Working safely with micro-organisms in Laboratory Science: Practical Skills (National 5)

Laboratory Science: Practical Skills **(National 5) is a mandatory unit within the *National 5 Laboratory Science Skills for Work Course* [1]. Outcome 1 of the unit requires learners to demonstrate competence in some basic laboratory microbiological techniques, namely pouring media plates, subculturing of micro-organisms, preparing slides for microscopy and an awareness of appropriate safe disposal of microbiological waste. This involves learners in developing aseptic technique together with an awareness of the health and safety aspects of working with micro-organisms.**

At SSERC we believe in the considerable educational value of carrying out school practical work involving micro-organisms which, as the Safety in Microbiology Code of Practice says,

> *'... lends itself to investigative work in science and to the discipline of developing competence in practical skills. Microbiological skills are key components in the field of biotechnology and in the medical industries and services. The applications of microbiology are relevant to the everyday concerns of citizens in relation to food production, hygiene, health and waste management. It also allows for the evaluation and control of risk, a valuable life skill, as well as providing an insight into an area of science in which Scotland is a major global contributor in research and industrial production. In the 21st century responsible citizens will need to evaluate scientific issues related to microbiology and to develop informed views on the use and applications of micro-organisms.' [2]*

We are pleased that there is a growing interest amongst school science departments in offering the *National 5 Laboratory Science Skills for Work Course* to young people interested in developing their practical laboratory skills. Of course, microbiology is not the only practical component of the course; learners measure radioactivity, use various types of laboratory instruments and perform titrations [1]. However, the interdisciplinary nature of the course is generating questions to SSERC from interested science departments about the training requirements for both teaching and technical support staff, especially the requirements for the microbiology component.

Laboratory Science: Practical Skills **(National 5)**

Outcome 1 - Performance evidence [1]

Learners will work safely with micro-organisms in a laboratory setting
Learners will be required to demonstrate by practical activity that they are able to:

- Pour agar plates using aseptic technique to a satisfactory standard
- Subculture micro-organisms (bacteria, yeast **and** mould) using aseptic technique without contamination. Learners must subculture **each** micro-organism type using **one** of the following subculture techniques:
  - Liquid to solid
  - Liquid to liquid
  - Solid to liquid
  - Solid to solid
- Prepare wet and dry mounts to satisfactory standard. The preparation is in accordance with given instructions and the mounted material is clearly visible when viewed using a microscope.
- Work safely throughout.

Figure 1

This article aims to address the issues of training requirements and the levels of work appropriate to learners and their teachers working safely with micro-organisms to achieve the *Laboratory Science: Practical Skills* (National 5) outcomes and performance criteria (see Figure 1).

Risk assessment and the Code of Practice

Activities involving micro-organisms are controlled by the Control of Substances Hazardous to Health (COSHH) Regulations and teachers and technicians have a duty under the Health and Safety at Work Act to comply with any safety instructions given by their employers. These include using model risk assessments. In Scotland all 32 local authorities and SSERC member schools and >>

colleges have adopted the Code of Practice - *Safety in Microbiology for Scottish Schools and Colleges*, SSERC, 2018 [2] and Figure 2.

The process of risk assessing work involving microbiology should be to identify the risks in any activity and to consider adopting the Code of Practice as being suitable and sufficient to control these risks. By following the Code of Practice in this way, a risk assessment is being carried out. If an activity falls outwith the guidance in the Code of Practice, then an individual risk assessment for that activity must be carried out. **If an employer has provided additional guidance on assessing and recording risk, that guidance must be followed.**

Teacher/technician training and levels of work

Central to the Code of Practice is the concept of levels of work. Three levels of work are determined by a combination of risk factors including choice of micro-organism, teacher training, age of learners and availability of trained technicians [2]. For level 1 work with learners (primary or early secondary), teachers do not require specialist microbiological training beyond normal good school science laboratory practice. For level 2 work with learners (early secondary to senior phase), science teachers may require training and some supervision which can be provided by a knowledgeable teacher (most often a biologist) or technician or by a short in-school training session. The SSERC instruction sheets and short films Microbiological Techniques [3] should be a useful resource in such training as will reference to and familiarity with the Code of Practice [2]. Most school microbiological laboratory work carried out by learners will be at levels 1 and 2, although students in the senior phase may carry out particular level 3 tasks under the supervision of a teacher, or technician trained to level 3.

