Genetic modification of bacteria

Posted by Anonymous on Wed, 2019-03-13 17:34

Genetic modification of bacteria: I'd like to make transgenic bacteria by placing a jellyfish gene producing Green Fluorescent Protein (GFP) into *E. coli*. I know that genetic modification is quite tightly regulated, but I can't seem to find any information on whether this is allowed to be done in schools or not.

Can schools conduct genetic transformation or gene induction experiments using commercially available kits? What regulations apply to Australian schools? What facilities are required and what are the hazards and risks?

Voting:
☆☆☆☆☆
No votes yet

Year Level:
Senior Secondary
Laboratory Technicians:
Laboratory Technicians

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Answer by labsupport on question Genetic modification of bacteria

Submitted by sat on 13 March 2019

Answer reviewed 10 February 2023

Science ASSIST has developed a comprehensive document called Guidelines for Best Practice for Microbiology in Australian Schools see GUIDELINES for best practice for microbiology in Australian schools

. We strongly recommend you download this document as it discusses in detail the underpinning knowledge and laboratory techniques required for schools to successfully prepare, deliver and disassemble microbiology practical activities.

Genetic modification of bacteria

The genetic modification of bacteria uses recombinant DNA technology. The methodology used is quite detailed and can involve the use of bacterial transformation where a DNA segment from one organism is incorporated into another to express new genetic information, or the use of certain substances to switch on or off specific genes. These processes have many safety aspects to consider and significant legislative implications as per the Office of the Gene Technology Regulator (OGTR).

Suitability of these activities for schools

It is important for schools to be aware of the risks and safety issues regarding the microbiological aspects of these activities and the rules and regulations of the Office of the Gene Technology Regulator (OGTR). Schools are also advised to check if the required techniques and procedures are allowed in their jurisdiction/school sector and conduct a site-specific biological risk assessment before proceeding to work with any microorganisms.

Science ASSIST places the use of commercial microbiology kits in its School microbiology Level 4 (medium to high risk) category as it includes advanced work using subculturing by students, the use of selective media, incubation temperatures above 30°C and/or other specialised manipulations of microorganisms. These procedures do not align with most school jurisdictional policies and require a much higher level of staff training and increased student supervision.

The inclusion of microbiology activities in text books does not guarantee that they are permitted in your jurisdiction.

Science ASSIST recognises that schools have an interest in these types of activities, and we recommend that schools consider excursions to laboratories that have appropriately trained staff and suitable facilities.

Legal requirements:

In Australia, the Gene Technology Act 2000 and the Gene Technology Regulations 2001, along with state laws have been developed to protect the health and safety of people and the environment through regulating certain dealings and activities using genetically modified organisms (GMOs).

The Australian Government has within the Department of Health & Aging established the Office of the Gene Technology Regulator (OGTR) which has legislative power to regulate and enforce requirements under the Gene Technology Act 2000 where work involving certain dealings with gene technology is being undertaken. All dealings with genetically modified organisms (GMOs) must be licensed, notified or exempt by law.

For information on activities regarding GMOs in schools, see

- 'GMO kits in Schools'[1] fact sheet available on the following webpage: https://www.ogtr.gov.au/resources/publications/gmos-schools
- 'Guidance notes for the containment of exempt dealings'[2] at https://www.ogtr.gov.au/resources/publications/guidance-notes-containment-exempt-dealings

Important considerations before conducting this activity

Science ASSIST recommends that if schools decide to go ahead with this type of activity that a detailed biological risk analysis and assessment needs to be conducted taking the following into consideration:

Legal obligations

This activity involves genetically modifying bacteria, which can have significant legislative implications as per the Office of the Gene Technology Regulator (OGTR). Although many kits marketed to secondary schools are considered exempt dealings, there are still obligations to ensure that

- your experiment is classified as Exempt dealings
- the genetically modified organisms (GMOs) produced must not be released into the environment and must be destroyed before disposal
- safe laboratory practices are in place to minimise the risk of biohazards

Facilities:

- The lab must be a PC1 laboratory
- The school must have an autoclave/laboratory pressure cooker to enable thorough sterilisation to be performed
- The laboratory must contain a means of decontaminating hands.
- All openings such as drains, windows and air vents should be fitted with mesh to prevent any movement of animals, and invertebrates in or out of the facility.[2]

Staff training:

- Teachers should be highly trained and experienced in good microbiological laboratory practice and have a good understanding of the gene technology involved in these activities. Teachers should have studied microbiology or molecular biology to the equivalent of 3rd year university.
- Non specialist teachers should not carry out this work.
- Technicians should have sufficient training and experience in microbiology, i.e., have studied microbiology as a minimum to the equivalent of Certificate IV at TAFE/RTO with units including aseptic techniques.

