exercise does not become competitive, with some pupils over-exerting themselves. This aspect of class control is also relevant if pupils are asked to blow into a manometer to raise the height of water in a tube.

Lung-function investigations can involve peak-flow meters, measurements of lung volume using bell jars, d-i-y plastic containers or calibrated bags and hand-held or displacement spirometers (equipment with a movable chamber from which air is inhaled and exhaled). Hygiene is crucial. Peak-flow meters (which measure forced exhalation and are used to monitor the lung function of asthmatics) are usually supplied with disposable mouthpieces. For non-disposable mouthpieces, disinfection with Milton is recommended (see the information in 'Displacement spirometers' below). The use of **displacement spirometers** and **sphygmomanometers** raises special requirements. The *Management of Health and Safety at Work Regulations* require that staff are trained in the use of any pieces of hazardous equipment which include these items. Such training is best arranged in-house, for example, at a regular science department staff meeting. Full guidance on the safe use of displacement spirometers and sphygmomanometers can be found in CLEAPSS publications[14], but the main issues to be considered are discussed below.

Displacement spirometers

- *Avoiding infection from mouthpieces, nose clips and corrugated tubing.* This will involve adequate disinfection, allowing sufficient time. 'Milton' is very effective and recommended but takes 30 minutes; ethanol is quicker (5 minutes) but leaves an unpleasant taste, so rinsing with water is essential (though not always very effective). The internal surfaces of tubing should be disinfected, if possible, with 70% ethanol for 10 minutes before the spirometer is stored after use.
- *Ensuring that there is an adequate supply of oxygen to maintain normal body functions.* Oxygen will be quickly exhausted if the spirometer is only filled with air, so it is customary to fill the spirometer with pure oxygen if more than a few breaths are to be taken when connected to the equipment. Some schools have reported difficulties in obtaining cylinders of medical oxygen for their spirometer, though CLEAPSS advises that a cylinder of industrial oxygen is acceptable. If exhaled carbon dioxide is removed with sodalime or 'Carbosorb', the normal ventilation stimulation mechanisms which typically accompany a decrease in oxygen will not operate. Monitoring a subject's mental alertness by asking him or her to perform simple spelling or arithmetic exercises will identify the approaching reduction of oxygen in the spirometer, before it reaches a dangerous level. Avoid using smaller mesh sizes of sodalime or Carbosorb in the spirometer canister; these increase the resistance to air breathed through the chemical.
- *Controlling the time spent breathing on the spirometer*. See above.
- *Avoiding the inhalation of corrosive dust from the sodalime canister*. Much dust can be removed by repeatedly pouring the absorbent from one container to another. This should be done outdoors, while facing away from the prevailing wind. At the very least, ensure that the valve is fitted correctly so that air is *not* breathed in through the carbon dioxide absorbent.
- *Avoiding respiratory distress induced by excessive exercise while breathing on the spirometer*. Older designs of spirometer have smaller-diameter tubing than is now used.

---

[14] Refer to the guidance in GL201, *Breathing Investigations*, CLEAPSS, October 2016 and *CLEAPSS Laboratory Handbook,* 1992, sections 15.11 and 15.12.

This offers greater resistance to air breathed in and out. With such models, levels of exercise may need to be restricted to prevent 'fighting for breath'.

- *Choosing a healthy volunteer to breathe on the spirometer*. Someone who plays in a school sports team is unlikely to have any medical problems which might be exacerbated by using the spirometer.

Sphygmomanometers

- *Controlling the time when blood does not flow to the tissues*. When the sphygmomanometer cuff is inflated around the upper arm, blood flow to the extremities of the arm must not be cut off for longer than is needed to record the blood pressure.
- *Avoiding making medical diagnoses*. It is all too easy to make a pronouncement on a seemingly abnormal blood pressure reading. However, the sphygmomanometer may not have been operated correctly and there are several factors that can elevate or otherwise influence the blood pressure measurements. These include previously smoking a cigarette, having recently taken exercise, the position of the arm relative to the heart during a measurement and constriction around the upper arm caused by sleeves rolled up. A sphygmomanometer must therefore only be used to teach about the *principles* of blood pressure regulation.

