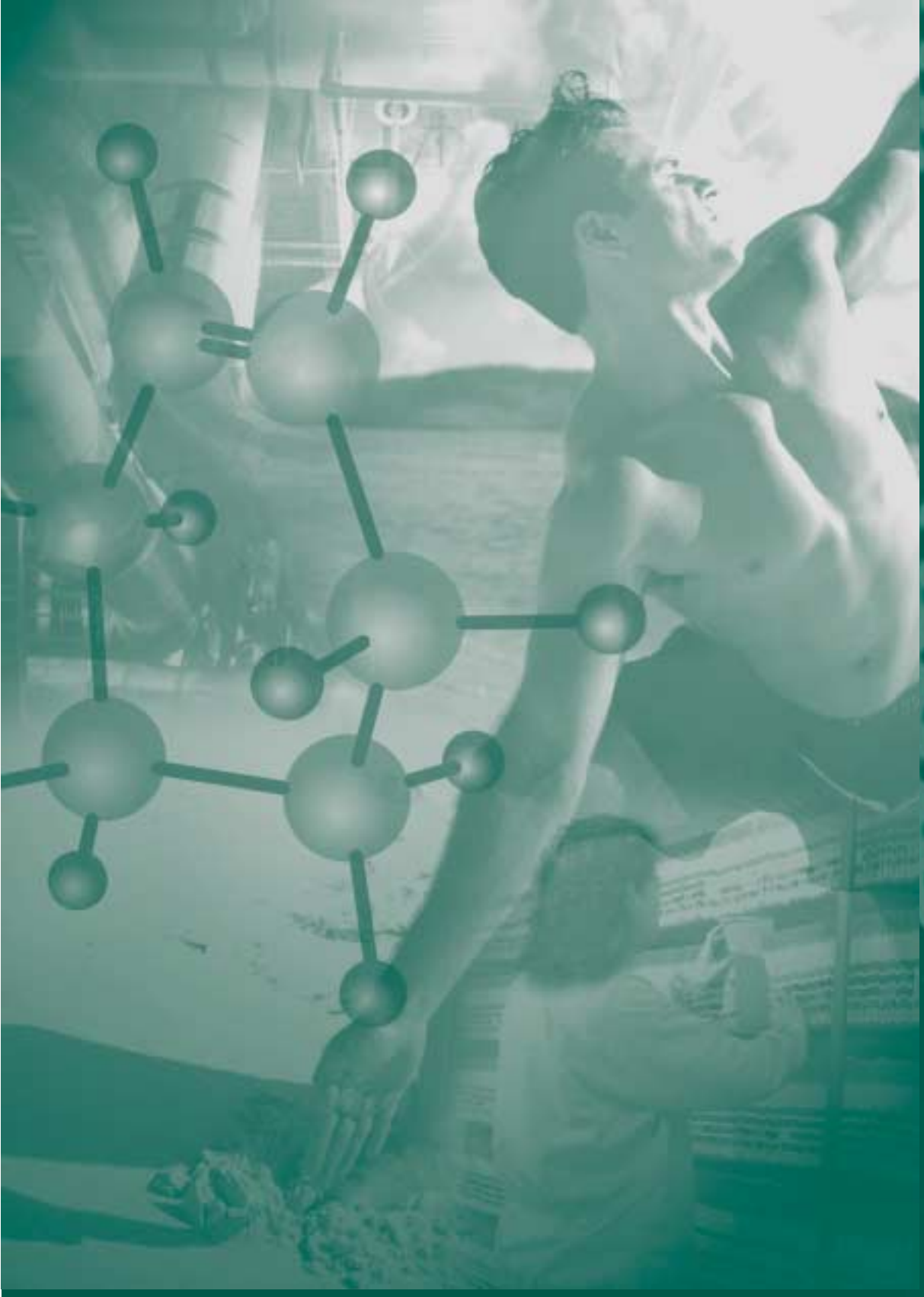
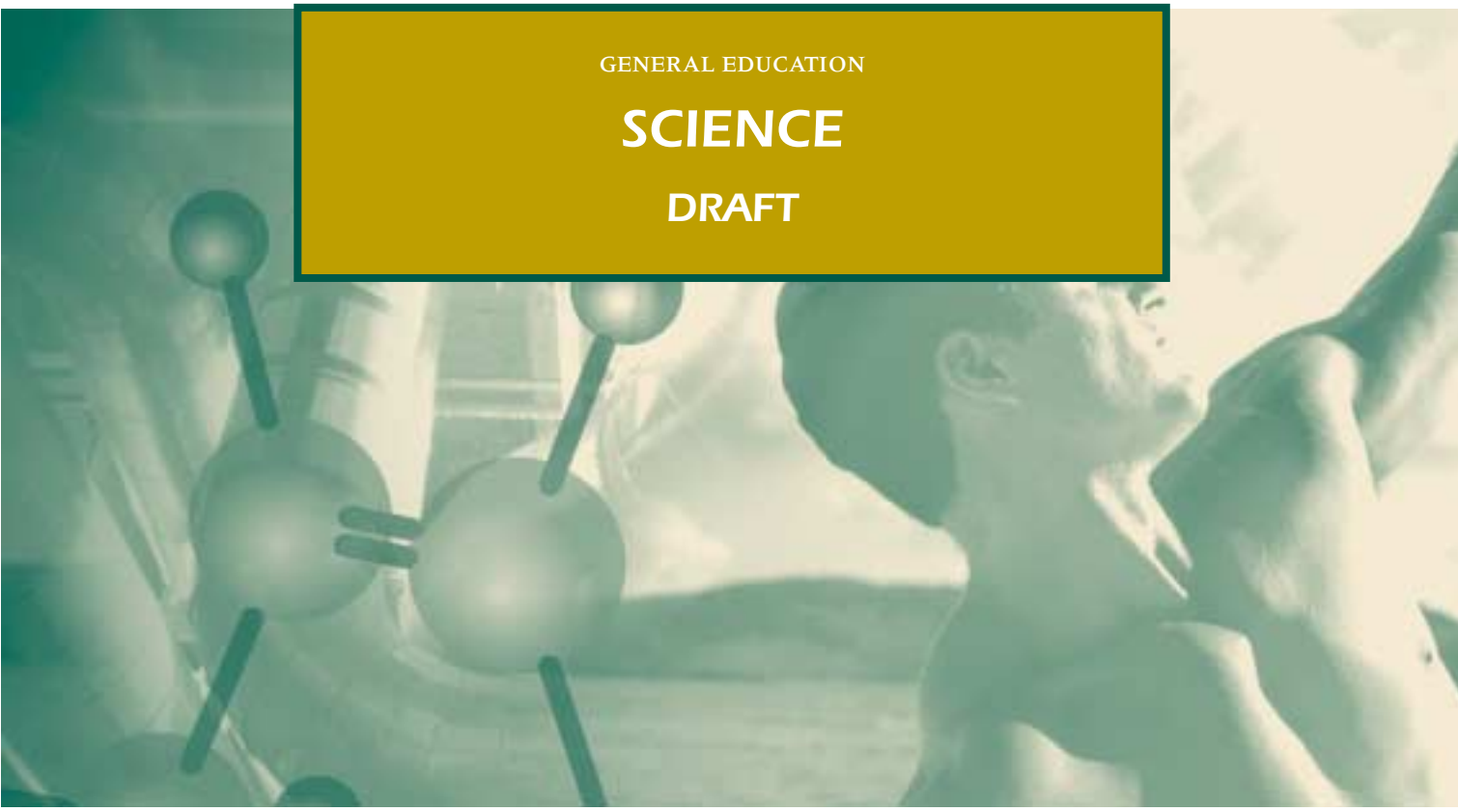


Science Draft

LCA LEAVING CERTIFICATE APPLIED

ARDTEISTIMÉIREACHT FHEIDHMEACH

SCIENCE	TOPICS IN COMMON														
	Built Environment	Chemicals	Children	Consumer Education	Cosmetics	Energy/Electricity	Environment	First Aid	Food/Nutrition	Health	Human Body	Hygiene	Lifestyle	Safety	Soil
COURSE															
Vocational Preparation & Guidance				■			■						■	■	
English & Communications															
Mathematical Applications				■		■									
Social Education			■	■			■		■	■			■		
Active Leisure Studies							■	■		■	■		■	■	
Agriculture/Horticulture		■					■		■	■		■		■	■
Childcare/Community Care			■	■				■	■	■	■	■	■	■	
Graphics & Construction Studies	■			■		■	■							■	
Craft & Design				■										■	
Engineering				■		■								■	
Hair & Beauty		■		■	■			■	■	■	■	■	■	■	
Hotel Catering & Tourism				■					■	■		■		■	
Information & Communication Technology														■	
Office Administration & Customer Care				■										■	
Technology	■	■		■		■	■			■				■	
Gaeilge															
Arts - Visual-Drama-Music & Dance															
Introduction to Information & Communications Technology															
Leisure & Recreation							■	■	■	■	■		■	■	
Modern Language															
Religious Education													■		
Sign Language															



GENERAL EDUCATION

SCIENCE

DRAFT

CONTENTS

MODULE 4

INTRODUCTION

RATIONALE

Science in the curriculum helps students understand the world around them. It contributes to their general education. The Science elective aims to develop scientific literacy for students so that they are confident and competent when faced with science in their everyday lives. It also aims to enable them to appreciate the skills and knowledge of science. Finally the elective aims to inform student so that if they wish to proceed to appropriate PLC courses they appreciate the kind of work involved.

Students may have studied science in primary school or have done Junior Certificate Science. The Science elective provides a continuation of science with the emphasis on everyday life. Equally students who may have had no exposure to science will in Science meet science in a relevant and concrete way before they leave school.

At Leaving Certificate level science syllabuses are designed to incorporate the following components:

- science for the enquiring mind or pure science, to include the principles, procedures and concepts of the subject as well as its cultural and historical aspects
- science for action or the applications of science and its interface with technology
- science which is concerned with issues - political, social and economic - of concern to citizens

The Leaving Certificate Applied Science modules focus on 'science for action' and 'science for citizens' and draws on 'pure science' on a 'need to know' basis. All modules have a social dimension, consider ethical issues and provide students with the scientific knowledge they need for everyday life.

NUMBER AND SEQUENCE OF MODULES

There are four elective modules in Science. Each module is independent and can be taken separately. The first unit in each module "Working in a laboratory" is common to all four modules.

Module 1: Science and Health

Module 2: Science and the Environment

Module 3: Consumer Science

Module 4: Food

DESCRIPTION OF MODULES

WORKING IN A LABORATORY

The unit provides the laboratory focus for all the Science modules. It is common to all four modules. The purpose of the unit is to develop the students' practical laboratory skills so that they can use practical work in the other units of each module.

Students should be familiar with the content of this module before beginning any other units in each of the modules. All of this Unit should be demonstrated by the teacher and practised by students.

MODULE 1: SCIENCE AND HEALTH

The Science and Health module uses the health of the student and her/his family as a focus and aims to introduce relevant ideas and concepts from all aspects of science. The purpose of the module is to develop an appreciation of the interrelationships between science, technology and society that are part of the everyday world. It aims to develop students' understanding of the science underlying their own health.

MODULE 2: SCIENCE AND THE ENVIRONMENT

The purpose of this module is to enable students to develop a basic understanding of the relationship between science and their environment. The module will develop an appreciation of the interrelationships between science, technology and society that are part of the everyday world.

MODULE 3: CONSUMER SCIENCE

The purpose of this module is to present science in a social context. It hopes to promote true understanding of some consumer relevant scientific phenomena, thus empowering students to make informed, intelligent decisions regarding scientific issues. The module will develop an appreciation of the interrelationships between science, technology and society that are part of the everyday world.

MODULE 4: FOOD

This module aims to develop a basic knowledge of food chemistry in relation to nutrition, food processing and hygiene. It aims to develop students' understanding of the science underlying food. It promotes an appreciation of the interrelationships between science, technology and society that are part of the everyday world.

GENERAL RECOMMENDATIONS

KEY FEATURES OF THE SCIENCE ELECTIVE

The Science elective places the student at the centre of the learning. Students focus on issues of relevance to themselves e.g. health, food, or consumer issues. They research the issues through practical work and investigations in the laboratory, fieldwork, ICT and a range of other activities. This approach to science focuses on the processes of science and its applications rather than content. It links science, technology and society in a meaningful way for students.
The content reflects a scientific approach, incorporating investigations, based on scientific principles. The modules engage students in investigations relating to enquiry, issues, technology and basic laboratory techniques, through scientific approaches and methods. Using ICT in science is also part of the unit.

Practical work is a key feature. Unit 1 is common to all four modules. It focuses on developing practical laboratory skills. Health and safety is emphasised. The practical laboratory investigations originate in a 'need to know' or a 'need to solve a problem' basis. Each module has suggested suitable laboratory practicals.

Teacher guidelines are provided to facilitate different methods and approaches to teaching and learning within each module to achieve the expected Learning Outcomes. **The guidelines are not prescriptive.** There is scope for teachers to exercise their own professional judgement based on the interests, needs and abilities of the group.

APPROACHES TO TEACHING AND LEARNING

Teaching the Science elective will draw on a range of different strategies. These are discussed in turn.

Activity based learning

The Leaving Certificate Applied focuses on teaching strategies that facilitate students' learning. It is equally important in science that active strategies such as:

- group discussion
- brainstorming
- field trips
- interviews
- verbal and visual presentations (e.g. collages, posters)

and many others are used. The main difference in science is there will be practical laboratory work as well.