Microorganisms used:

- Microorganisms used in school laboratories must be no higher than a Risk Group 1 bacteria (RG1). The risk level of the microorganisms in the kit purchased must be confirmed by the school and RG1 should not be assumed.
- RG1 microorganisms are unlikely to cause human disease in healthy individuals. Examples include the *E. coli K-12* strain. However, these are still considered opportunistic and may be a risk to people who are immunocompromised or immunosuppressed.

Activity/manipulations:

- **Subculturing**
  - The bacteria may be provided as colonies on an agar plate, a broth culture or a lyophilised culture. Performing the transformation experiment requires subculturing. Subculturing should only be conducted using pure cultures of RG1 microorganisms. Students should never subculture from cultures that they have inoculated because of the high risk of contamination with unknown microorganisms.
  - Many school jurisdictions do not allow microorganisms to be subcultured.
- **Selective media:**
  - The type of media used in schools should not be selective or enriched agars which may encourage the growth of pathogens.
  - Some kits require the addition of an antibiotic (ampicillin) to agar, which produces a selective medium for the growth of *E.coli* which contains the gene for ampicillin resistance.
  - Nutrient agar is a simple media which supports the growth of a wide variety of bacteria and moulds and is suitable for use in school laboratories.
- **Ampicillin:**
  - The agar needs to contain the antibiotic ampicillin, a member of the penicillin family This may adversely affect staff/students with penicillin allergies. – Appropriate laboratory techniques will significantly reduce this risk.
  - The bacteria after the successful genetic modification is a penicillin-resistant organism and must not be released/dispersed into the environment.
- **Incubation temperature:**
  - The recommended temperature for the incubation of microorganisms in schools is at room temperature or up to a maximum of 30°C and NOT ABOVE 30°C to minimise the likelihood for growth of potential human pathogens that are adapted to human body temperature.
  - These activities require incubation at temperatures above 30°C as the *E. coli* may not grow well at lower temperatures.

Staff/student health:

- Ask the question: Do any staff or students, who will be close to the activity, have an allergy to Ampicillin (penicillin) or are immunosuppressed?

Work Practices for exempt dealings[2]:

- Restrict access to the laboratory when dealing with GMOs.
- Laboratory rules must be strictly adhered to, i.e., no eating or drinking in the lab.
- PPE must be worn to protect the front part of the body from exposure to GMOs.
- PPE must be removed, stored or disposed of before leaving the facility.
- PPE contaminated with GMOs should be decontaminated before disposal or reuse.
- All methods on the open bench should be performed to minimise any aerosol production.
- All benches and equipment used to produce GMOs should be decontaminated at the completion of the activity.
- All cultures containing GMOs should be adequately labelled to identify them as opposed to non-GMO cultures and sealed when stored to prevent escape of GMOs.
- All GMOs must be destroyed by sterilization at the end of the activity and not released into the environment.
- An autoclave or laboratory pressure cooker at 15psi, 121°C for 15-30 minutes is required to decontaminate microbial cultures and waste.
- Adequate sterilization must be confirmed and recorded. Records must be available for external sources to view if requested
- Hands must be washed with soap and water on completion and before leaving the laboratory.

References:

[1] Office of the Gene Technology Regulator, (2021 November), *GMOs in Schools,* Retrieved from the Australian Government, Department of Health and Aged Care, Office of the Gene Technology Regulator website: https://www.ogtr.gov.au/resources/publications/gmos-schools

[2] Office of the Gene Technology Regulator, (2011 September), *'Guidance Notes for the Containment of Exempt Dealings*' Retrieved from the Australian Government, Department of Health and Aged Care, Office of the Gene Technology Regulator website: https://www.ogtr.gov.au/resources/publications/guidance-notes-containment-exempt-dealings

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