Science departments invariably have a 'no-eating and drinking' policy for pupils working in all laboratories. However, it is not uncommon for teachers to conduct **taste-testing investigations**, for example, to map the 'taste-sensitive' areas of the tongue, in a laboratory without thinking about the risks or how this undermines the normal laboratory rules. Such work is best done in a food technology room, canteen or equivalent area where hygiene can be assured. If a laboratory *really* has to be used, it should be clear to the pupils how exceptional the circumstances are. The very strict hygiene precautions[15] that must be taken should be *seen* to be taken, ie, washing down/ disinfecting benches to remove any discarded or spilt chemicals or microorganisms and the use of disposable paper or plastic utensils (normally *not* laboratory glassware), straws, swabs etc.

14.4.4 Use of hazardous chemicals

These are encountered in a variety of ways in biological investigations. When the use of harmful or irritant chemicals in an investigation is contemplated, they are rarely considered sufficiently hazardous to warrant restricting the activity. Corrosive chemicals are treated with greater caution but **toxic chemicals** often provoke an extreme response, perhaps with a decision taken to abandon the activity involving them. This may, of course, be a legitimate action following a full risk assessment. However, adopting suitable control measures, such as modifying the procedure or wearing eye protection and gloves, could often allow the activity to continue. In many cases, worries about the effects of toxic chemicals on *pupils* are an over-reaction since the chemical will often be diluted so that it is not even classified as hazardous. Examples include the use of plant growth substances in tissue culture or the application of animal hormones such as adrenaline in animal physiology studies. However, a technician who prepares the dilution will be more at risk and control measures must be applied. Hazardous fungicides may have been used to treat seeds but these can nevertheless be handled safely wearing disposable gloves or by ensuring that hands are washed immediately afterwards.

Breeding investigations with *Drosophila* fruit flies are sometimes restricted because of the use of **ethoxyethane** (diethyl ether) as an anaesthetic. This has a narcotic action and is extremely flammable but, with good ventilation and the strict avoidance of working near naked flames, it will often be acceptable to use the chemical rather than seek out alternatives which may be less effective. However, chilling fruit flies by placing them in a refrigerator and then examining them on freezer blocks can be a successful alternative strategy. Another genetics investigation involves the tasting of the chemical **phenylthiocarbamide** (PTC) [also known as phenylthiourea (PTU)]. An ability to

[15] See GL209, *Hygiene when teaching science*, CLEAPSS, October 2016.

taste this substance is genetically controlled and there is a fixed proportion of the population that inherits the allele for tasting PTC. However, the chemical is toxic, generating the widespread belief that its use is not allowed. It may seem bizarre to suggest that tasting a toxic chemical is quite permissible, but we regularly do this, eg, with caffeine, when drinking coffee or cola drinks. Provided the amount tasted is sufficiently low, there will be no toxic effects. With PTC-impregnated papers, purchased from educational suppliers, the dose is strictly limited to a safe level. Schools should no longer attempt to prepare their own PTC papers by soaking filter paper in PTC solution[16].

When the hazardous chemicals are part of the armoury of plants and animals, however, it is not uncommon for concerns to escalate to unwarranted, extreme heights. It is recognised that there are many species of **poisonous plants**[17] commonly found in gardens, school grounds etc, but it is often only certain parts that accumulate toxins and simply handling the materials carries no risk. Even if poisonous parts of a plant are eaten, for many species, significant quantities need to be ingested before ill effects are experienced. As an example, for the castor oil plant, the seeds contain quantities of ricin. This is one of the more-potent plant toxins. Case histories have shown that, on different occasions, young children have consumed between three and twelve seeds and suffered fatal effects. Doses would probably need to be higher for older pupils to consume lethal amounts. In assessing the risks of using castor oil seeds in school, teachers need to consider the likelihood that their pupils would have the inclination and the opportunity of eating a sufficient quantity of seeds during practical work. Similarly, the fears expressed by teachers about the poisonous wild plants that often grow in a natural wildlife garden can often be allayed after a careful analysis of the actual risks of plants being eaten.