General Teaching Guidelines

The approach should be concrete and practical. The objective is for the students to grasp underlying scientific principles and not the scientific detail of the topics under consideration

In any unit a flexible approach is suggested. The learning outcomes do not have to follow the order laid out. The approach to the units should match the interest, experiences and needs of the students.

Some of the topics under consideration in the modules may seem to be complex. However the references listed with each module illustrate strategies for dealing with complex issues in very concrete ways

It is suggested that the first period of each unit within the modules be spent eliciting students' previous ideas concerning the subject at hand. Brainstorming and/or working in small groups and then reporting back to the class is very useful for gaining a response.

It is suggested that students keep a personal reflective diary of their attitudes and experiences in science as well as a record of the work done in class. This could be included as an additional key assignment.

Whilst all the Learning Outcomes should be addressed, teachers may not have time to cover all of suggestions in the Teacher Guidelines. It is suggested that a teacher focus on topics that her/his particular group finds interesting. Key assignments should reflect the interests of the individual class group.

In order to develop students' confidence, it is suggested that they are encouraged to ask questions and then the questions are answered through the work in the modules. There are a number of ways in which questions can be encouraged:

- 'free question time' within the class or topic
- a question 'brainstorm' at the start of a topic
- a 'question box' available where students can put their questions
- each student or group of students prepares questions to be asked of others in turn around the class
- 'question-making' homework

Where classes have both students who have done Junior Certificate Science and students who have not, it will be important to build on students' skills and knowledge and to use it for the benefit of the whole class. Students may have used equipment before. They could show, with supervision, other students how to use the equipment. Similar strategies may be useful when introducing concepts that some may have met. It will be important to emphasise that finding out and using scientific knowledge is very important in Science.

Evaluation of evidence is a key aspect of science. Students are to be encouraged to analyse their work and to see how it stands up to scrutiny.

Language in Science

Science has its own language. This includes words like devise, estimate, and interpret as well as the technical terms. Students will need to use the language of science appropriately. Strategies for developing students' language confidence and competence are essential.
A number of approaches are possible. Students' comprehension of both technical and non-technical words can be helped by strategies such as

using illustrations and diagrams to complement the spoken word, compiling a glossary of key words e.g. technical terms as part of the summary or revision work on a topic. Students' language skills can be developed by providing opportunities for students to talk or write using the words in a range of contexts both inside and outside the school.

Practical work

Practical work is an essential part of science. It serves many purposes:

- to encourage accurate observation and careful recording
- to promote scientific patterns of thought
- to develop manipulative skills
- to give training in problem solving
- to elucidate the theoretical work so as to aid comprehension
- to arouse and maintain interest in the subject
- to make biological, chemical and physical phenomena more real through actual experience

There are different types of practical work.
A very useful classification is[1]:

- Exercises: developing practical skills and techniques
- Experiences: getting a feel for phenomena
- Investigations: finding answers to scientific problems

Exercises are structured practicals that develop specific laboratory skills. This kind of practical work is found in the common unit 1. Some of the other practical work in the modules may be exercises e.g. testing for bacteria and fungi. Students need this kind of practical work if they are to be able to work safely in the school laboratory.

Experiences are usually short, simple exploratory practicals that enable the students to get a 'feel' for phenomena. They use the senses to stimulate thought and discussion and thus can lead to a thorough understanding. These simple experiments are an important teaching strategy. Many of the experiments in the modules are of this kind e.g. using a signal generator and loudspeaker shows the hearing range of human beings.

[1] Woolnough, B. and Allsop, T. Practical Work in Science. (Cambridge: Cambridge University Press, 1985), p 47.

Students can *investigate* in similar way to scientists. They can ask questions and decide how to get the evidence needed to answer their own questions. They can find out which toothpaste is the most alkaline or basic, they can investigate which disinfectant is the best value.

Throughout the modules practical work is used to enable students to become confident and competent in their science work.

Research and problem-solving

Research and problem solving are key features of the Science electives. The questions are set by the students. Students find out the answers through practical work, surveys, using the Internet, visits and structured questionnaires. They then analyse the information obtained and present it to the class.

Integration with other subjects

The Science modules integrate with many other courses in the Leaving Certificate Applied. There are obvious links with English and Communications and Mathematical Applications. ICT can be used throughout the modules for recording and presenting information and graphs as well as for research. Increasingly it will be possible to use datalogging to make measurements. The links to Social Education are evident in Science and Health and Consumer Science modules. Essentially, provided there is the time and interest to explore the Science modules could be integrated with many of the other courses in the programme.

One other aspect of integration that should be explored is the links between the Science modules and the standard Leaving Certificate Science courses. This could be a two way process. The Leaving Certificate Physics class could prepare a presentation on X-rays for the Science and Health module and the Science and Health students could brief the Physics students on the uses and indeed risks of X-rays.

Portfolio of work

For each module it is recommended that students compile a portfolio of work. Students should

- maintain a record of all work carried out in this Module
- maintain a record of all practical laboratory tests/experiments and investigations
- maintain a record of a structured visit to a local food/drinks/dairy etc. industries, including Aims, Objectives, Methods, Photographs/ Pictures from publications produced by the industry visited, Results, Conclusions, Evaluation of the final record and a Self-evaluation.
- maintain a record of interviews, lectures/talks given by guest speakers
- maintain a record of all media resources used e.g. newspaper articles television programmes, websites, CD-ROMs.

UNIT COMMON TO ALL MODULES

WORKING IN A LABORATORY

UNIT COMMON TO ALL MODULES

WORKING IN A LABORATORY

PURPOSE

The unit provides the laboratory focus for all the Science modules. It is common to all four modules. The purpose of the unit is to develop the students' practical laboratory skills so that they can use practical work in the other units of each module.

Students should be familiar with the content of this module before beginning any other units in each of the modules. All of this Unit should be demonstrated by the teacher and practised by students.

PREREQUISITES

None.

AIMS

The unit aims to:

- enable students to develop basic practical skills and safe working practices in laboratories.

UNITS

Unit 1: Working in a laboratory

Unit 1: Working in a laboratory

LEARNING OUTCOMES	TEACHER GUIDELINES
The student will be able to:	
1. understand and adhere to laboratory rules	
2. appreciate the need for personal protection equipment (e.g. goggles, lab coat) and wear them as appropriate when carrying out experiments	▶ Identify the PPE appropriate to the module and discuss when use might be appropriate.
3. locate the fire equipment/safety blanket/first aid kit and know how select and use the correct extinguisher for different classes of fires	▶ Draw a plan of the laboratory. ▶ Talk and demonstration and/or video by Fire Prevention Officer.
4. recognise international hazard warning symbols and labels	▶ Students should view and find out about the hazards symbols on chemicals/reagents used in the relevant module. ▶ Present this information in poster form.
5. outline standard procedure in the case of accidents	▶ Design an accident report form for the laboratory. See First Aid in Leisure and Recreation module. ▶ Make a list of the most common physical, chemical and biological hazards encountered in the laboratory.
6. locate equipment, chemicals reagents, as appropriate	▶ Design labels (computer) for each cupboard /press etc. listing contents.
7. appreciate and adhere to regulations regarding setting–up and clearing-up after laboratory practicals	▶ Design a schedule for setting up practicals and clean up after practicals.
8. identify and use correctly a range of glassware on a 'need to use' basis	▶ Choose and use the correct glassware apparatus and assemble correctly e.g. beakers, burettes, pipettes and pipette fillers, dropper pipettes, testing tiles, conical flasks, graduated cylinders etc.

Unit 1: Working in a laboratory (Continued)

LEARNING OUTCOMES	TEACHER GUIDELINES
9. identify and use correctly a range of laboratory equipment and techniques on a 'need to know' basis	▶ Identify equipment such as electronic balance, microscope, incubator, oven, Bunsen burner, hot plate, pH meter, ion exchange column, calorimeter, thermometer, gas collecting apparatus. ▶ Develop skills to be able to use techniques e.g. separating techniques, choose and use appropriate chemicals, correctly and safely use electronic balance, prepare and view slide samples correctly, prepare cultures correctly and safely, use a thermostat correctly, check that the ion exchange column is working correctly.
10. handle chemicals and micro-biological materials safely and correctly as required	▶ Teacher demonstration; transfer quantities of chemicals safely, using appropriate glassware, equipment etc. ▶ Practise measuring, transferring etc. liquids from one container to another.
11. use electrical and gas supplies safely and correctly	▶ Use a hot plate in preference to a Bunsen Burner. ▶ Make a brief summary of relevant aspects of the Safety, Health and Welfare Act 1989; post up in the laboratory.
12. use ICT appropriately.	▶ Reports, questionnaires, notices etc.

LEAVING CERTIFICATE APPLIED

Practical Skill Assignment

COURSE: SCIENCE

MODULE: _____

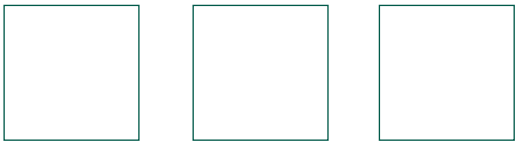
1. I can recognise the following equipment in the laboratory:

Conical flask	☐	Graduated cylinder	☐
Pipette	☐	Burette	☐
Funnel	☐	Pipette filler	☐

2. I have used:

Electronic balance	☐
Microscope and prepared slides	☐
pH meter	☐
Hot plate/Bunsen burner	☐
Thermometer	☐

3. I am familiar with the following hazard symbols:



4. I can prepare a slide for the microscope ☐
5. I can transfer liquids safely between containers ☐
6. I can locate the following safety equipment:

Fire extinguisher	☐
Fire blanket	☐
First Aid kit	☐
Eye wash apparatus	☐

Signed: _____ Date: _____

(Name of student)

MODULE 1

SCIENCE AND HEALTH

MODULE 1:

SCIENCE AND HEALTH

PURPOSE

The Science and Health module uses the health of the student and her/his family as a focus and aims to introduce relevant ideas and concepts from all aspects of science. The purpose of the module is to develop an appreciation of the interrelationships between science, technology and society that are part of the everyday world. It aims to develop students' understanding of the science underlying their own health.

PREREQUISITES

None.

AIMS

This module aims to

- give students an understanding of the human body
- inform students that basic health and fitness are important
- develop students' appreciation of basic health and how the health system uses science and its technological applications in diagnosis and treatment of many common illnesses
- enable students to understand the impact of the environment on health
- enable students to read a newspaper article on a matter of health and understand the basic terms used
- empower students to ask appropriate questions of health professionals that they may meet
- enable students to find out information from encyclopaedia, CD-ROM, website or other media on a health and/environment issues, make sense of the information provided and evaluate it critically.

UNITS

Unit 2: The Human Body

LEARNING OUTCOMES

The student will be able to:

1. identify the characteristics of living things
2. appreciate that cells are the building blocks of living organisms
3. appreciate how the DNA in genes determine many characteristics
4. recognise the different body systems
5. be able to describe and name body systems and functions accurately
6. understand the functions of the different body systems
7. relate the different body systems to their own bodies.

TEACHER GUIDELINES

- Use brainstorms, observation, discussion and visits to elicit the characteristics from students.
- Examine different cells and tissues under a microscope e.g. onion cell stained with methylene blue, prepared slides.
- Look at DNA in videos, posters, under a microscope etc.
- Survey class for some characteristics e.g. tongue rolling, cucumber tasting, ear lobes.
- General functions, no learning off of names of parts.
- Look at diagrams, models, charts and other media, including multimedia.
- Use a signal generator and loudspeaker to identify the hearing range of humans.
- Relate the functions of the different systems to the characteristics of living things.

Unit 3: Maintaining health 1

LEARNING OUTCOMES	TEACHER GUIDELINES
The student will be able to:	
1. identify the characteristics of good health	▶ Check with students what they may have learnt about the topic of this unit in their Social & Health Education module and build on this. ▶ Brainstorm on what is good health. ▶ Analyse indicators of good health – sufficient energy, good food, rest, exercise, personal hygiene. ▶ Investigate how lifestyle depends on health.
2. understand the concept of energy and appreciate the conservation of energy	▶ Energy circus – simple experiments to show energy changes in the laboratory.
3. appreciate how the body gets energy from food through respiration – word equation only food + oxygen = water + carbon dioxide + energy	▶ Burn food to show release of energy (do not use peanuts, use crisps or bread).
4. explain the role of food – providing sufficient energy for daily life and the nutrients needed to maintain and repair the body	▶ Review main elements of a healthy diet. ▶ Review diet of self and family.

Unit 3: Maintaining health 1 (Continued)

LEARNING OUTCOMES	TEACHER GUIDELINES
5. explain the role of diet in maintaining health	▶ Look at messages about diet in the media. ▶ Look at advice from national bodies about diet e.g. food pyramid. ▶ Investigate how poor diet leads to illness e.g. lack of iron anaemia
6. describe the role of exercise in maintaining health	▶ Investigate the reasons why exercise is important in maintaining good health. ▶ Investigate different types of exercise their effects on the body e.g. measure pulse when resting and after exercise or measure volume of exhaled air before and after exercise or measure heartbeat using sensors and computers (if available). ▶ Find out about fitness tests, talk to PE teacher and/or fitness instructor, visit local leisure centre. ▶ Develop a personal exercise plan.
7. describe the body's need for rest	▶ Appreciate the need for sleep – time for repair and renewal. ▶ Survey different groups to identify sleep requirements for different ages e.g. young people and the elderly.
8. appreciate that personal hygiene can prevent many diseases.	▶ Identify the areas both on the body and at home where hygiene is essential. ▶ Test, using agar plates different surfaces for bacteria etc. ▶ Test different commercial products to see which is the best in controlling bacteria etc.