In order to support level 2 microbiological laboratory work in schools and to supervise students who carry out level 3 tasks, staff trained to level 3 are required. For level 3 work teachers and technicians should be thoroughly trained and skilled in aseptic technique (see Figure 3).

See also a more detailed SSERC statement on training requirements [4].

Level 3 tasks required to support microbiological work in schools:

a) order, receipt, labelling and storage of cultures;
b) preparation of sterile media and sterile equipment;
c) preparing sub cultures for class use;
d) sampling from bioreactors;
e) sterilisation and disposal of cultures;
f) sterilisation of used equipment;
g) management of incidents of spillage;
h) staining of incubated plates (e.g. starch agar).

Figure 3

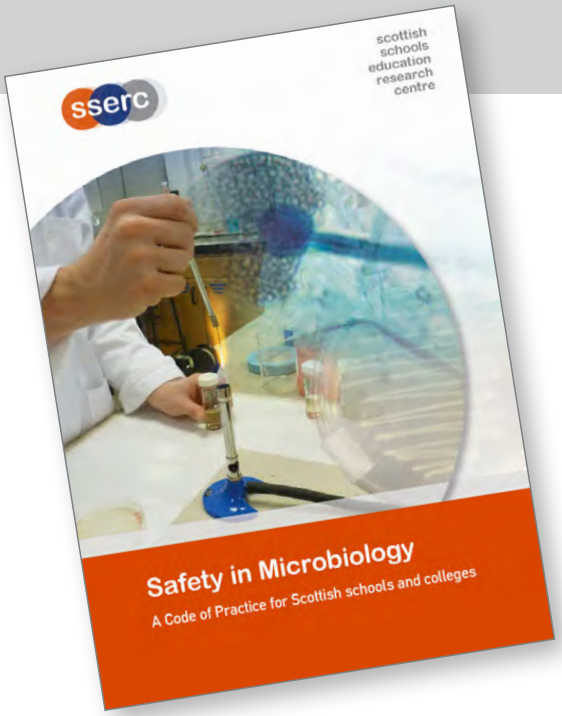

Figure 2 - *Safety in Microbiology - A Code of Practice for Scottish Schools and Colleges* [2].

How do these levels apply to *Laboratory Science: Practical Skills* (National 5)?

It is possible to meet the Outcome 1 performance criteria by carrying out only work at level 2. Done in this way, no specialist training is required for teachers beyond an in-school training session delivered by someone themselves trained to level 3. In order to carry out tasks to support the delivery of the course the expertise of someone (usually a technician) trained to level 3 is required (see Figure 3).

Subculture work can be carried out by learners using known micro-organisms deemed to be safe for use in schools. These are listed in appendices 1, 2, 3 and 4 of the Code of Practice [2] and should be sourced from recognised suppliers. However, confining work to level 2 for teachers and learners requires cognisance of some subtleties in the Code of Practice. The issue is the techniques which require transfer of an organism from a liquid culture. Transfer from liquid cultures increases the risk of spillage, or the formation of aerosols (invisible 'mists' of small droplets of moisture which might contain microbes that could be inhaled). Done using Appendix 2 organisms (Figure 4), these liquid transfers are level 3 tasks and would, therefore, require learners to be trained and supervised by someone trained to level 3. The easiest way to minimise risk and restrict liquid transfers to level 2 work is to use *Saccharomyces cerevisiae* (yeast) which is listed in Appendix 1 (Figure 5). By using *Saccharomyces cerevisiae* (yeast) for liquid to solid, and liquid to liquid transfers the learning outcomes for *Laboratory Science: Practical Skills* (National 5) can be met by learners and teachers working at level 2.