Some species of animals also use toxins for attack and defence. Those which produce particularly potent **venoms** such as many species of poisonous snake are subject to the requirements of the *Dangerous Wild Animals Act* and cannot be kept and handled without a licence. Such animals will not be encountered in schools. Other animals, including various species of insect and arachnid, produce venoms and consequently are regarded with deep suspicion. **Tarantula spiders** kill their prey by injecting poisons and some teachers question their suitability for studies in schools. However, many species are unlikely to bite humans and, even if they did, the effects of injected venom are not usually extreme. There is therefore no reason, on the grounds of their dangerous behaviour, why such animals should not be kept in schools. It is, however, recommended that they are *not* regularly handled as their sharp body hairs may produce an allergic reaction or enter the eye and the welfare of the animals is improved if they are left undisturbed. A hive of **honey bees** would make a valuable addition to many school grounds but teachers regularly express concerns of the dangers of pupils being stung[18]. In fact, pupils are less likely than adults to suffer any distress if they were to be stung, which is not likely to occur unless a colony is vandalised. A large number of stings would normally need to be made to induce a serious toxic effect. A very small minority of pupils, however, are hypersensitive to bee stings and suffer an allergic reaction but their presence in a class would normally be known. Common-sense respect for a colony of bees is more appropriate than an inordinate fear of its dangers. The CLEAPSS publication provides guidance on hive location & management and risk assessments. One final example is the **Florida stick insect**, or two-striped walking stick, which may spray an irritant chemical when handled. The eyes are most at risk but sensible precautions will protect the handler from harm.

---

16 See CLEAPSS publication SRA 025, *Taste tests: PTU (phenylthiourea) / PTC (phenylthiocarbamide) Strips*.

17 For details of which plants are poisonous, refer to *Poisonous Plants and Fungi in Britain: Animal and Human Poisoning*, M R Cooper and A W Johnson, the Stationery Office, 2nd edition, 1998, ISBN 0112429815. The Royal Horticultural Society www.rhs.org.uk provides a list of harmful garden plants; search with keywords 'poisonous plants'.

18 See PS087, *Bees and beekeeping in schools*, CLEAPSS, December 2009.

Appendix 1 Human blood sampling: recommended procedures

A. Introduction

A.1 Why study blood?

In the study of human blood, a part of many biology courses, it is important that the blood is shown to be a composite liquid containing several different components, including red cells. Aspects of physiology, including the determination of blood groups, clotting time and measurements of blood sugar levels, are also very valuable and suitable topics for practical studies. Most students are fascinated by such work and eager to look at blood smears under the microscope, determine their blood groups and so on. However, there are difficulties in obtaining blood samples, even the drop or two required for such activities.

Some establishments have found it possible to obtain time-expired blood from a local hospital or blood bank of the National Transfusion Service. (The latter is more likely to be willing to supply red cells from time-expired blood suspended in saline, which will not be suitable for all investigations.) However, it is more exciting and in some cases more appropriate for students to study their own blood; hence the need for this guidance. (Precautions 2, 3, 4, 10, 11, 12, 13 and 14 of the Sterile Procedure (Appendix 2) apply if time-expired blood or red cells are used.)

A.2 The risks involved

Wherever blood samples are taken, whether in a hospital clinic or in an educational establishment, there is a slight possibility of transmitting blood-borne viruses, the most significant being human immunodeficiency virus, HIV (the cause of AIDS) and hepatitis viruses B and C. However, blood-borne viruses are only transmitted if blood from a carrier or infected person infects another person via, say, a scratch in the skin; the key control measure is that a student only studies his or her own blood. **There is no significant risk if the correct sterile procedure is fully carried out in taking a blood sample**.

With the implementation of the Management of Health and Safety at Work Regulations in 1992, the principle was established of assessing risks before any hazardous operation is begun. Teachers who wish to allow their students to take blood samples safely have argued that they can control the circumstances in which the procedures are carried out so that all suitable precautions are taken to ensure that there can be no possibility of disease transmission. The guidance given in these notes can form the basis of the required sterile procedures that must be used.