Unit 4: Maintaining health 2

LEARNING OUTCOMES	TEACHER GUIDELINES
The students will be able to:	
1. understand the role of prevention in maintaining good health	▶ Find out how health depends on lifestyle. ▶ Identify a range of strategies that will help maintain good health.
2. appreciate that regular check-ups can help in identifying problems and treat them e.g. eye tests, dental visits, smear tests, breast and testes examinations	▶ Find out what check ups are advised for people at different ages.
3. know that there are many ways in which disease-causing organisms can enter the body	▶ Research how common diseases are transmitted, detected and treated.
4. appreciate how the different infectious diseases are transmitted	▶ Research the causes of common diseases.
5. understand how the body fights disease	▶ Appreciate the role of bacteria, viruses and fungi in causing illness. ▶ Find out which diseases that are common now and which were common fifty years ago.
6. appreciate that certain diseases can be prevented by appropriate inoculation	▶ Survey the class to find out what immunisation and vaccinations they have had. ▶ Find out the history of inoculation e.g. Jenner and cowpox. ▶ Find out the appropriate immunisations and vaccinations when travelling to different parts of the world.

Unit 4: Maintaining health 2 (Continued)

LEARNING OUTCOMES	TEACHER GUIDELINES
7. review the effects of a poor quality environment on health	▶ Identify gases that are present in the atmosphere and appreciate the need for fresh air i.e. plenty of oxygen. ▶ Compare the levels of carbon dioxide in inhaled and exhaled air. ▶ Test local air and water quality e.g. by observing lichens in the environment, test water for dissolved solids. ▶ Using a sound level meter measure local noise levels. ▶ Make a poster and/or presentation on the dangers of UV radiation and its link to skin cancer.
8. understand the effects of smoking on health	▶ Measure lung capacity of a smoker and a non-smoker. ▶ Burn a cigarette and look at the residues e.g. tar. ▶ Survey class and/or school to see how many students smoke. ▶ Discuss in small groups the question of passive smoking.
9. identify behaviour and environmental conditions that pose a risk to health	▶ Study one behaviour that poses a risk to health e.g. smoking and lung cancer, poor diet and heart disease, casual sex and AIDS/HIV. ▶ Study one possible environmental risk to health.
10. present the best advice on maintaining health and appreciate that this advice changes as we understand more about the body and its systems.	▶ Investigate the best advice on diet, exercise, sleep, check-ups, immunisation etc. through newspapers, television and videos and the world wide web and make a presentation/poster on their research.

Unit 5: Children's health

LEARNING OUTCOMES

The student will be able to:

1. describe the menstrual cycle
2. identify the different stages of development of the foetus
3. list the needs of the mother during pregnancy
4. describe the different stages of development of a child
5. describe an appropriate diet for children at different ages
6. list the different tests that are done to small children to monitor their development

TEACHER GUIDELINES

- Provide information on and promote understanding of the male and female reproductive systems, menstruation, how and when conception takes place and methods of family planning.
- Using videos, posters, charts review the development of the baby from conception to birth.
- Find out by research the needs of the mother during pregnancy e.g. rest, exercise, diet. Appreciate the importance of a healthy, balanced diet for foetal development.
- Find out the effects of smoking and alcohol on the developing foetus.
- Appreciate how the needs of children change as they grow and develop.
- Discuss the benefits of breast feeding.
- Review main elements of a healthy diet e.g. food pyramid.
- Find out children's needs for energy, especially fat, and vitamins and minerals.
- Talk from a nurse or a health visitor on children's diet.
- Compare the fat content of low fat milk and full fat milk in the context of the needs of growing children.
- Find out why the PKU test is done immediately after birth.

Unit 5: Children's health (Continued)

LEARNING OUTCOMES	TEACHER GUIDELINES
7. identify strategies that help keep children healthy	▶ Visit a local health clinic and find out about the records kept on children's health. ▶ Invite a community nurse to visit the class. ▶ Appreciate the function of the different developmental tests. ▶ Find out the regular check-ups that children need e.g. regular visits to the dentist. ▶ Appreciate the role fluoride in water plays in reducing dental caries. ▶ Find out if the local water supply contains fluoride. ▶ Debate the issue of water fluoridation.
8. identify the different inoculations given to children	▶ Research the history of vaccination. ▶ Visit a local health clinic. ▶ Investigate the different diseases and find out why immunisations and vaccinations are given to children. ▶ Understand why immunisations and vaccinations are free to children. ▶ Debate the issue of whooping cough vaccination.
9. list common forms of disability and how they are caused.	▶ Appreciate the difference between mental and physical disability. ▶ Understand that disabled children have the same needs as able-bodied children. ▶ Appreciate that some forms of disability can be prevented or modified e.g. rubella immunisation of girls aged 10-14, taking folic acid prior to conception reduces incidence of spina bifida. ▶ Other forms of disability may be genetic e.g. cystic fibrosis, Down's syndrome.

Unit 6: Investigating the body

LEARNING OUTCOMES

The student will be able to:

1. identify how information about the human body is obtained

2. appreciate how body chemicals give information about the body

3. appreciate how basic measurements give information about the human body

4. understand how electricity, electromagnetic radiation, sound, and magnetic fields can give information about the human body

TEACHER GUIDELINES

- Review and discuss what information can be obtained from the human body.
- Measure body fat using a callipers.
- Observe how eyes, hair, fingernails, skin can change over a period of time.
- Find out the procedures for and information obtained from blood, urine tests etc.
- Investigate how the amount of sweat produced by the skin varies in different parts of the body e.g. the top and bottom surfaces of the hand.
- Investigate the procedures for and information obtained from temperature, blood pressure and other measurements.
- Use sensors and computers to display measurements from the human body e.g. heat loss from the hand or heart rates.
- Investigate light, sound, electricity and magnetism in the school laboratory.
- Investigate the procedures for and information obtained from X-rays, ECG, ultrasound, MRI and other procedures.
- Look at X-rays and other tracings to see how the information is presented.
- If doing the environment module, find out, what radiation dose comes from routine X-rays and compare this with the radiation dose from radon.

Unit 6: Investigating the body (Continued)

LEARNING OUTCOMES	TEACHER GUIDELINES
5. appreciate that pain is an indicator of something wrong with the body	▶ Research how pain indicates something is wrong and how absence of pain can be very dangerous.
6. realise that different people have different pain thresholds	
7. appreciate the role of medication, rest, diet and exercise in the treatment of illness	▶ Many illnesses can be treated with appropriate medication e.g. those caused by bacteria. Other are better treated through rest, diet and exercise e.g. those caused by viruses.
8. understand the role of medication in the treatment of illness	▶ Find out about the different medications used to treat illness e.g. antibiotics, painkillers.
9. appreciate the dangers of self-medication	▶ Investigate the regimen needed for different medications e.g. antibiotics need to be taken until the prescribed course is finished, diabetics require regular doses of insulin. ▶ Find out what happens to 'bugs' if courses of medicine are not completed.
10. appreciate that some diseases need more aggressive treatment	▶ Investigate how hormones can be used to treat a range of medical conditions e.g. insulin, thyroxin. ▶ Investigate the different treatments for cancer e.g. radiotherapy and chemotherapy. ▶ Find out why transplants are necessary. ▶ Invite a speaker from Irish Kidney Association or similar to talk to the class.

Unit 6: Investigating the body (Continued)

LEARNING OUTCOMES

11. outline some of the features of alternative medicine

12. identify the different roles of health care workers.

TEACHER GUIDELINES

- Identify a range of alternative medical therapies and the basis on which they work.
- Investigate the scientific basis of one therapy.
- Investigate health care workers in a local hospital, GP surgery or health clinic.
- Research (in groups) the different work of doctors, nurses, radiographers etc. and make a presentation to the class.
- Invite a health care worker to talk to the class about the scientific aspects of their work.

RESOURCES

Equipment: basic science equipment as found in school laboratories

REFERENCES

Basic Skills. Health, Hygiene and Safety by Di Barton and Wilf Stout. London: John Murray, 1988.

Science. The Salter's Approach GCSE Volume 1 Year 10 Units
by B. Campbell, J. Lazonby, R. Millar and S Smyth.
London: Heinemann, 1997. The unit *Keeping Healthy* is very useful and there is an accompanying workbook.

Science. The Salter's Approach GCSE Volume 2 Year 11 Units
by B. Campbell, J. Lazonby, R. Millar and S. Smyth,
London: Heinemann, 1997. The unit *Seeing the Body* is very useful and there is an accompanying workbook.

Medical Physics. University of Bath Science 16-19
by Martin Hollins Walton-on-Thames: Nelson, 1992

The World of Science by Andrew Hunt(ed.). London: John Murray, 1997

The World of Science. Teacher's Resource Book by Andrew Hunt(ed.). London: John Murray, 1997

Eco-friendly Enterprise, CDVEC, Curriculum Development Unit, The Natural Resources Development Centre, Trinity College Dublin. Dublin: TCD/CDU, 1997.

TEACHING PACKS, BOOKLETS, LEAFLETS AND POSTERS

Breathing Made Easy. Chemical Industry Education Centre, York

Disease Booklets: Asthma, Bacterial Infections, Epilepsy, Migraine, Ulcers, Viral Infections available from ASE

Life-Saving Science: Serendipity and Success. ABPI available from ASE

Medicines and Drugs: The Facts. ABPI available from ASE

Medicines, Health and You - Posters Sets 1 and 2.
ABPI available from ASE
The three publications of ABPI are excellent resources for practical work, questions and other activities.

From Molecule to Medicine Science information leaflets for KS4 and Post –16 students

OTHER BOOKS:

- Primary Science
- Junior Certificate Science
- Leaving Certificate Biology, Physics, Chemistry and Home Economics

NEWSPAPERS

Sunday Business Post – health page

Irish Times - features page, science page on a Monday

There are many websites devoted to health and specific conditions. These will be a useful resource in the work of the module
e.g. www.onhealth.com www.icgp.ie

TELEVISION PROGRAMMES

Medical dramas e.g. ER, Casualty

Consumer programmes often feature health items

Travel programmes will deal with health care while travelling and in hot climates

VIDEOS

'The Miracle of Life'

CD ROMs

Dorling Kindersley, "The Human Body"

KEY ASSIGNMENTS

MODULE 1: **SCIENCE AND HEALTH**

CHECKLIST

I have completed the practical skills assignment (if not previously done). ☐

OR

I have contributed to the design of at least one questionnaire. ☐

I have carried out and written up at least five practical laboratory – based group experiments (involving one or two other students). ☐

I have visited one location of health care (e.g. clinic or a hospital ward or a doctor's surgery or some other aspect of health care) OR listened to a presentation by a health care worker, and prepared a scientific account of the visit or talk. ☐

I have researched one aspect of science and health using newspapers books and the Internet and made a presentation (oral or visual) to the class. ☐

Signed: _____ Date: _____

(Name of student)

Appendix 1: Laboratory Practicals

Five laboratory practicals recommended for this module are given below. Additional laboratory practical work is recommended and suggestions are given in Appendix 2 at the back of this book.

Unit	Practical	Materials	Additional Information	Result/ Calculation
2	Examining cells & tissues	Microscope onion cells methylene blue prepared slides	Use of cheek cells not advised cf. Safety guidelines from DES	Observe, draw
3	Effects of exercise	Balloons – measure volume of exhaled air before and after exercise	Adequate supervision, care needed with asthma and other complaints	Observation
4	Residues in a cigarette	U – tube Pump Balance Cigarette	Care with asthmatics in room	Observation Measure mass before and mass after, calculate % increase in mass
5	Comparison of full fat and low fat milk	Microscope Slide and coverslips Stain Milk samples		Observe, draw
6	Investigate light, sound, electricity and magnetism	Standard school equipment	Links to JC Science and LC Physics	Observation Recording

Signed: _____ Date: _____

(Name of student)

MODULE 2:

SCIENCE AND THE ENVIRONMENT

MODULE 2:

SCIENCE AND THE ENVIRONMENT

PURPOSE

The purpose of this module is to enable students to develop a basic understanding of relationship between science and their environment. The module will develop an appreciation of the interrelationships between science, technology and society that are part of the everyday world.

PREREQUISITES

None.

AIMS

The module aims to:

- enable students to understand that science and technology can both provide a clean safe environment in which to live and contribute to the deterioration of the environment
- promote appreciation of the importance of protecting the environment
- develop students' understanding of the relationship between pollution and health
- enable students to read a newspaper article on the environment and understand the basic terms used
- empower students to ask appropriate questions on environmental issues
- enable students to find out information from encyclopaedia, CD-ROM, website or other media on environmental issues, make sense of the information provided and evaluate it critically.

UNITS

Unit 1: Working in a Laboratory

Unit 2: Air

Unit 3: Water

Unit 4: Soil

Unit 5: Energy

Unit 6: Built Environment

Unit 1 is in Section 2 pages 16-18

Unit 2: AIR

LEARNING OUTCOMES	TEACHER GUIDELINES
The student will be able to:	
1. name the gases in air and give the percentage composition	▶ Identify these gases, using a Periodic Table.
2. appreciate that oxygen is produced by photosynthesis	▶ Show that oxygen is produced in photosynthesis using pondweed, include the test for the presence of oxygen, properties and uses. ▶ Show that CO_2 is necessary for photosynthesis, based on teacher demonstration, including the test for starch.
3. describe the properties and uses of carbon dioxide and discuss the need for 'green space' in relation to town planning	▶ Show the presence of carbon dioxide in the air. ▶ Inter-dependence between plants and humans (gaseous requirements). ▶ Class debate, based on town planning map showing designated 'green space'.
4. identify different sources of air pollution	▶ Find out sources of air pollution. ▶ Explain how the levels of these air pollutants can be reduced and how they can affect health.
5. appreciate the relationship between lichen growth and air quality	▶ Investigation using two different local areas (one rural, one urban), analyse information.
6. explain the relationship between the combustion of fuels and air pollution	▶ Relate to the 'greenhouse effect', global warming and the production of airborne particulates.