>>

APPENDIX 2

Selected organisms for work at levels 2 and 3

All micro-organisms listed in Appendix 1 and the following organisms:

Fungi
Agaricus bisporus
Armillaria mellea
Aspergillus oryzae
Botrytis cinerea
Botrytis fabae
Chaetomium globosum
Coprinus lagopus
Fusarium graminearum
Fusarium solani
Fusarium oxysporum
Helminthosporium avenae
Kluveromyces lactis
Lindnera jadinii (also called *Candida utilis*)
Monilinia fructigenea (also called *Sclerotinia fructigena*)
Mucor hiemalis
Mucor mucedo
Myrothecium verrucaria
Neurospora crassa
Penicillium expansum
Penicillium roquefortii
Phaffia rhodozyma (e.g. coloured organism)
Physalospora obtusata
Phycomyces blakesleanus
Phytophthora infestans
Plasmodiophora brassicae
Pleurotus ostearus
Pythium de baryanum
Rhizopus oligosporus
Rhizopus sexualis
Rhizopus stolonifer
Rhytisma acerinum
Saccharomyces cerevisiae
Saccharomyces diastaticus
Saccharomyces ellipsoides
Saprolegnia litoralis
Schizosaccharomyces pombe
Sordaria fimicola
Sporobolomyces species
Trichoderma reesei

Bacteria
Acetobacter aceti
Agrobacterium tumefaciens
Azotobacter species
Alcaligenes eutrophus
Bacillus megaterium
Bacillus stearothermophilus
Bacillus subtilis
Cellulomonas species
Chromatium species
Janthinobacterium lividum (also called *Chromobacterium lividum*)
Escherichia coli (strain B or strain K12)
Gluconobacter oxydans
Lactobacillus species
Micrococcus luteus (also called *Sarcina lutea*)
Micrococcus roseus
Methylophilus methylotrophus
Pectobacterium carotovorum (also called *Erwinia carotovora*)
Photobacterium phosphoreum
Pseudomonas fluorescens
Rhizobium species
Rhodopseudomonas palustris
Spirillum serpens
Staphylococcus epidermidis
Streptococcus lactis
Streptococcus thermophilus
Vibrio natriegens (also called *Beneckea natriegens*)

Viruses
Cucumber Mosaic Virus
Potato Virus X
Potato Virus Y (not the virulent strain)
Tobacco Mosaic Virus
Turnip Mosaic Virus

Figure 4 - *Safety in Microbiology - A Code of Practice* Appendix 2.

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APPENDIX 1

Selected organisms for work at level 1

- Bread making or brewer's yeast (*Saccharomyces cerevisiae*)
- Dried yoghurt cultures (bacteria used to make yoghurt)
- Blue-green algae
- Green algae
- Free living protozoa
- Lichens
- Slime moulds

Figure 5 - *Safety in Microbiology - A Code of Practice* Appendix 1.

Our recommendations for organisms to be used to carry out the required microbiological techniques for *Laboratory Science: Practical Skills* (National 5) course while working at level 2 are shown in Figure 6.

These recommendations make it possible to perform the appropriate techniques using the required range of organisms for *Laboratory Science: Practical Skills* (National 5) without level 3 training for teachers or learners. It is worth re-emphasising that it is still necessary to have someone within the school trained to Level 3 in order to carry out the relevant technical support tasks described in Figure 3.

It should be noted that SSERC has recently revised *Safety in Microbiology - A Code of Practice for Scottish Schools and Colleges*. All references in this article are to the revised version which is available on our website [2]. <<

Technique	Organism	Code of Practice reference	Type
Solid to solid	*E. coli* or *M. luteus* or *B. subtilis*	Appendix 2	Bacterium
Liquid to solid	*S. cerevisiae* (yeast)	Appendix 1	Fungus
Solid to liquid	*E. coli* or *M. luteus* or *B. subtilis*	Appendix 2	Bacterium
Liquid to liquid	*S. cerevisiae* (yeast)	Appendix 1	Fungus
Solid to solid	*Mucor hiemalis*	Appendix 2	Mould

Figure 6

References

[1] *Laboratory Science: Practical Skills* (National 5) Skills for Work Unit Specification June 2017 link to SQA website https://www.sqa.org.uk/sqa/38267.html.