B. Procedure

B.1 Assessing the risks

Education employers which have issued instructions that blood samples must not be taken in their establishments will have informed teachers of this restriction. Teachers must take into account the maturity and behaviour of the students involved and appraise their ability of ensuring safe working. Appendix 2 provides the sterile procedure to be adopted.

B.2 Precautions to be taken

Teachers must ensure that students fully understand the precautions that must be taken and the possible consequences of not taking them. This is valuable as a contribution to general education as well as essential for blood sampling to be safe.

Any students or staff who know that they are HIV-positive or have tested positive for hepatitis B and/or C viruses should not give blood samples. Procedures must be such that affected students can be excluded from, or allowed to opt out of, the sampling activity without having to admit publicly that they have tested positive for HIV or hepatitis. Confidentiality must be preserved at all times. Teachers and lecturers need considerable skills in managing such situations. As many as 2-3% of

students in some areas may be hepatitis B and/or C positive but their identity in a group will often not be known to teaching staff. It should be made clear to students that they must not take part if they have good reason to believe that they may pose a particular risk to others. At the same time, however, the teacher or lecturer should allow students to decline to take part without in any way drawing attention to any possibility of infection; see B.3 below.

B.3 Student participation

There must be no pressure on a student to give a blood sample. Teachers should make it clear by their attitude that it is perfectly normal for some students not to want to have a sample taken and not to want to take any part in the work involved. If this is done well, it is likely that such students will gradually become involved in the work. Students should be allowed to change their minds either way.

B.4 Parental permission

For students below the age of 16, it is prudent to obtain the permission of parents or guardians, well in advance. This may also be considered advisable for post-16 students. A suitable form is given in Appendix 3.

B.5 Who takes the blood samples?

The teacher must supervise the activity closely but students will take their own samples of blood. The use of an automatic finger-lancing device (see Appendix 4) is strongly recommended. The teacher assembles the instrument with a fresh lancet and then hands it to the student who simply presses the device onto the skin and triggers the lancet. The instrument is handed back to the teacher who then disposes of the lancet safely (see Appendix 2).

B.6 Suitable sites for taking blood samples

Blood should be taken with a sterile lancet from the side of a student's finger, near the nail, using a new lancet for each person. It is not recommended that blood is taken from a finger tip because of the greater thickness of the skin at this point and the risk of subsequent infection. The ear lobe has sometimes been suggested as an alternative site but this is also not recommended because of the risk that a student will jerk his or her head as the sample is taken and the difficulty of transferring drops of blood for investigation.

The best position is 5-10 mm from the lower corner of the nail (see diagram). It is easier to insert the lancet if the finger has been crooked at the top joint.

To help ensure a sufficient flow of blood from the punctured skin, the hand should be warm (so encouraging blood flow to the skin). It is sometimes helpful to force blood to the extremities by vigorously shaking the hand or rapidly moving the arm in a circle around the shoulder joint (take care to ensure that the arm cannot hit anything!).

B.7 Care with lancets

Teachers must carefully supervise the issue, use and subsequent disposal of the lancets (using a 'sharps' container: see Appendix 4).

B.8 Sterile procedure

A sterile procedure (e.g. as in Appendix 2) must be adhered to.

Appendix 2 Sterile procedure

Before the lesson

1 Slides or any other glassware which might come into contact with the site from which a blood sample is taken should be sterilised by autoclaving at 121 °C (103.5 kN m^{-2}, 15 lbf in^{-2} above atmospheric) for 15 minutes or by heating dry at 160 °C for 2 hours.

2 A suitable disinfectant, able to kill viruses, should be freshly prepared. 1% Virkon is most convenient. An alternative disinfectant is a solution of sodium chlorate(I) (sodium hypochlorite) containing 10 000 ppm available chlorine. This can be obtained by preparing a 10% dilution of a laboratory solution of sodium chlorate(I) containing not less than 10% (100 000 ppm) available chlorine. Concentrated sodium chlorate(I) is CORROSIVE. [Note that domestic hypochlorite (bleach) solutions have already been diluted, often by an unspecified amount. It is difficult to make up accurate dilutions using such sources of the chemical.]