Unit 2: AIR (Continued)

LEARNING OUTCOMES	TEACHER GUIDELINES
7. show an understanding of the 'greenhouse effect'	▶ Draw a simple cycle, relate to global warming. ▶ Demonstrate the 'greenhouse' effect in the laboratory.
8. demonstrate an understanding of the importance and functions of the ozone layer and appreciate the effects of UV rays	▶ Draw a simple cycle. ▶ Find out about compounds which are known to destroy the layer, relate ozone depletion to skin cancer. ▶ Investigation - everyday products which contain/contained these compounds.
9. identify how indoor air pollution can occur	▶ Investigation of pollutants, their sources, effects and how they can be reduced, eliminated or replaced, relate to oxides of nitrogen, carbon dioxide, tobacco smoke etc. ▶ Investigate airborne particles in outdoor air and how smog is formed.
10. demonstrate some understanding of the causes and effects of acid rain.	▶ Show by experiment how the pH of rain water varies (rural/urban).

Unit 3: Water

LEARNING OUTCOMES

The student will be able to:

1. list the properties and uses of water
2. name two gases in water
3. explain the importance of clean water
4. identify the advantages of hard and soft water
5. identify the main sources of water pollution

TEACHER GUIDELINES

- Brainstorm everyday uses of water.
- Show by experiment the presence of oxygen and carbon dioxide in water.
- Role of water in the body, water purification and the dangers to health of using unclean water.
- Culture bacteria from water sources - using pre-prepared agar plates.
- Observe the effects of a disinfectant on bacterial growth, teacher demonstration.
- Find out about the role of calcium and magnesium in healthy bones and teeth.
- Show by experiment how hardness in water can vary, using water from two different sources.
- Relate to detergents, domestic waste, water, sewage, slurry, silage, fertilisers and contaminated ground water.
- Name the active pollutants in the above, refer to the Periodic Table, relate to availability of nutrients for bacterial and plant growth, refer to eutrophication, relate to toxic substances which kill and damage water life.

Unit 3: Water (Continued)

LEARNING OUTCOMES	TEACHER GUIDELINES
6. explain the terms biodegradable, nutrients, toxins and appreciate the differences between a biological and non-biological detergent	▶ Draw cycles showing the relationship between pollutants and oxygen depletion in water. ▶ Show that oxygen levels in water vary with temperature, mention 'thermal pollution'. ▶ Find out how pollution levels can be measured by DO and BOD levels. ▶ Relate these terms to sources of water contamination. ▶ Discuss allergic reactions to biological washing powders. ▶ Show the action of enzymes in biological washing powders by experiment.
7. describe sewage and water treatment plants and understand why chlorine and fluoride (toxic at >1 PPM) are added to water for human consumption.	▶ Draw a flow chart. ▶ Structured visit to a water treatment plant, design a questionnaire. ▶ Brainstorm and discuss the physical and chemical differences between clean and dirty water samples. ▶ Show water filtration by experiment. ▶ Role of chlorine (kills pathogens) and fluoride (prevents dental caries) in Ireland's water supply.

Unit 4: Soil

LEARNING OUTCOMES	TEACHER GUIDELINES
The student will be able to:	
1. describe the composition of two different soils and identify the sources and functions of soil components	▶ Compare the structure of two soil samples, observe and record results, based on teacher demonstration. ▶ Show by experiment the structure of two different soil samples. ▶ Show the presence of humus and inorganic matter in two soil samples. ▶ Calculate the % humus and inorganic matter in the two samples. ▶ Practical investigation-research into the different types of soils.
2. explain the importance of presence of earthworms in a good soil and appreciate the importance of drainage in soils	▶ Make a wormery and observe the activity over a five day period. ▶ Test the drainage of two different soils.
3. describe how acids can weather limestone rock	▶ Test limestone with acid(including weathering of rock limestone), release of metal ions and show how these ions can be detected.
4. identify the main sources of soil pollution	▶ Relate to insecticides, herbicides, fungicides and heavy metal contamination.
5. name an insecticide, a herbicide and a fungicide	▶ Refer to the function of insecticides, herbicides and fungicides.

Unit 4: Soil (Continued)

LEARNING OUTCOMES

6. explain the term 'bioaccumulation' and suggest methods to reduce the over use of insecticides, herbicides and fungicides and suggest alternatives.

TEACHER GUIDELINES

- Historical investigation, refer to DDT and to bioaccumulation in food chains, food webs, in body fat and its effects on health/refer to 'Agent Orange', its uses and effects on health etc./refer to dioxin, its uses and effects on health - Seveso, Italy 1976 and Bhopal, India, 1986.
- Investigation – design a questionnaire to find out what a section of the population knows about the uses, alternatives, dangers etc. of pesticides.

Unit 5: Energy

LEARNING OUTCOMES

The student will be able to:

1. identify different forms and uses of energy
2. appreciate that fuels produce energy and name the units of energy associated with fuels
3. identify the different ways in which electricity is produced in Ireland
4. discuss current energy-related issues in Ireland and identify possible approaches which scientists and governments could consider to address some of the problems associated with energy production.

TEACHER GUIDELINES

- Include the units of energy and two examples of energy conversion.
- Investigation into the uses made of energy.
- Energy audit of school or home, analyse results
- Show by experiment using two different fuels –see Food module.
- Show the products of burning.
- Use a map to locate the electricity power plants in Ireland.
- Class debate to compare and contrast two methods of production, highlight advantages and disadvantages.
- Show by experiment the uses of electrical energy.
- Structured visit to an ESB station.

Unit 6: Built Environment

LEARNING OUTCOMES

The student will be able to:

1. appreciate that buildings are part of the environment and identify the reasons for developing the built environment

2. identify factors which affect the built environment

3. list three materials used in building and explain why these are used

TEACHER GUIDELINES

- Investigate the local built environment, record and tabulate the range and uses made of local buildings.
- Brainstorm (human need for shelter, warmth, protection, for work etc.)
- Investigate ventilation, light and heat in a room.
- Show by experiment that CO_2 levels vary in a room which is occupied/unoccupied.
- Show by experiment that light levels vary in a room at different times of the day & when different sources of light are used.
- Show that temperature varies in a room at different times of the day and when different sources of heat are used.
- Show that some substances are good conductors of heat and/or electricity and others are not, use a range of materials.
- Identify good insulators.
- Relate the materials identified to their properties - slate, thatch, cement, timber, glass, ability to conduct heat, insulating materials etc.
- Materials used in building should be non-toxic to both plants and animals. Find out about toxic materials used in buildings e.g. methanal, asbestos, glass fibre etc.

Unit 6: Built Environment (Continued)

LEARNING OUTCOMES	TEACHER GUIDELINES
4. identify the services required within the built environment	▶ Survey a room at home or school e.g. the laboratory, relate the services required to factors such as water, ventilation, sewage disposal, light (natural & artificial), heating (use of fuels, conduction, convection and radiation), electricity supply etc.
5. identify the uses of electricity in the home	▶ Test simple electric circuits. ▶ Investigate different types and uses of circuits used in the home. Identify ways of conserving energy with reference to a range of household appliances. ▶ List the safety features associated with electricity supply e.g. fuses, circuit breakers, ELCB. ▶ Wire a plug correctly. ▶ Show how a fuse works (with diagram).
6. investigate the supply and use of water in the home	▶ Brainstorm on need for clean water e.g. for health and in food preparation. ▶ Need to dispose of waste water safely. ▶ Water treatment prior and post use, see laboratory practical in Unit 3. ▶ Role of fluoride in drinking water (dental caries) ▶ Water supply in the home - use of gravity - water supply from storage tank in attic.

Unit 6: Built Environment (Continued)

LEARNING OUTCOMES

7. identify risks and hazards in the environment.

TEACHER GUIDELINES

- Find out about the risks in the environment, include lightning conductors, risks of some building materials e.g. methanal, asbestos etc., poor insulation of electric wiring, use of smoke detectors etc.
- Write to the RPII, Enfo and Department of the Environment for information, check appropriate websites.
- Demonstration showing how radioactivity can be detected.
- Investigate radiation in the environment, natural radiation (background), dangers of ionising radiation.
- Investigate radon gas, routes by which it can enter buildings, how to detect, monitor and reduce the gas levels.
- Guest speaker.
- Class debate on a selected risk.

RESOURCES

Equipment: basic science equipment as found in school laboratories

TEACHER REFERENCE BOOKS AND JOURNALS

Eco-friendly Enterprise, Curriculum Development Unit & The Natural Resources Development Centre, Trinity College Dublin

Chemistry in Action, P. Childs (ed), tel: 061-202075; fax: 061-202568; e-mail peter.childs@ul.ie (articles relating to the environment)

Chemistry and the Environment, J. Johnston, N. Reed & B. Faust (eds), The Royal Society of Chemistry, Burlington House, Piccadilly, London WIV OBN

Environmental Licensing and Control in Ireland, A Guide for Industrialists, Enterprise Ireland (Forbairt), Glasnevin, Dublin 9 (tel: 01-808200; fax: 01-8082259) Teacher reference book

Technology Ireland, T. Kennedy (ed.) Enterprise Ireland, Merrion Hall, Strand Road, Dublin 4 (tel: 01-2066337/01-2066000; fax: 01-2066342; website: www.enterprise-ireland.com

NSCA Pollution Glossary, National Society for Clean Air and Environmental Protection, 136 North Street, Brighton, East Susses, BN1 1RG

Environment Bulletin, Y. Rowland (ed.) Department of the Environment and Local Government, Custom House, Dublin 1. (tel: 01-8882601; fax: 01-8882014; e-mail: yvonne_rowland@environ.irlgov.ie)

State of the Environment in Ireland, L. Stapleton (ed.), Environmental Protection Agency, Ardcavan, Wexford (tel: 053-47120; fax: 053-47119)

OTHER BOOKS

Primary Science
Junior Certificate Science
Leaving Certificate Biology, Physics and Chemistry
Reference materials listed for other Leaving Certificate
Applied Science Modules

SOURCES OF REFERENCE MATERIALS

Commission of the European Union, 39 Molesworth Street, Dublin 2 (tel: 01-6712244)

Copies of EU documents may also be obtained from European Union documentation centres in the universities in Cork, Dublin, Galway and Limerick

ENFO Publications, Department of the Environment and Local Government Information Service, 17 St. Andrew Street, Dublin 2. (tel: 01-1890-200 191; fax: 01-8882947; e-mail: info@enfo.ie; website: www.enfo.ie)

Government Publications Sales Office, Sun Alliance House, Molesworth Street, Dublin 2 (tel: 01-6793515 / 01-6710309) Publications relating to legislation, statutory instruments and directives may be obtained from this address.

Radiological Protection Institute of Ireland, 3 Clonskeagh Road, Dublin 14 (tel: 01-2697766; fax: 01-2697437)

KEY ASSIGNMENTS

MODULE 3: **SCIENCE AND THE ENVIRONMENT**

CHECKLIST

ENVIRONMENT

I have completed the practical skills assignment (if not previously done) ☐

OR

I have contributed to the design of at least one questionnaire ☐

I have carried out and written up at least five practical laboratory – based group experiments (involving one or two other students) ☐

I have visited an environmental water treatment plant or waste water treatment plant, listened to a presentation by a member of staff and prepared a scientific account of the above visit ☐

I have researched one aspect of the environment using newspapers, books and the Internet and made a presentation (oral or visual) to the class ☐

Signed: _____ Date: _____

(Name of student)

Appendix 1: Laboratory Practicals

Five laboratory practicals recommended for this module are given below. Additional laboratory practical work is recommended and suggestions are given in Appendix 2 at the back of this book.

Unit	Practical	Materials	Additional Information	Result/ Calculation
2	Air borne particles. **OR**	Microscope slides. Vaseline. Microscope. Cover slips.	Place vaselined microscope slides in two different places. Place a cover slip oneach slide (reference).	Compare slides. Tabulate.
2	Test for the presence of water in air and PH of water in air. **OR**	Cobalt chloride. Paper. pH paper. Test tube and ice.	Leave for one week. Make sure that the cobalt chloride paper is dry. Use Universal indicator paper.	Record results.
	Test for O_2 and CO_2	Timber splint. Test tube. Limewater. Gas-making apparatus. HCl, $CaCO_3$ H_2O_2, MnO_2	Make sure that the splint does not touch the inside of the damp test tube.	Record results.
3	Culture bacteria and/or fungi.	Agar plates Inoculating loop Bunsen burner Oven Labels Microscope Slides & coverslips	Pre-prepared plates. Use two water samples from different sources. Lake or stream water could be used. Compare both samples.	Observe and draw. Tabulate.
4	Weathering of rock. **OR**	Samples of different rock. Electronic balance. Range of acids. Dropper pipette. Trough. Timer. Filter paper.	Place rocks in trough. Weigh before and after. Leave acids on rocks for the same time. Mop dry with filter Paper. Wear rubber gloves. Re weigh.	Observe results. Tabulate. Calculate % weight loss.