[2] *Safety in Microbiology - A Code of Practice for Scottish Schools and Colleges*, SSERC, 2018 available at https://www.sserc.org.uk/health-safety/biology-health-safety/codes-of-practice/.

[3] SSERC Microbiological techniques. Available at https://www.sserc.org.uk/health-safety/biology-health-safety/microbiological-techniques/.

[4] Advice on Training Requirements. Available at https://www.sserc.org.uk/health-safety/biology-health-safety/updates-on-health-and-safety-practice/.

Further reading and useful websites

- SSERC Microbiological techniques. This is a series of both cards and films which will be a useful source of training for teachers and learners, available at https://www.sserc.org.uk/health-safety/biology-health-safety/microbiological-techniques/.
- Topics in Safety, Topic 15: Microbiology, Association for Science Education, 2018.
- Basic Practical Microbiology: A Manual, Microbiology Society, 2016.
- Microbiology Online. This is the education resource website of the Microbiology Society, available at https://microbiologyonline.org/.

‘Gauzegate’

There will, hopefully, be few if any science departments across the country that have not come across this issue. And by the time you read this it is likely that the situation will have been resolved without too much drama. But at the risk of boring you, a brief recap.

A few weeks ago it was discovered that a few samples of ceramic-centred Bunsen gauzes from two suppliers had come back with a positive test for a very low level of contamination with asbestos. HSE issued advice on what to do, mirrored by ourselves and CLEAPSS.

Perhaps the key point from this is that HSE described the risk from these gauzes as **‘extremely low’**. In fact, when discussing dust and particles that tend to rub off these gauzes in storage, they said **‘these particles and fragments do not represent an airborne risk’**.

All the suppliers then rushed to get testing done on their current stock by approved laboratories and can all now assure potential customers that any new gauzes they buy will be entirely asbestos-free.

They have been unable, however, to offer reassurance for stock purchased prior to this event. Either testing was not done or it was done overseas, in good faith, but not matching the UKAS standards required to certify them as asbestos-free.

As a result, it looks like all ceramic-centred gauzes will have to be disposed of as asbestos-containing waste. This may seem an over-reaction but the Asbestos Regulations reverse the burden of proof in this context. Once there is suspicion, then material must be assumed to contain asbestos unless it can be proven not to. In this case that is not possible and so it needs to be disposed of.

The disposal process is quite simple, is not dangerous and does not, unlike most asbestos work, require special training or equipment.

Any gauzes should be carefully double-bagged and kept for disposal by a licensed asbestos contractor. HSE say that any other gauzes in the same tray/cupboard, even if they are plain metal, should also be disposed of.

Figure 1 - Bunsen gauze (Image by NagayaS (CC BY-SA 4.0)).

Apart from these, **there is no need to dispose of any other equipment stored with the gauzes**. Tripods, Bunsens and the like should simply be wiped down with a damp cloth and the cloth disposed of along with the gauzes.

We have come across cases where contractors have been sent in by the Local Authorities and have turned up in full ‘hazmat’ suits and removed everything - in one case even the cupboard. They have clearly not read the HSE’s guidance. If this happens, refer them to the guidance here [1].

At the time of writing, early October 2018, we are aware of no more than three schools that have found contaminated gauzes. We are unable to name the suppliers: HSE have asked us not to as there may yet be criminal prosecutions and early publicity could endanger their case.

