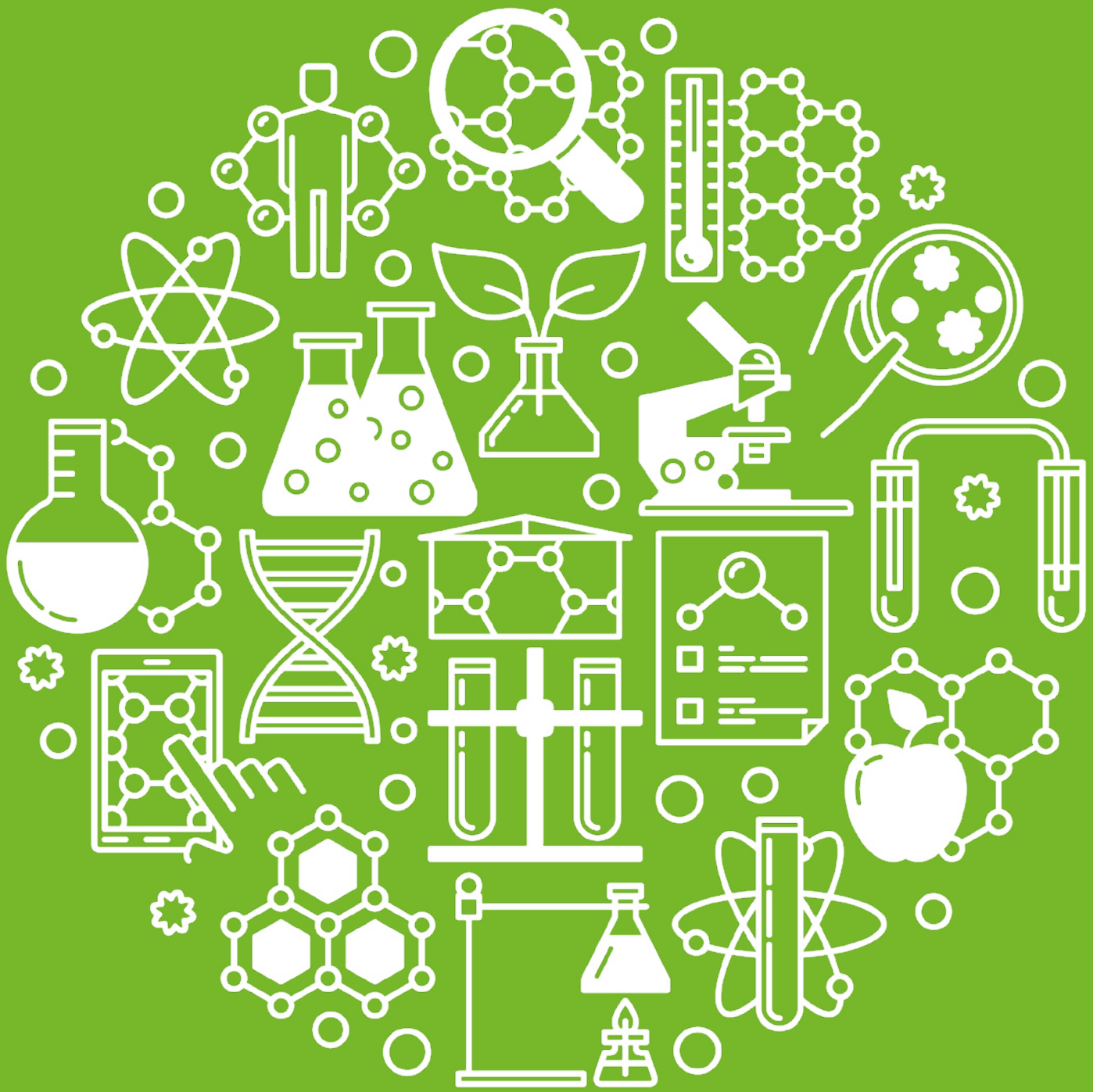
Science Outreach Practicals



University of HUDDERSFIELD
Inspiring global professionals

Awards

We're proud of our awards including winning the first Global Teaching Excellence Award.