Appendix 1: Laboratory Practicals (Continued)

4	Detection and Identification of Metal ions.	Samples of different metal salts. Platinum loop. HCl. Bunsen burner.	Chlorides should be used. Use a range of salts Calcium, Magnesium Potassium, Sodium, etc.	Tabulate.
5	Products of burning fuels.	Two fuels. Funnel. Tubing. Beaker (large). Boiling tube. Bung with two holes. Test tube. Ice. Cobalt chloride. Paper. Limewater. Electronic balance. Timer.	Remember to weigh the funnel before beginning the experiment.	Tabulate. Calculate % water and soot.
6	Light intensity in a room. **OR**	Light meter. Different sources of light.	Sources of light - day light, bulbs of different wattage, candle etc. Record at different time of the day. Place	Tabulate Graph.
6	Variation in temperature levels in rooms. **OR**	Thermometers.	thermometers in different places in two rooms. Record every 40 minutes for 1 school day.	Tabulate Graph.
6	CO_2 levels in an occupied and an unoccupied room.	Beakers. Timer. Filter paper. Six funnels. Electronic balance. Oven. Limewater.	Put same volume of limewater in six beakers. Leave 3 in occupied and 3 in an occupied room for 24 hours. Filter, dry and re- weigh.	Calculate % $CaCO_3$

Signed: _____ Date: _____

(Name of student)

MODULE 3

CONSUMER SCIENCE

MODULE 3:

CONSUMER SCIENCE

PURPOSE

The purpose of this module is to present science in a social context. It hopes to promote true understanding of some consumer relevant scientific phenomena, thus empowering students to make informed, intelligent decisions regarding scientific issues. Given the time constraints, it is important to cover topics that are of immediate interest to young people, thereby increasing the motivation required for meaningful learning.

PREREQUISITES

None.

Note: Students should not test/use laboratory prepared substances from this module on themselves or on other students.

AIMS

The module aims to

- develop students' appreciation of how science is used in the manufacturing industry
- give students the opportunity to investigate consumer products and make informed judgements regarding issues such as "value for money" and "health and safety"
- provide opportunities for students to participate in scientific processes relevant to the consumer
- give students an understanding of the role of some commonly used medicines
- enable students to read a newspaper article on consumer matters and understand the basic terms used
- empower students to ask appropriate questions on consumer issues
- enable students to find out information from encyclopaedia, CD-ROM, website or other media on consumer issues, make sense of the information provided and evaluate it critically.

UNITS

Unit 2: Food and Medicines

LEARNING OUTCOMES

The student will be able to:

1. explain why plants are the first link in the food chain
2. give the word equation for photosynthesis
3. identify the organisms responsible for food spoilage
4. understand the importance of food safety
5. explain what is meant by genetically modified food
6. explain genetic terms in common usage in the media

TEACHER GUIDELINES

- Prepare slide of spirogyra and view chloroplast under microscope.
- Test leaves of plants exposed to light and dark conditions for starch.
- Demonstrate that oxygen is produced in photosynthesis.
- Grow bacteria and fungi using prepared agar plates.
- Brainstorm for students` ideas on food poisoning.
- Test effect of commercially produced disinfectants on bacterial growth.
- Newspaper articles or other sources dealing with E.coli and Salmonella.
- Practical investigation demonstrating effects of freezing, salting, pickling, dehydrating, sugaring and relate to sell by date printed on common consumer products.
- Check products at home, compare their shelf lives and explain why some last longer than others.
- Brain storm for genetic terms in media collect newspaper articles on GMFs.
- Draw flow charts showing production of, for example, genetically modified soya.
- Use CD ROM.
- Check labelling of food products in local supermarkets.

Unit 2: Food and Medicines (Continued)

LEARNING OUTCOMES	TEACHER GUIDELINES
7. explain that DNA is the cell's heredity material	▶ Make a model of DNA. ▶ View DNA under microscope.
8. outline the story of penicillin with reference to the observations and experiments of Fleming, Chain and Florey and the social climate at the time	▶ Visit library and use ICT to find out about the development of penicillin. ▶ Teacher demonstration to produce penicillin from a mould. ▶ Student practical investigation to show effect of previously prepared penicillin on culture of bacteria. ▶ Video.
9. classify a number of medicines under headings of use, side-effects and cost	▶ Visit local chemist or supermarket and read labels and guidelines given by manufacturer.
10. explain what is meant by the *active ingredient* of a product and check its % volume in a number of widely available products.	▶ Test effect of powders produced commercially for the treatment of athletes foot and compare with one produced by students. **Caution: Students should not test/use laboratory prepared substances on themselves or on other students.**
11. design a table illustrating which brands offer value for money regarding for example content of paracetemol, vitamin C, Folic acid etc.	▶ Examine ingredients of a range of products available for the treatment of colds and flu and identify common substances. ▶ Practical investigation to check a variety of commercially available orange juices for Vitamin C content using DCPIP.

Unit 3: Cosmetics

LEARNING OUTCOMES	TEACHER GUIDELINES
The student will be able to:	
1. draw diagram of skin and outline functions of its parts	▶ Students design an experiment to investigate sense of touch on three different skin surfaces. ▶ Students design an experiment to investigate which skin surfaces produce most sweat. ▶ Test effect of anti-perspirants on sweat production. ▶ Brainstorm for differences between old and young skin and find out what causes skin to wrinkle.
2. define cosmetic	▶ Brainstorm for definition of a cosmetic. ▶ Discuss difference between plastic and cosmetic surgery. ▶ Discuss cosmetics used by historical figures e.g. Cleopatra.
3. define and prepare an emulsion	▶ Practical investigation to illustrate the principle of an emulsion.
4. prepare a variety of cosmetics and outline their effect on skin	▶ Laboratory preparation of for example a moisturiser, talcum powder, shaving cream, nail varnish and remover, eye shadow. **Caution: Students should not test/use laboratory prepared substances on themselves or on other students.**
5. identify ingredients of commercially produced cosmetics and explain their inclusion in composition of product	▶ Students bring cosmetics they have at home to school, check/compare composition in small groups.

Unit 3: Cosmetics (Continued)

LEARNING OUTCOMES	TEACHER GUIDELINES
6. explain the difference between lotion, cream and ointment	▶ Collect advertisements from magazines and discuss claims made by manufacturers. ▶ Students survey people in the community on their product preferences. ▶ Find out how an older person with particularly good skin looked after her/himself. ▶ Visit a cosmetic production company or, if not, check one out on the web and find out how it operates. ▶ Check which firms use animal testing and find out what happens the animals. ▶ Collages
7. compare home-produced products with those produced commercially under headings such as cost, effectiveness, animal rights, waste etc.	▶ Students bring in a moisturiser they use at home and compare its effectiveness against the one they have prepared in the laboratory. ▶ Prepare samples of herbal preparations for the treatment of for example sunburn and compare with commercially available products. ▶ Role play between a cosmetic sales representative and a pharmacist.

Unit 4: Cleaning Agents

LEARNING OUTCOMES

The student will be able to:

1. state the difference between solute and solvent, between hard and soft water, between soapy and non-soapy detergents, between biological and non biological detergents
2. explain how detergents work in the washing process
3. investigate the effectiveness of commercially produced detergents
4. examine the effects of biological and non-biological detergents and explain result
5. outline the role of enzymes
6. explain principles of stain removal
7. compare effectiveness of commercially produced stain removal products with those prepared by students
8. outline principles of the dry cleaning process
9. assess the environmental effects of detergents.

TEACHER GUIDELINES

- Laboratory practical to illustrate solute/solvent, hard/soft and soap/non-soapy.
- Discuss process using a flow chart.
- Laboratory preparation of soap.

  Caution: Students should not test/use laboratory prepared substances on themselves or on other students.
- Students predict which detergent will be most effective on for example chocolate, grease etc., perform test, observe result and then try to explain.
- Laboratory investigation.
- Students ask older people in the community what they used for removing stains from fabrics before the advent of commercially produced products.
- Laboratory investigation.
- If time allows it may be appropriate to consider dyeing fabrics.
- Visit a dry cleaners and interview personnel.
- Newspaper articles and Enfo sheets dealing with effect of phosphates on our rivers and lakes.
- Visit a local lake/stream/river and look for evidence of phosphates.

Unit 5: Plastics

LEARNING OUTCOMES	TEACHER GUIDELINES
The student will be able to:	
1. define polymer	▶ Make models of polymers..
	▶ Laboratory practical *disappearing cup.*
2. define plastic	▶ Collect a variety of plastics and discuss under headings such as use, durability, cost etc.
	▶ Brainstorm.
3. identify petroleum as the raw material for plastic	▶ Ask students where they think plastics come from.
4. distinguish between natural and synthetic polymers	▶ Brainstorm
	▶ Students work in small groups and tabulate results.
5. list a number of products which in the past were produced using materials other than plastic	▶ Consult libraries, ICT, local suppliers to find typical applications of different plastics and find out what was used before the advent of plastics.
	▶ Draw graphs to illustrate the growth in production of plastics since 1900.
6. compare life cycles of glass and plastic bottles regarding energy costs/recycling etc.	▶ Consult libraries, ICT.
7. identify materials useful for food preservation	▶ Practical investigation.
8. identify materials useful for heat and electrical insulation	▶ Practical investigation

Unit 5: Plastics (Continued)

LEARNING OUTCOMES	TEACHER GUIDELINES
9. describe methods and problems associated with plastic waste disposal	▶ Libraries, ICT. ▶ Visit land fill site. ▶ Enfo sheets. ▶ Brainstorm.
10. list ways of recycling plastics in the home 11. identify ways environmentally conscious enterprises could recycle plastic	▶ Libraries, ICT.
12. list advantages and disadvantages of plastics.	▶ Students work in small groups and tabulate results.

Unit 6: Environment

LEARNING OUTCOMES	TEACHER GUIDELINES
The student will be able to:	
1. distinguish between the respect shown for the earth by indigenous societies with that shown by industrialised societies	▶ Role play
2. explain what is meant by thinking globally and acting locally.	▶ Brainstorm ▶ Students design a questionnaire to examine how their classmates deal with their immediate environment.
3. identify water as an essential natural resource	▶ List ways water is used in the home. ▶ Brainstorm ▶ Draw a bar chart showing average water consumption for some household activities. ▶ List ways students could cut down on their use of water and explain why this would be sound environmental practice. ▶ Investigate the amount of water lost by a dripping tap.
4. identify the effect of waste water from homes, farms, industries on the environment	▶ Newspaper articles. ▶ Results of studies done by government agencies. ▶ Enfo sheets.
5. contrast nature's natural cycles with industries linear systems	▶ Nitrogen cycle vs. mine - manufacture – discard.

Unit 6: Environment (Continued)

LEARNING OUTCOMES	TEACHER GUIDELINES
6. identify main energy sources and give consequences	▶ Fossil fuels and oil. ▶ Design a questionnaire to measure energy use in home. ▶ Brainstorm for ways of reducing energy consumption.
7. define pH 8. define acid rain.	▶ Test pH of a variety of substances e.g., toothpaste, orange juice, water, unpolluted rain water, HCl, NaOH. ▶ Investigate effects on plants and/or buildings, rivers.
9. identify recycable household waste. Describe how and where it could be recycled.	▶ Enfo TY pack. ▶ Visit a recycling plant or find out how materials are recycled. ▶ Survey the community to find out how many use bottle banks and / or green bins. ▶ Visit a landfill site and identify substances which could be put to better use. ▶ Design posters encouraging people to recycle.

RESOURCES

Equipment: basic science equipment as found in school laboratories

REFERENCES

- Leaving and Junior Cert. Science text books
- ***Science. The Salter's Approach GCSE Volume 1 Year 10 Units*** by B. Campbell, J. Lazonby, R. Millar and S Smyth. London: Heinemann, 1997.
  Science. The Salter's Approach GCSE Volume 2 Year 11 Units by B. Campbell, J. Lazonby, R. Millar and S. Smyth, London: Heinemann, 1997.
- Other science LCA modules

UNIT 1: FOOD AND MEDICINES

- EU funded CD-ROM on biotechnology is being distributed free to 2nd level schools. Already available on the Internet at: - www.reading.ac.uk/NCBE.
- ***Genetic Engineering and Farm Animals*** CIWF
- ***Life Saving Science: - Science Serendipity and Success*** Pupil Activities and Teacher notes. The British Pharmaceutical Industry.

WEB SITES: agbioworld.org cgiar.org/ifpri

UNIT 2: COSMETICS

- ***Make your own cosmetics*** by Neal's Yard Remedies, Published by Aurum Press 1997
- ***Science at Work, Cosmetics,*** Published by Addison-Wesley Publishers Limited 1979

UNIT 3: CLEANING AGENTS

Trade Secrets - Cleaning by A. Fraser Published by Orion Books ltd. 1999

The Osborne Big Book of Experiments

UNIT 4: PLASTICS

Platform an educational project on plastics for 14-16 year olds

UNIT 5: ENVIRONMENT

Eco-friendly Enterprise Linking Environmental Education and Community Enterprise Programmes, CDVEC, Curriculum Development Unit, The Natural Resources Development Centre, TCD.

The ***Enfo*** pack on water

The ***Enfo*** pack on air

KEY ASSIGNMENTS

MODULE 4: **CONSUMER SCIENCE**

CHECKLIST

I have completed the practical skills assignment (unless previously done)	☐
OR	
I have contributed to the design of at least one questionnaire	☐
I have carried out and written up at least five practical laboratory - based group experiments (involving at least one or two other students).	☐
I have visited at least one local enterprise (factory, supermarket, drycleaners, chemist), listened to a presentation by a member of staff, and prepared a scientific account of the above visit.	☐
I have researched one aspect of consumer science using newspapers, books and the Internet and made a presentation (oral or visual) to the class.	☐

Signed: _____ Date: _____

(Name of student)

Appendix 1: Laboratory Practicals

Five laboratory practicals recommended for this module are given below. Additional laboratory practical work is recommended and suggestions are given in Appendix 2 at the back of this book.