For the future, the suppliers have all had their current stock tested appropriately and will, presumably continue to do so. In order to reassure yourself when purchasing stock in the future, ask to see a copy of the test certificate. This should be from a certified UKAS accredited laboratory and will contain some variant of this symbol. <<

UKAS TESTING

Reference

[1] http://www.hse.gov.uk/asbestos/wire-gauzes.htm (3rd paragraph of the ‘What do I need to do?’ section).

Changes to Radioactivity Legislation

This article is of particular importance to schools that own radioactive sources with activities greater than 200 kBq, for example a 370 kBq caesium-137 sealed source.

It doesn't seem that long ago (because it wasn't) that SSERC was getting in touch with all local authorities and independent schools to help them with the registration process that the HSE's new Ionising Radiation Regulations 2017 (IRR17) requires. Now there is another change in the law but this time it is environmental rather than health and safety legislation that is affected. Confusingly, both sets of rules use the same terms to mean different things.

The Legal Background

The new rules are called the Environmental Authorisations (Scotland) Regulations 2018 (EASR2018). These replaced the Radioactive Substance Exemption Order (Scotland) 2011 on September 1st of this year. Under the 2011 legislation, all school sources were either classed as out of scope or exempt. The term "exempt" could be confusing. Exempt sources were not "exempt" from any legal restrictions. Rather, you were exempt from telling SEPA, the Scottish Environment Protection Agency, that you had them.

Under EASR2018, most school sources are covered by General Binding Rules. There is only one significant change in procedure that we will come to shortly. One source that schools are currently permitted to hold comes into a new category called Notification. The term "Notification" is also used in IRR17 and was used in previous HSE legislation. In all cases, it has a different meaning. If this seems tortuous, do not worry.

What you must do

- If you have a 370 kBq caesium-137 sealed source, inform SSERC via rpa@sserc.scot;
- SSERC will then notify SEPA.

The source will almost certainly be similar to the one shown in Figure 1. There is a small chance that you own one of the Frederiksen 370 kBq caesium sources with a clear acrylic handle (Figure 2). We must know about these too [1]. The new law applies to any sources with an activity greater than 200 kBq. The caesium sources are the only ones that should be in schools. If you have others, please get in touch.

Figure 1 - Most Cs-137 370 kBq sources will be similar to this one.

Notification is done school-by-school rather than on a local authority basis, but kudos to SEPA for allowing it to be carried out by an external agency. This can therefore be done by SSERC as part of your RPA service.

When you must do it

Please tell us as soon as possible. Notification must take place by March 2019 and will be required every 3 years. Again, SSERC will handle this. We will know of any disposals or transfers of sources to new sites that take place between notifications because these are things that you are obliged to tell us.

Changes to disposal practices

The only other change, the one we alluded to when General Binding Rules were mentioned above, concerns disposal of sealed sources. Under the previous environmental legislation, all sealed sources permitted in Scottish schools except for the Cs-137 370 kBq source could be disposed of to dustbin (note that a protactinium generator does not qualify as a sealed source). EASR2018 is slightly different. To avoid sealed sources being recycled along with scrap metal, disposal to dustbin can only take place if you know that the source will end up in landfill. >>

We do not publish guidance online about disposal other than to ask that you get in touch with us. It is fairly rare that someone wants to get rid of an expensive-to-replace item that enhances a fascinating part of the curriculum, but it does happen. If you have made a disposal before, you will find that we will now ask you to take the following additional steps:

- Check that waste that cannot be recycled will go to landfill;
- Embed your waste source in mortar before disposal.

By grouting your waste source, even if rubbish is sorted by hand for recycling, your source will not end up being identified as scrap metal. Full instructions will be given by SSERC should you have to make a disposal.

We do not feel that these changes will cause significant problems for schools. As ever, if you have a query regarding the keeping or use of radioactive materials or would like to buy a source, email rpa@sserc.scot. <<

Reference

[1] Note that your RPA no longer permits this type of Frederiksen sources to be bought by member schools but if you have any, keep using them subject to their passing an annual leak test.

Figure 2 - Three Frederiksen sources.

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