Global Teaching Excellence Award
We won the first Global Teaching Excellence Award. It recognised the University's commitment to world-class teaching and its success in developing students as independent learners and critical thinkers (Higher Education Academy, 2017).

University of the Year
The Times Higher Education named us as University of the Year in November 2013. The award recognises a university that has demonstrated exceptional performance.
They liked our "bold, imaginative and innovative initiatives."

The Queen's Anniversary Prize
In 2019 we won a Queen's Anniversary Prize. It's one of the most coveted honours in UK Higher Education and was earned in recognition of the innovative and ground-breaking work in advanced measurement in smart manufacturing made by our Centre for Precision Technologies. This follows our 2019 Prize for innovations made by our Institute of Railway Research, and our 2015 Prize for expanding the global boundaries of new music.

A Five Star University
QS Stars has given us Five Stars overall. This international benchmarking system renders Five Star universities as world-class in areas such as Teaching, Employability, Facilities, Innovation, Internationalisation and Inclusiveness.

Athena SWAN
We're serious about gender equality. We want an equal number of men and women on our science and engineering courses, for instance. Our commitment was recognised in 2015 and again in 2020 and 2022 with the Athena SWAN Bronze Award.

www.hud.ac.uk/science-outreach-practicals

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Welcome

At the University of Huddersfield, we are committed to inspiring the next generation of scientists through our relationships with schools and colleges. We are always looking at ways to establish, build and strengthen these relationships by offering innovative and relevant activities which are of value to both teachers and learners.

We're delighted to introduce our range of Science Outreach Practicals. These are a new suite of A Level Practicals for all Practical Assessment Groups and our Taking it Further Practicals for post 16 learners embarking on an A Level or BTEC course.

A Level Practicals

- Want to do something different for your learners? Whether you want them to have a fully immersive, university laboratory experience or need additional access to scientific resources, we offer carefully designed Biology and Chemistry practical investigations, for all Practical Assessment Groups, that meet CPAC and specification requirements.
- They can be used in place of a practical usually taught by a teacher, or be used in addition to practicals taught in school or college. The aim is to broaden learner knowledge by encouraging challenge and scientific enquiry.
- The sessions are delivered on our campus by our University staff and provide opportunities to use specialist scientific equipment and to experience a scientific laboratory environment.

Taking it Further Practicals for Post 16 Learners

- These practicals are designed to cater for all post 16 learners. Whether your learners are embarking on an A Level or BTEC course, these practicals aim to enhance the learning experience. Each practical is carried out here at the University and allows learners to engage with specialist staff, use specialist scientific equipment and learn about current research.

Your Visit

- Lunch is not supplied, but your learners will be provided a room to eat their own packed lunch.
- We can arrange a subject talk about the University courses, by an admissions tutor, as part of your visit.
- A tour, by one of our student ambassadors, of the facilities in Applied Sciences and the University campus can also be included.

In this guide
You'll find details of each of the Science Outreach Practicals, and for A Level Practicals how these meet CPAC and specification requirements. You can also find this information on our website at **www.hud.ac.uk/science-outreach-practicals**

www.hud.ac.uk/science-outreach-practicals

How to book

To book and arrange your Science Outreach Practical, or for general enquiries, please email the science outreach office.
science.outreach@hud.ac.uk

All our practicals are free of charge.
Please note that some of the practicals will require 3 weeks notice due to experiment set up.

"The event was very well organised and appropriate to the skill levels of students. Staff were very knowledgeable, helpful and friendly."

Teacher's feedback, from Greenhead College-Huddersfield, about organic synthesis, Chemistry A Level Practical.

Course information

If you'd like information about Biological Sciences, Chemical Engineering, Chemistry, Forensic Science, Optometry, Pharmacy or Science Extended Degree courses here at Huddersfield please contact:

Biological Sciences
Dr Anna Murphy
Admissions Tutor
Email: a.murphy2@hud.ac.uk

Chemical Engineering, Chemistry, Forensic Science and Pharmaceutical Chemistry
Dr David Cooke
Admissions Tutor
Email: d.j.cooke@hud.ac.uk

Optometry
Dr Niall Hynes
Admissions Tutor
Email: n.j.hynes@hud.ac.uk

Pharmacy
Dr Kofi Asare-Addo
Admissions Tutor
Email: k.asare-addo@hud.ac.uk

Science Extended Degree
Mrs Rukhsana. R. Din
Admissions Tutor
Email: r.r.din@hud.ac.uk

Microscopy: Mitosis. *Using a light microscope to study mitosis in plant cells.*

Why is this relevant for your learners?