During the lesson

3 Because of the risk of contamination through broken skin, the participation in this practical work of anyone with any sort of open wound, particularly on or near the face or hands, should be strictly limited. Depending on the nature and position of the wound, the student may need to be excluded from the work altogether.

4 Students and teachers must thoroughly wash both hands using soap and water. Those giving blood samples must pay particular attention to washing the site chosen for the sampling. Dry hands using only disposable towels.

5 Using a cotton wool swab, wipe the chosen site with 70% alcohol [70% *v/v*, propan-2-ol (isopropanol) or ethanol] and allow it to dry.

6 Remove a new sterile disposable lancet from its packet (or detach the cap over the lancet tip) immediately prior to its use. Do not allow the sharp end to touch anything.

7 Puncture the skin of the chosen site using the lancet and immediately place the lancet into a 'sharps' container. *Lancets must be used once only.*

8 Collect the blood by letting a drop or two fall in to a sterile tube or on to a sterile slide or sterile rod. There must be no contact between the area of the lancet prick and any apparatus unless the apparatus has been sterilised.

9 Apply a sterile gauze dressing to the puncture site and press gently until bleeding has stopped. Once blood flow has stopped, place the dressing in the container used for the lancets or an autoclavable bag.

10 Any blood spilt on the bench etc. must be wiped up at once using the freshly-prepared disinfectant. Hold the swab with forceps or wear suitable protective gloves.

11 The greatest care must be taken to avoid contamination of the skin with blood from another person. If this should occur, however, the contaminated area must be washed thoroughly with soap and water.

12 When students have finished with the slides and any other contaminated glassware that will be reused, these should be placed in a discard jar of the disinfectant. Note that sodium chlorate(I) is inactivated by the presence of organic matter, including blood. Sharp items for disposal should be placed in the 'sharps' container with the lancets. Non-sharp items (e.g. blood-grouping cards) should be placed in the disposal bag with the swabs and dressings.

13 At the end of the practical, wash hands again using soap and water and dry thoroughly using only disposable towels.

After the lesson

14 The disposal bag with the contaminated swabs, etc, should be closed, not sealed, and autoclaved; it is then sealed and placed in the normal refuse. The slides and other contaminated glassware from the discard jar should also be autoclaved, wearing gloves to protect the skin from

the disinfectant. The slides can then be washed for reuse (particular care must be taken in handling any coverslips, which may cause cuts). The 'sharps' container is then sealed and disposed of with other clinical waste that is collected from the school.

Appendix 3 Sample letter and consent form

Dear Parent/Guardian

During the next few weeks we shall be studying blood during science lessons. Students usually find it very interesting to look at samples of their own blood under a microscope or to carry out other investigations with it.

This letter is to ask your permission for a sample of blood to be taken from your son/daughter. Please note the following points.

1 Only one or two drops will be taken from a prick in a finger.

2 A Community Health Physician has approved the sterile procedure we will use.

3 The sample will be taken only if your son/daughter wants it to be done and you also have agreed.

Please complete the form below and return it to me as soon as possible.

Yours sincerely

Science Teacher

****

For the parent/guardian

I am *willing/not willing** for a sample of blood to be taken from my child for use in a science lesson.
Signed: ..... (Parent or Guardian)
Date: ..... **Please cross out the one that does not apply*.

Appendix 4 Sundry items

1. 'Sharps' containers

These are available from most science equipment suppliers and also from www.amazon.co.uk, at economical prices.

2. Automatic lancing device

To cater for diabetics, there are many brands of auto-lancing devices (such as *Accu-Chek*, *Autolet,* Microlet, *OneTouch, Sterilance* and *Unilet*, with associated lancets). These are available from several sources such as www.owenmumford.com, www.gpsupplies.com, www.valuemed.co.uk, as well as www.amazon.co.uk.