Caution: Cosmetics and other similar substances prepared in the laboratory should not be used by students or on students. The substances should be discarded after they have been tested in the laboratory.

Unit	Practical	Materials	Additional Information	Evaluation
2	Testing effectiveness of prepared penicillin.	Bunsen burner. Inoculating loop. Safety goggles. Petri dish containing a penicillin disc. Agar plate which has been treated with *Staphylococcus albus* available from scientific suppliers.	Heat loop in flame. Cool loop. Use it to lift penicillin disc out of petri dish and place in centre of dish containing bacteria. Seal with tape and leave in incubator at 25 °C.	Observation.
3	Moisturiser.	13g beeswax. 45cm³ liquid. Paraffin. 1g borax. 16.5cm³ rosewater perfume. 2, 250cm³ beakers labelled X and Y. 3 stirrers. Dropper. Bunsen burner. Tripod. 3 heatproof mats. Jar for end product. Gloves. Goggles.	Put beeswax and liquid paraffin into beaker X. Heat until wax melts stirring all the time. Leave to cool. Put borax and rosewater into beaker Y. Heat until borax dissolves stirring all the time. Leave to cool. Pour contents of Y into X and stir. Add 1 or 2 drops of perfume and stirput cream in jar and label it.	Observe and test prepared moisturiser.

Appendix 1: Laboratory Practicals (Continued)

Unit	Practical	Materials	Additional Information	Evaluation
	And compare students' moisturiser with commercial product.	2 approaches a) similar to Leaving cert. to demonstrate lower surface of leaves loses more water by transpiration. b) 2 graduated cylinders water 2 moisturisers.	a) paint moisturiser onto leaves and record which ones dry out first. b) place moisturiser on top of column of known volume of water in a graduated cylinder compare rates of evaporation.	
4	Hard Water.	Standard school equipment.	Links to JC Science.	Observation Recording
5	Making natural plastics.	1 tablespoon of vinegar 1/3 l or 33 cl whole milk.	Warm the milk. Add the vinegar, the amounts are approximate. Strain the mixture keeping the solid curds. Dry them on kitchen paper and mould them. If left to dry in a warm place they become very solid and hard. They can then be painted. Food colouring can be added to make different coloured shapes.	
6	Testing pH of variety of substances.	Toothpaste, orange juice, water, unpolluted rain water, HCl, NaOH pH meter or pH paper.		

MODULE 4

FOOD

Module 4:

FOOD

PURPOSE

This module aims to develop a basic knowledge of food chemistry in relation to nutrition, food processing and hygiene. It promotes an appreciation of the interrelationships between science, technology and society that are part of the everyday world.

PREREQUISITES

None.

AIMS

The module aims to:

- give students an understanding of the importance and the function of food
- give students an appreciation of the relationship between health and human nutrition
- enable students to outline the basic manufacturing and preservation processes involved in the food industry
- enable students to explain the importance of hygiene in food processing and preparation
- enable students to read a newspaper article on a matter of food and diet and understand the basic terms used
- empower students to ask appropriate questions of dieticians and food industry specialists whom they may meet
- enable students to find out information from encyclopaedia, CD-ROM, website or other media on food issues, make sense of the information provided and evaluate it critically.

UNITS

Unit 1: Working in a Laboratory

Unit 2: Food chemistry

Unit 3: Food nutrition

Unit 4: Nutrition and health

Unit 5: Microbiology

Unit 6: Food processing

Unit 1 is in Section 2 pages 16-18

Unit 2: Food Chemistry

LEARNING OUTCOMES

The student will be able to:

1. name the main food types and explain the role of proteins, fats and carbohydrates in the body
2. demonstrate a basic understanding of pH
3. understand the importance of water in the body and to life
4. list the advantages and disadvantages of hard and soft water.

TEACHER GUIDELINES

- Carry out and write up an experiment to test for the presence of these in foods.
- Show that a range of foods are acidic, basic or neutral.
- Show that only some foods are soluble in water.
- Find out about the role of water in the body, water purification and the dangers of using unclean water.
- Measure the % water in three foods.
- Find out about role of calcium and magnesium for healthy bones and teeth.
- Test for hardness of water using water from two different sources.

Unit 3: Food Nutrition

LEARNING OUTCOMES

The student will be able to:

1. name the units which make up the three main food types and explain their role in the body
2. name the units of energy associated with foods
3. appreciate the different nutritional components of foods

TEACHER GUIDELINES

- Restrict to glucose, amino acids, three fatty acids and glycerol in relation to functions in the body.
- Explain kJ, kcal. and the relationship between kJ and kcal.
- Investigate and record the energy values of a range of different foods.
- Measure experimentally the energy in food using one fat and one carbohydrate and one containing both food types.
- Relate the energy needs of living organisms to the seven characteristics of living things.
- Find out experimentally the carbohydrate content of different foods containing different amounts of sugar.
- Test for the presence of starch.
- Record the protein content of different foods.
- Distinguish between essential and non-essential amino acids, based on source and use in the body.

Unit 3: Food Nutrition (Continued)

LEARNING OUTCOMES	TEACHER GUIDELINES
4. list the energy requirements of different individuals, based on age occupation, etc.	▶ Record for a range of age groups, tabulate information.
5. label a diagram of the human digestive system	▶ Draw, showing where each food is digested.
6. explain the role, source and importance of fibre in diet	▶ Research information. ▶ Measure fibre content using three breads made from different grains.
7. appreciate the role, source and importance of vitamins and minerals in diet.	▶ Research and tabulate under the headings: sources, functions, deficiency symptoms for vitamins A, B group, C, D, E, K, iron, calcium, iodine and sodium. ▶ Describe and show the presence of vitamin C in foods and how it can change with cooking/processing.

Unit 4: Health And Nutrition

LEARNING OUTCOMES	TEACHER GUIDELINES
The student will be able to:	
1. understand the need for a balanced diet and identify the nutritional needs of people of different age groups	▶ Choose three age groups, tabulate information. ▶ Design a balanced diet for one of the following - (i) child, (ii) teenager, (iii) senior citizen, (iv) office worker, (v) athlete.
2. evaluate the nutritional risks/benefits of a range of diets	▶ Investigation – e.g. structured interview with one or two of (a) vegetarian, (b) vegan, (c) home economics teacher, (d) dietician, evaluate information.
3. identify the elements in the diet necessary for healthy bones and teeth	▶ Discuss the role of diet in dental health and relate to dental hygiene. ▶ Test three different toothpastes, under the headings – value, type of container e.g. (polymer, metal), pH and 'grittiness'.
4. investigate the role of diet in a range of health issues	▶ Investigation – (a) coronary heart disease, (b) cancer, (c)osteoporosis e.g. -structured interview with dietician and/or other guest speaker.
5. appreciate the dietary requirements in a range of health ailments	▶ Guest speaker on (a)diabetes, (b) coeliac disease (c)cystic fibrosis, (d) PKU . ▶ Relate diabetes to insulin and - biotechnology/genetic engineering (basic information only); -relate coeliac disease to gluten in the diet and to a range of foods; -relate PKU to an amino acid in the diet and to blood test for all neonates.
6. identify eating patterns which can pose a risk to health.	▶ Relate to food additives, poor diet, eating disorders, etc.

Unit 5: Microbiology

Particular attention to Health and Safety Guidelines is required

LEARNING OUTCOMES	TEACHER GUIDELINES
The student will be able to:	
1. list the three basic bacterial cell shapes and the difference between aerobic and anaerobic bacteria	▶ Draw and label.
2. identify fungi and identify the factors affecting bacterial and fungal growth	▶ Name one bacterium (one shape) based on its oxygen requirement. ▶ Examine and sketch yeast and two fungi which spoil food using a sample of (i) bakers yeast, (ii) two named fungi which cause food spoilage (grown in the laboratory). Use a microscope.
3. identify the sources of bacteria responsible for food poisoning and food spoilage	▶ Culture bacteria from sources using a selection of at least three sources e.g. milk, fruit, food preparation surfaces, nails, hair, skin etc. (one food, one food preparation surface and one example from the person) to show bacterial and/or fungal growth, using pre-prepared agar plates. ▶ Tabulate under the following headings - (i) bacteria causing food poisoning, (ii) source, (iii) symptoms of poisoning, (iv) conditions for growth.
4. describe the effects of an antibiotic and a disinfectant on bacterial growth	▶ Observe and record results, based on a teacher demonstration.
5. describe five different ways in which food can become contaminated with micro-organisms and identify the correct conditions for the storage of a range of foods	▶ Structured interview with (i) home economics teacher, (ii) health inspector and/or (iii) other guest speaker – record information.
6. list the main steps, in sequence, in cleaning a food preparation area.	

Unit 6: Food Processing

LEARNING OUTCOMES

The student will be able to:

1. appreciate that food is processed before it is eaten and/or stored and identify commercial food processes
2. be familiar with the EU labelling of food products
3. identify the main categories of food additives
4. describe the different methods of preserving the following - tinned tomatoes, pickled onions, carrots(jar), tinned peaches, bacon and fish
5. demonstrate some understanding of the term 'genetically modified organisms'
6. identify a range of food industries

TEACHER GUIDELINES

- Brainstorm on food processing e.g. washing, peeling, cooking, freezing, canning, bottling.
- Visit to supermarket to identify different types of food processing.
- Collect a range of labels and explain the terms used.
- Tabulate information under the following headings - (i) natural or artificial., (ii) category name, (iii) function, (iv) name two foods containing the named additive.
- Find out what is meant by 'additive induced hyperactivity'.
- Categorise the E numbers, in relation to different food additives.
- Summarise the preservation processes.
- Summarise (use a flow chart) the process of curing.
- Carry out and write up an experiment to show the pH of four different pickled foods.
- Class discussion on pros and cons of GMOs.
- List Irish food industries e.g. those that use yeast, process milk and milk products, process cereals, make soft drinks.

Unit 6: Food Processing (Continued)

LEARNING OUTCOMES	TEACHER GUIDELINES
7. explain the processing in ONE food or drink industry (milk *or* cereal *or* drinks)	▶ Select one of milk, cereal or drinks (preferably a local industry) as a focus for the study of food processing.
MILK 1. list the composition of different types of milk and describe the process of pasteurisation	▶ Investigation – record the composition of the following - full milk, low fat milk, powdered milk, UHT long-life milk. ▶ Compare souring in different full milks: test three milks based on - (a) initial pH, (b) initial fat, (c) change in pH over three days. ▶ Structured visit to a local dairy: (a) brainstorm, (b) prepare a questionnaire, (c) leave spaces for extra questions (not anticipated) (homogenisation, separation of milk into fractions) and (d) write a scientific report.
2. compare composition of butter, dairy spreads and low-fat spreads	▶ Visit a local supermarket and record differences, based on content, of three of each of the products listed.
3. identify and classify different types of cheese	▶ Give three examples, research - (library, Internet, magazines, local cheese-making and/or yoghurt enterprise etc.).
4. identify three different types of yoghurt	▶ Define the terms, bio, live culture, fromage frais. ▶ Make yoghurt. ▶ Student tasting panel for three commercial brands. ▶ Test the water content of three yoghurts.

Unit 6: Food Processing (Continued)

LEARNING OUTCOMES	TEACHER GUIDELINES
CEREAL	
1. list the four main cereal types and demonstrate some understanding of the composition of different flours and breads	▶ Examine, follow by group discussion, - recognise wheat, oats, rye and barley (from grain, books, video etc.). ▶ Investigate the composition of different flours and different breads, including additive. ▶ Investigation – research three flours and three breads.
2. appreciate the different raising agents used to make bread 3. outline the role of yeast in bread making	▶ Investigate the action of bread soda and yeast. ▶ Examine yeast using a microscope, follow by group discussion. ▶ Draw a flow chart illustrating the role of yeast. ▶ Find out why yeast is generally used in commercially made bread.
DRINKS	
1. outline the process of wine making	▶ Draw a diagram showing the process of wine-making. ▶ Examine yeast, follow by group discussion. ▶ Guest speaker, record information.
2. appreciate that wine deteriorates when exposed to oxygen	▶ Show the effect of oxygen on samples of white and red wine by measuring the change in acidity over three days (a) initial pH, (b) pH - day one, two and three.

Unit 6: Food Processing (Continued)

LEARNING OUTCOMES

3. outline the process of soft drinks manufacturing.

TEACHER GUIDELINES

- Structured visit to a soft drinks industry: (a) brainstorm, (b) prepare a questionnaire, (leave spaces for extra questions), (c) write a scientific report.
- Draw a flow chart showing the process of soft drinks manufacturing.
- Investigate the amount of carbon dioxide in different soft drinks, compare mass of CO_2 gas lost on refluxing 3 soft drinks.

RESOURCES

Equipment: basic science equipment as found in school laboratories

TEACHER REFERENCE BOOKS

Science, The Salter's Approach by B. Campbell, J. Lazonby, R. Millar, S. Symty GCSE, Volumes 1 and 2, London: Heinemann 1997

Food for Healing by R. Charles Michelin House, 81 Fulham Road, London: Cedar, Mandarin Paperbacks 1995

Hygiene in Practice by J. A. Murphy, Dublin: Gill and Macmillan.

