Nitrogen and living things

In the two most recent SSERC bulletins [1, 2] we offered descriptions of practical and discussion activities on the broad theme of 'fertilisers and food security'. In Curriculum for Excellence (*CfE*) this theme is located in Line of Development 03 (Concept development in the Sciences [3]) and in the unit entitled Life on Earth in each of the National 4 and National 5 courses in Biology [4,5]. At National 4 and 5 the theme broadens to include knowledge of the nitrogen cycle and the role of nitrogen in ecosystems.

Figure 1 *- Root nodules.*

Here we offer some activities which support learning relating to the nitrogen cycle and micro-organisms involved in nitrogen fixation.

Figure 2 *- Lupin (Lupinus polyphyllus).*

Practical activity 1

Isolating nitrogen-fixing bacteria from the root nodules of leguminous plants

Rhizobium is an example of a nitrogen fixing microorganism found in the root nodules (Figure 1) of legumes such as peas, beans and clover. The root nodules of the common garden plants known as lupins (Figure 2) have conveniently large root nodules which contain Rhizobium. At SSERC we used lupins for this practical. The aims of the practical are to allow learners to:

- Identify root nodules on leguminous plants.

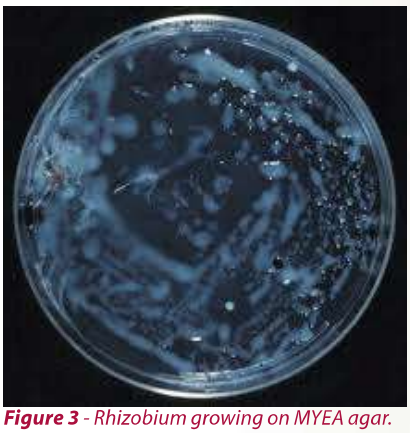

Figure 3 *- Rhizobium growing on MYEA agar.*

- Isolate and grow *Rhizobia* on an agar medium (Figure 3).
- Carry out microbiological 'sterile techniques'.

Practical activity 2

Nitrogen-fixing bacteria in soil

Azotobacter is a nitrogen-fixing bacterium found free-living in soil. *Azotobacter* can be isolated by growing it in a nitrogen-free medium (Figure 3). The aims of this practical are to demonstrate that:

- There are microorganisms in soil which can be grown on nutrient agar.
- Some soil microorganisms can grow on a nitrogen-free medium.
- Those growing on a nitrogen-free medium must be fixing nitrogen gas from the air.

Figure 4 *- Nitrogen and Living Things cards.*

Card based activity

Nitrogen and Living Things

This activity (Figure 4) can be used in a variety of ways which allow learners to explore the role of nitrogen in living things and the role of microorganisms in the nitrogen cycle.

A detailed student protocol and a teacher/technical guide for each of the practical activities, and the *Nitrogen and Living Things* cards, can be found on the SSERC website [6]. ◀

Curriculum links

Line of development 03

At second level - *SCN 2-03a*, learners can explore the role of fertilisers through practical activities involving, for example, house plant nutrient fertilisers. The effect of factors such as dilution of the fertiliser or use of different fertilisers can be investigated.

At third level - *SCN 3-03a*, learners grow plants using a variety of growth promoters and inhibitors to investigate ways in which plant growth can be altered. Learners could undertake research into the use of these and of alternatives, including the growth of genetically-modified (GM) plants. They can explore the role of pesticides, herbicides and fungicides. They could consider organic farming methods and compare these with the use of artificial chemicals and GM crops, enabling learners to develop informed views on the use of each.

At fourth level - *SCN 4-03a*, learners design an artificial fertiliser taking account of the major nutrients that are required by a plant for healthy growth i.e. nitrogen, phosphorus and potassium in appropriate proportions. They can consider the solubility of salts containing the major nutrients, and potential problems associated with their overuse. There are useful opportunities to develop numeracy skills, for example in the calculation of percentage compositions of simple fertilisers.

National 4 - Life On Earth

Investigate/research the nitrogen cycle including the role of microorganisms.

National 5 - Life On Earth

Animal and plant proteins are produced from nitrates. The roles of nitrifying, denitrifying, root nodule and free-fixing soil bacteria.

References

[1] SSERC (2013), Fertilisers and food security, SSERC Bulletin **244**, 4-7.

[2] SSERC (2013), Eutrophication - investigating the effects of fertilisers on the growth of an algal population, SSERC Bulletin **245**, 4-7.

[3] Learning and Teaching Scotland, *Sciences: Concept development in the sciences*. Available at http://www.educationscotland.gov.uk/Images/Conceptdevelopmentinthesciences2_tcm4-550290.pdf (Accessed 19th December 2013).

[4] SQA (2012). Course Unit Support Notes for new National Qualifications are available on the SQA website at http://www.sqa.org.uk/sqa/45724.html.

[5] SQA (2012). Course Unit Support Notes for new National Qualifications are available on the SQA website at http://www.sqa.org.uk/sqa/45725.html.

[6] Available at http://www.sserc.org.uk/index.php/biology-2/biology-resources/biology-national-4/n5-life-on-earth/3418-energy-in-ecosystems. The SSERC website is available at www.sserc.org.uk. Please note that to access all resources on the website you will need to register and be provided with a log-on ID and password.