OTHER BOOKS

Primary Science
Junior Certificate Science
Leaving Certificate Biology, Physics and Chemistry
Reference materials listed for other Leaving Certificate Applied Science Modules

SOURCES OF REFERENCE MATERIALS

CERT, 1999; Targeting Hygiene, CERT Amiens Street, Dublin 1, Contact person – Ann Whelan, (tel.: 01-8556555; fax 01-8556821. e-mail info@cert.ie; website: http://www.cert.ie).

Department of Health, Health Promotion Unit, Hawkins House, Dublin 2 (tel.: 01-6714711).

Food Safety Information Centre, Abbey Court, Lower Abbey Street, Dublin 1 (tel. Freephone: 1800-336677).

Health and Safety Authority and National Irish Safety Organisation, 10 Hogan Place, Dublin 2 (tel.: 0 1-6147000).

Irish Hotels Federation, 13 Northbrook Road, Dublin 6 (tel.: 01-4976459; fax: 01-4974613; e-mail: ihf@iol.le).

National Dairy Council, Grattan House, Lower Mount Street, Dublin 2 (tel.: 01 - 6619599

Odlum Group Ltd., Alexandra Road, Dublin 1, Contact person - Patricia Sullivan, (tel.:01-8741741).

VIDEOS AVAILABLE FROM THE FOLLOWING -

Department of Health, Health Promotion Unit, Hawkins House, Dublin 2 (tel.: 01-6714711).

Health and Safety Authority and National Irish Safety Organisation, 10 Hogan Place, Dublin 2 (tel.: 0 1-6147000).

KEY ASSIGNMENTS

MODULE 4: **FOOD**

CHECKLIST

I have completed the practical skills assignment (if not previously done) ☐

OR

I have contributed to the design of at least one questionnaire ☐

I have carried out and written up at least five practical laboratory – based group experiments (involving one or two other students) ☐

I have visited a food/drinks industry, listened to a presentation by a member of staff and prepared a scientific account of the above visit ☐

I have researched one aspect of food using newspapers books and the Internet and made a presentation (oral or visual) to the class. ☐

Signed: _____ Date: _____

(Name of student)

Appendix 1: Laboratory Practicals

Five laboratory practicals recommended for the module are given below. Additional laboratory practical work is recommended and suggestions are given in Appendix 2 at the back of this book.

Note: Microbiological samples must be handled with care at all times, in accordance with Health and Safety Regulations.

Unit	Practical	Materials	Additional Information	Result/ Calculation
2	pH of Foods. **OR**	Six foods. pH indicators or pH meter. De ionised water. Beakers. Mortar & pestle. buffer tablets.	Foods may need to be ground up. Make sure all are soluble in water. Make sure pH meter is standardised.	Tabulate.
2	Food Solubility.	Six foods. De ionised water. Mortar & pestle. Filter paper, funnels, beakers, electronic balance.	Foods may need to be ground up. Make sure all are not soluble in water.	Tabulate.
3	Fat in foods.	Two foods. Microscope. Slides and coverslips. Sudan 111 Brown Paper.	Qualitative experiment. Grease Spot.	Tabulate.
	Test for Starch.	Iodine Solution. Food.	Test a variety of foods.	
	Protein in food.	Two foods. Test-tubes. Biuret's reagent.	Qualitative.	
4	Toothpaste test.	Three different toothpastes. Microscope. Slides & coverslips. pH meter. De ionised water. Pipettes and filler. Electronic balance. Beakers. Buffer tablets.	Use same amount of toothpaste. Examine for grittiness. Dissolve in water. Measure pH. Standardise pH meter Qualitative.	Tabulate.

Appendix 1: Laboratory Practicals (Continued)

5	Examine yeast and two fungi. **OR** Culture bacteria and/or fungi.	Yeast. Two fungi. Microscope. Slides & coverslips. Agar plates. Inoculating loop. Bunsen burner. Oven. Labels. Milk. Fruit.	Use bakers yeast. Grow two fungi, 1 on tomatoes or orange and 1 on bread. Pre-prepared plates.	Observe/Draw. Observe and draw.
6a 6a	Water content of yoghurt. **OR** Souring of milk.	Three yoghurts. Evaporating basins. Hot plate. Water bath. Electronic balance. Three different milk samples. pH meter. Beakers. Incubator.	Evaporate to constant weight. Record change in pH over a 3-5 day period. Incubate at 37 °C	Tabulate Calculate % of water. Tabulate.
	OR	buffer tablets.	Standardise pH meter.	
6b	Identify 2 Grains. Test for starch. **OR**	Two Grains. Microscope. Mortar & pestle. Test tubes. Bunsen burner. Filter paper. Funnels. Beakers. Dropper pipette. Iodine solution. Slides & coverslips.	Make solutions of the extracts. Filter, examine residues using microscope.	Observe and draw grains. Record results.
6c	Effect of air (oxygen) on open wine samples.	Two samples of wine (red & white). pH meter. Beakers. De ionised water. Buffer tablets.	Leave wines exposed to air for 3 days. Record pH initially, after 1, 2 and 3 days. Standardise pH meter.	Tabulate.

APPENDIX 2

ADDITIONAL LABORATORY PRACTICALS

Appendix 2: Additional Laboratory Practicals

Additional laboratory practicals are suggested for each of the modules. This list is not exhaustive or complete.

Module and Unit	Practical	Materials	Additional Information	Result/ Calculation
Science & Health 2.	Hearing range of humans.	Signal generator loudspeaker.	Care needed, emphasise range of frequencies varies with individual.	Listen to range of sounds.
Science & Health 3.	Investigate energy and energy changes.	Clockwork toys, radiometer, solar cells, motors, microphone.	Link to JC Science.	Block diagrams.
Science & Health 3.	Energy in food.	Different kinds of food. Boiling tubes. Thermometer. Bunsen burner.		Tabulate.
Science & Health 3.	Measurement of pulse, heart rate and the effect of exercise.	Timer. Computer controlled sensors and probes.	Adequate supervision, care needed with asthma and other complaints.	Tabulate/bar charts.
Science & Health 3.	Test different surfaces for bacteria.	Agar plates. Inoculating loop oven.	Care with handling bacteria.	Comparison/ Draw diagrams.
Science & Health 3.	Test effectiveness of different commercial products in removing bacteria.	Agar plates. oven.	Care with handling bacteria.	Comparison/ Draw diagrams.
Science & Health 4.	Testing air – compare levels of CO_2 in inhaled and exhaled air.	Limewater, cobalt chloride paper.	Links to JC Science.	Tabulate.

Appendix 2: Additional Laboratory Practicals (Continued)

Module and Unit	Practical	Materials	Additional Information	Result/ Calculation
Science & Health 4.	Measuring air quality.	Survey lichens in local environment.		Tabulate.
Science & Health 4.	Testing water Acidity. Dissolved solids.	Water samples pH paper or meter filter paper evaporating basin etc.		Tabulate.
Science & Health 4.	Measuring noise levels.	Sound level meter.		Tabulate.
Science & Health 4.	Measure lung capacity.	Respirometer.		Tabulate.
Science & Health 6.	Measure body fat.	Callipers.	Care with students, this may be sensitive.	Tabulate.
Science & Health 6.	Investigate sweat from different surfaces.	Cobalt chloride paper. Plastic gloves.	Student can with help plan this investigation.	Observation. Tabulate/bar charts.
Science & Health 6.	Measurement of body variables.	Timer. Computer controlled sensors and probes.	Adequate supervision, care needed with asthma and other complaints.	

Science and the Environment: Additional Laboratory Practicals

Note: Microbiological samples must be handled with care at all times, in accordance with Health and Safety Regulations.

Module and Unit	Practical	Materials	Additional Information	Result/ Calculation
Environment 2.	Photosynthesis O_2 given off.	Pondweed. Trough. Funnel. Graduated test tube. Water. Bicarbonate.	Bicarbonate will increase the rate of photosynthesis.	Calculate the rate of photosynthesis. Graph.
Environment 2.	Photosynthesis CO_2 necessary. Test for starch.	Two potted plants. Two plastic bags. Soda lime. Evaporating basin. Iodine. Methylated spirits. Hot plate.	Clear plastic bags should be used toallow sunlight to enter.	Tabulate.
Environment 2.	Detect IR.	Prism. Lamp. Screen. Thermopile.	Thermopile thermometer with a blackened bulb.	Record increase in temperature.
Environment 2.	Detect UV.	Prism. Lamp. Screen. Microscope slide. Petroleum jelly.	Slide can also be coated with vaseline. Armbands can be used.	Record result.
Environment 2.	Greenhouse effect.	Four sheets of glass. Seed tray. Soil sample. Thermometers.	Place in sunlight. One thermometer in 'glasshouse', one outside, record temperatures daily.	Tabulate.
Environment 2.	Acid rain.	Two containers to collect rain water. pH meter. Buffer tablets.	Standardise pH meter. Collect rain water over a period of time, one urban one rural.	Tabulate.

Science and the Environment: Additional Laboratory Practicals (Continued)

Module and Unit	Practical	Materials	Additional Information	Result/ Calculation
Environment 2.	Lichens and air pollution.	Map. Plant key.	Choose 10 trees from an urban and a rural area. Name the trees.	Draw maps. Tabulate results.
Environment 3.	O_2 and CO_2 in water	Gas collecting apparatus Test tubes Lime water Splint Hot plate	Boil the water Collect and test for both gases	Record results.
Environment 3.	Solubility of O_2 in water at different temperatures.	Water sample. Hot plate. Gas collecting apparatus. Graduated test tubes.	Choose three different temps. Replace graduated test tube for each increase in temp. Test for O_2.	Tabulate and Graph.
Environment 3.	Biological and non-biological washing powders.	Three samples of each powder. Six beakers. Labels. pH meter. De ionised water. Graduated cylinder. Electronic balance. Three foods. Buffer tablets. Six pieces of cloth (white)- same size. Waterbath. Scissors. Oven.	Stain two cloths with protein, two with carbohydrate and two with fat. Weigh. Dissolve detergents. Place 1 protein cloth in biological and 1 in non-biological, Repeat for others. Place in incubator at temp. recommended for each powder. Leave for one day Dry cloths and re weigh.	Tabulate. Calculate % effectiveness of the detergents.
Environment 3.	Model of water filtration.	Plastic litre bottle. Glass wool/ cotton wool. Stones. Gravel. Sand. Litres of water Beakers.	Cut end off bottle. Wear gloves if glass wool is used. Use two water samples from two different sources.	Compare waters before and after.

Science and the Environment: Additional Laboratory Practicals (Continued)

Module and Unit	Practical	Materials	Additional Information	Result/ Calculation
Environment 3.	Physical/ chemical properties of water.	Water sample. pH meter. Buffer. Microscope. slides/coverslips. Hotplate. Freezer. Salt, Sugar etc. Filtration apparatus. Electronic balance. Thermometer. Cobalt Chloride paper.	Examine and test appearance, solvent properties, smell, suspended particles, colour, density, BP, MP, latent heat ice floats, test for H_2O etc. Standardise pH meter.	Tabulate.
Environment 4.	Design a wormery.	Large clear plastic container. Gravel. Sand. Earth. Humus. Decaying leaves. Chalk. Earth worms. Black paper. Water. Mortar & pestle.	Grind the chalk to a powder. Make small holes in the paper covering the top of the container. Leave for 5 days. Examine each day.	Tabulate observations.
Environment 4.	Soil drainage.	Three stands. Three funnels. Glass wool or cotton wool. Three different soil samples. Six graduated cylinders. Timer.	Wear gloves when handling glass wool. Measure the volumes of water after a fixed time. Relate rate of drainage to soil type.	Tabulate Graph.
Environment 4.	Composition of two soils.	Two soils. Graduated cylinders. Water. Electronic balance .	Take the same weight of samples. Use deionised water. Allow to settle.	Tabulate.

Science and the Environment: Additional Laboratory Practicals (Continued)

Module and Unit	Practical	Materials	Additional Information	Result/ Calculation
Environment 4.	Water, humus and inorganic matter in soils.	Two soil samples. Hotplate. Electronic balance. Evaporating basins. Desiccator. Bunsen burner.	Same weight of both Soils. Cool before re-weighing.	Tabulate. Calculate % of water, humus and inorganic matter.
Environment 5.	Energy of a fuel.	One fuel. Evaporating basins. Electronic balance. Hot plate. Calorimeter. Thermometer. Water. Tongs.	Weigh fuel. Use candle as a fuel. Record rise in temp. carefully. Bunsen Burner also required.	Tabulate. Calculate energy content of fuels using formula. Mass x Specific Heat Capacity x Change in Temp.
Environment 5.	Energy conversions.	Electric circuit. Buzzer. Bulb. Clapper. Conducting wire with low resistance.	Show different forms of energy - potential, light, electrical, heat, sound, etc.	Tabulate.
Environment 6.	Electrical conductors and insulators.	Electric circuit. Range of conductors and insulators. Power supply or battery. Bulb.	Range of conductors should vary in their ability to conduct.	Tabulate Graph.
Environment 6.	Show how a fuse works.	Electrical circuit. Steel Wool. Variable resistance. Bulb.	Use circuit as above. Vary resistance.	Record current. Tabulate.

Science and the Environment: Additional Laboratory Practicals (Continued)

Module and Unit	Practical	Materials	Additional Information	Result/ Calculation
Environment 6.	Glass and the sun's rays.	Glass Thermometers.	Four sheets of glass arranged like a glasshouse. Place one thermometer under glass and one outside. Record temps. Every 40 mins. for 1 school day.	Tabulate Graph.
Environment 6.	Detect radioactivity.	Radioactive source (s) Radiation detector.	Demonstration.	Tabulate.
Environment 6.	Conduction of heat by different metals.	Different metal rods. Boiling water. Wax. Thumb tacks. Timer.	This practical can be used to also to show That non-metals are bad conductors of Heat.	Tabulate Graph.
Environment 6.	Model of water filtration.	Plastic litre bottle. Glass wool/ cotton wool. Stones. Gravel. Sand. Litres of water. Beakers. Microscope, slides and coverslips. pH meter. Buffer tablets. Filtration apparatus. Filter paper. Electronic balance .	Carry out physical and pH analyses before and after filtration. Cut end off bottle. Wear gloves if glass wool is used. Use water samples from two different sources.	Compare waters before and after.

Consumer Science: Additional laboratory practicals

Caution: Cosmetics and other similar substances prepared in the laboratory should not be used by students or on students. The substances should be discarded after they have been tested in the laboratory.

Module and Unit	Practical	Materials	Additional Information	Result/ Calculation
Consumer Science 2.	Penicillin from a mould. Before proceeding with practical check to make sure that students do not have allergy to *Penicillium.*	*Penicillium* culture available from scientific suppliers. Malt agar plate. Inoculating loop. Incubator. Cork borer. Class set of sterile petri dishes.	Inoculate malt agar plate with P. culture. Incubate at 25-30 C for 7 days. Using a cork borer remove agar from immediately around P.culture and place in sterile petri dishes. Avoid breathing spores, use masks.	Observe and draw.
Consumer Science 2.	Testing effectiveness of disinfectant on food spoilage organisms.	4 petri dishes containing bacteria grown using food stuffs. 3 commercially available disinfectants. 3 pieces of filter paper soaked in each of the disinfectants.	Place soaked filter papers in 3 dishes. Label each with the name of the disinfectant as a control no disinfectant in the 4th dish.	Observe and compare.
Consumer Science 2.	Testing athlete's foot powder.	Malt agar plates (soil fungi grow well on malt agar). Soil. Athlete's foot powder. Bunsen burner. Inoculating loop.	Mark bottom of dish with name, date and a line dividing dish in half. Label one side "foot powder" and the other "no foot powder. Sprinkle a little powder on side marked .	Observe and compare.

Consumer Science: Additional laboratory practicals (Continued)

Module and Unit	Practical	Materials	Additional Information	Result/ Calculation
			"foot powder". Sterilise loop by placing in flame. Cool loop and place a tiny lump of soil in the middle of the dish. Incubate at room temp. for 2-4 days. Repeat with compound prepared by students.	
Consumer Science 3.	Home made treatment for athlete's foot.	10g beeswax. 45ml almond oil. 15ml wheatgerm oil. 5ml comfrey tincture. 5 drops of thyme. Essential oil. 5 drops of tea tree essential oil. Marsh mallow. Use rubber gloves.	Heat the beeswax and almond oil in a water bath until the beeswax has melted add the wheatgerm oil and the marsh mallow and comfrey tinctures and stir remove from heat and cool slightly add the essential oils and mix pour into a glass jar and allow to set Use gloves, do not use.	See above.
Consumer Science 3.	Sense of touch.	Pieces of foam, wood, linen, velvet, blotting paper, tissue paper, glass, metal blind fold.	Students work in pairs, make sure everyone knows names of materials. One of the pair is blindfolded. Her partner strokes forehead with one of the materials and asks her to guess what it is. Repeat for back of hand and fingertips. Repeat for each of the materials.	Record results.

Consumer Science: Additional laboratory practicals (Continued)

Module and Unit	Practical	Materials	Additional Information	Result/ Calculation
Consumer Science 3.	Skin surfaces and sweat.	Cobalt chloride. Paper. Sellotape. Clock.	Tape cobalt chloride paper on to test surface and record how long it takes to turn pink.	Tabulate results.
Consumer Science 3	Emulsion	$10cm^3$ olive oil $10cm^3$ liquid paraffin soap solution water caustic soda 6 test tubes with stoppers test tube rack 2 droppers 3 $10cm^3$ graduated cylinders labels clock gloves goggles	Label tubes 1 to 6. Put $2cm^3$ water into tube 1 and 2. Add $2cm^3$ olive oil to tube 1. Add $2cm^3$ liquid paraffin to tube 2. Stopper both tubes. Shake tubes 1 and 2 well and leave them in rack for 5 minutes. Record appearance. Put $2cm^3$ of water into tubes 3 and 4. Add 5 drops of soap solution to each of tubes 3 and 4. Add $2cm^3$ of olive oil to tube 3 and $2cm^3$ of liquid paraffin to tube 4. Stopper both, shake and leave in rack for 5 minutes record result for tubes 5 and 6. Repeat as for tubes 3 and 4 but use caustic soda instead of soap solution. Record appearance after 5 minutes (when caustic soda is added to oil, it reacts with some of the oil to make soap. The soap makes any remaining oil emulsify).	Observe and record.

Consumer Science: Additional laboratory practicals (Continued)

Module and Unit	Practical	Materials	Additional Information	Result/ Calculation
Consumer Science 3.	Talcum powder.	Perfume 20g french chalk (magnesium silicate). 5g calcium carbonate. 1g magnesium stearate. 250cm flask with stopper. Dropper. 250cm^3 beaker. Sieve. Container for end product.	Put 3 drops of perfume into flask and swirl it around. Pour french chalk, calcium carbonate and magnesium stearate into flask and shake well. Push the powder through a sieve into a beaker. Use a stopper to break up any lumps. Put talc into a container and check how good it is at absorbing moisture using plastic gloves. CARE.	Observe and record.
Consumer Science 3.	Aftershave.	30 ml methylated spirit. 3.5 ml glycerine. Graduated cylinder funnel Bottle with stopper. 2 clamp stands. Clock. 2 thermometers with bungs. 2 watch glasses. 2 pieces of cotton. 2 rubber bands. Water. 3 labels.	Put a funnel into a bottle and pour in industrial spirit and glycerine. Add 15 ml water put lid on bottle and shake. Label after shave. Put some of your after shave on to piece of cotton and wrap around the bulb of one of the thermometers. Clamp thermometer in one of the clamp stands and label after shave. Repeat for cotton soaked in water and label clamp stand water. Read the temp. of each every 5 minutes for half an hour.	Record and graph results (discuss why skin fells cool after applying after shave)

Consumer Science: Additional laboratory practicals (Continued)

Module and Unit	Practical	Materials	Additional Information	Result/ Calculation
Consumer Science 4.	Detergents.	16 pieces of cotton. 4 stained with chocolate. 4 stained with grease. 4 stained with ink. 4 stained with red wine. 4 commercially available detergents. Bunsen burner. Beakers.	Place stained pieces of cloth into separate beakers. Students add amount of detergent recommended by manufacturer to water at recommended temp.	Record results and decide which brand seem to offer value for money in terms of cost and effectiveness.
Consumer Science 4.	Biological detergents.	Hard boiled egg. 2 beakers. Biological and non-biological detergent.	Peel egg when cool. Put warm water and biological detergent into one beaker. Repeat for 2nd beaker but use non-biological detergent. Leave in a warm place for 2 days.	Examine result.
Consumer Science 5.	Disappearing cup.	Acetone. Polystyrene cup. Petri dish. Goggles. Use rubber gloves.	Wear goggles. Add acetone to petri dish. Place an empty polystyrene cup in the centre of dish.	Record result.

Food: Additional laboratory practicals

Note: Microbiological samples must be handled with care at all times, in accordance with Health and Safety Regulations.

Module and Unit	Practical	Materials	Additional Information	Result/ Calculation
Food 2.	Test for and calculate the % water in foods.	Three foods. Evaporating basins. Electronic balance. Hot plate. Cobalt Chloride Paper.	Make sure that the foods chosen contain water. Weigh foods before and after.	Tabulate. Calculate % water.
Food 2.	Water Hardness.	Two water samples. Soap Solution. Graduated cylinders. De ionised water. Hot plate. Ion Exchange. Column.		Tabulate.
Food 3.	Energy in foods.	Three foods. Evaporating basins. Electronic balance. Hot plate. Calorimeter. Thermometer. Water. Tongs.	Sugar, cooking oil and potato crisps. Record rise in temp. Carefully. Bunsen Burner also required.	Tabulate. Calculate energy content of foods using heat gained by water. Mass x Specific Heat Capacity x Change in Temp.
Food 3.	Fibre in bread.	Two breads. De ionised water. Electronic balance. Mortar & pestle. Filter paper. Funnels. Hot plate. Beakers.	Take same weights of both foods. Grind bread samples. Boil samples to dissolve starch grains. When filtering, add boiling water until all starch had been washed into beaker. Fibre remains as residue. Quantitative.	Tabulate. Calculate % fibre.

Food: Additional laboratory practicals (Continued)

Module and Unit	Practical	Materials	Additional Information	Result/ Calculation
Food 3.	Vitamin C in food.	Three foods. Filter paper. Funnels. Test-tubes. Hot plate. Beakers. DCPIP indicator tablets. Knife. Mortar & pestle. Orange squeezer. Homogeniser.	Foods - 2 orange 2 apple and 2 lemon. Filter orange and lemon juice. Cut up apple. Homogenise apple. Filter apple juice. Test juice of 1 range, 1 lemon and 1 apple with DCPIP. Boil juice of 1 orange 1 lemon and 1 apple. Cool. Re-test with DCPIP. Qualitative.	Tabulate.
Food 3	Calcium and Magnesium in Water.	One Water Sample.	As water hardness above.	Tabulate.
Food 6.	pH of pickling agent.	Four pickled foods. pH meter. pH tablets. Buffer tablets.	Standardise pH meter.	Tabulate.
Food 6.	Yoghurt making.	Starting culture. Milk. Thermometer. Yoghurt making kit - or a Thermos flask. Hot plate.	Use natural yoghurt as the starting culture.	
Food 6.	Effect of air (oxygen) on open wine.	Two samples of wine (red & white). pH meter. Beakers. De ionised water. pH tablets. Buffer tablets.	Leave wines exposed to air for 1-3 days. Record pH over 1-3 days. Standardise pH meter.	Tabulate.

Food: Additional laboratory practicals (Continued)

Module and Unit	Practical	Materials	Additional Information	Result/ Calculation
Food 6.	CO_2 in non - alcoholic drinks.	Three drinks. Conical flasks. Corks. Tubing. Clamps. Balloons. Electronic balance.	Use three soft drinks. Weigh empty balloon. Weigh balloon. with CO_2 Quantitative.	Tabulate. Calculate volume of CO_2

RESOURCES

TEACHING OF SCIENCE

These are books that discuss and review the teaching and learning of science.

Author	Title	Publisher
Bentley, Di and Watts, Mike (eds.)	***Learning and Teaching in School Science***	Milton Keynes: Open University Press, 1989.
Centre for Science Education, Sheffield City Polytechnic.	***Active Teaching and Learning Approaches in Science. (ATLAS)***	London: Collins Educational, 1992.

SAFETY

Author	Title	Publisher
The Association for Science Education.	***Safety in the Lab.***	Hatfield: ASE, 1990
The Association for Science Education.	***Safeguards in the School Laboratory***	Hatfield: ASE, 1996.
Department of Education	***Safety in School Science. Safety in the School Laboratory: Disposal of Chemicals***	Dublin: Department of Education, 1996.

JOURNALS

The two most useful journals for science teachers at second level are:
SCIENCE - the journal of the ISTA, the science teachers' association
School Science Review – the journal of the ASE, the UK science teachers' association

ICT AND SCIENCE

There are many applications of information and communication technology in science. Here are some references and web-sites. There are also many excellent CD-ROM's.

Author	Title	Publisher
ASE - Association for Science Education (UK)	***School Science Review - theme issue on ICT and science education***	Volume 79, Number 287, December 1997
Frost, Roger.	***The IT in Secondary Science Book***	London: IT in Science, 1994. ISBN 0-9520257-2-8
The Chalkface Project	***Applying IT to Science***	Milton Keynes: The Chalkface Project, 1997
Frost, Roger.	***The IT in Science of Datalogging and Control***	London: IT in Science, 1995. ISBN 0-9520257-1-X

WEB-SITES

Organisation	Address	Comments
Association for Science Education	http://www.ase.org.uk/	excellent resource for science education
ISTA	http://indigo.ie/~istasec/	Site of the Irish Science Teachers' Association
ScoilNet	http://scoilnet.ie	Site for teachers and students – a good starting point

VIDEOS FOR SCIENCE

Many schools have collected a variety of videos that they find useful. The local Education Centre will often lends videos. The Yorkshire Television series Scientific Eye is an excellent resource for Junior Science and may be useful for Leaving Certificate Applied. Understanding Electricity, the educational service of the electricity supply industry has some useful videos, a catalogue is present in most schools.

USEFUL ADDRESS

The Association for Science Education [ASE],
College Lane, Hatfield, Hertfordshire AL10 9AA.
Tel: 00 44 1707 267411
Book Sales Department Direct Line 00 44 1707 283001
Fax: 00 44 1707 266532 Web site: www.ase.org.uk

The Book Sales service is fast, efficient and payment can be made by credit card.

Published by The Stationery Office
To be purchased directly from:
Government Publications Sales Office,
Sun Alliance House,
Molesworth Street, Dublin 2.
Or by mail order from:
Government Publications, Postal Trade Section,
4-5 Harcourt Road, Dublin 2.
Tel: 01-647 6834/5 Fax: 01-475 2760
Or through any bookseller.
Price: £1.50

This programme has been funded by the European Social Fund

Designed by: Langley Freeman Design Group Limited