The study of mitosis is important at a scientific level because of its sheer complexity – all cells have to divide and reproduce. Defects in mitosis can lead to cells dividing when they shouldn't be dividing, leading to overgrowth of the cells. Many cancer cells show this property of unregulated growth and division because they are mutated in those genes which control mitotic checkpoints.

In this investigation learners will have the opportunity to use specialist scientific equipment to study mitosis up close and make accurate observations.

How this practical meets specification requirements.

- Magnification calculations.
- Differences between optical and electron microscopes.
- Recognise organelles from EM images.
- Mitosis division stages and Mitotic Index.
- Use of graticule/micrometre.
- What an artefact is.
- Differential staining.
- Slide preparation, producing drawings/diagrams.

Biology A Level Practicals www.hud.ac.uk/science-outreach-practicals

Microbiological techniques: Bacterial transformation.

Transform a laboratory strain of Escherichia coli with plasmid DNA containing a gene that encodes a green fluorescent protein (GFP) from the jellyfish Aequorea victoria.

Why is this relevant for your learners?

In the world of modern biotechnology, genetic modification plays a central role for developments. It has evolved from a craft-based industry allied, to brewing and baking, to a major influence on human health and agricultural production.

This investigation will allow learners to gain hands on experience of a key genetic modification technique and discuss the ethical, social and safety concerns involved in genetic modification.

How this practical meets specification requirements.

- Recombinant DNA technology – what it is, the methods.
- Evaluation of ethical, financial and social issues.
- Applications to industry, agriculture and medicine.
- Principles of genetic engineering. Use of plasmids.
- Why microorganisms are used in biotechnological processes.

Exploring the electrical activity of skeletal muscle.

Recording the electrical activity of skeletal muscle using a human electromyogram (EMG).

Why is this relevant for your learners?

Electromyography is a technique that measures the electrical activity of the muscles and the nerves controlling the muscles. The data recorded is an Electromyogram (also known as an 'EMG' or 'Myogram'). In the clinical setting, EMG is most often used when people have symptoms of weakness, and examination shows impaired muscle strength.

It can help to differentiate muscle weakness caused by neurological disorders from other conditions. In this investigation learners will use specialist, scientific equipment to record the EMG of voluntary and evoked muscle activity and investigate nerve conduction velocity, with the opportunity to discuss the safe and ethical uses of organism.

How this practical meets specification requirements.

- Investigating the effect of an environmental variable on movement of an animal.
- The role of receptors, Schwann cells and myelination.
- Structure and function of myelinated and non-myelinated neurones.
- The structure and role of the synapse.
- Generation and passage of action potential.
- Investigation of nerve conduction velocity.
- Ethical and safe use of organisms.

Computer modelling: Are you part chimpanzee? *To use databases to analyse DNA and protein sequences and create an evolutionary tree.*

Why is this relevant for your learners?

The study of evolution is driven by a thirst for knowledge, allowing understanding of the past and prediction of the future. Evolution occurred when dinosaurs dominated the planet, when Darwin voyaged on the HMS Beagle and is occurring right now. In this investigation learners will have the opportunity to use specially designed databases to analyse the DNA and protein sequences of different animals and compare them to humans to see how closely we are related. They can then use this to create their own evolutionary tree based on real scientific data.

How this practical meets specification requirements.

- The nature of the genetic code.
- The biological classification of species.
- Classification and Phylogeny.
- Evidence for evolution by natural selection.
- Principals of natural selection in the evolution of populations.
- Advances in immunology and genome sequencing to clarify evolutionary relationships.

Electrophoresis: Plant PCR. *To amplify chloroplast DNA using polymerase chain reaction (PCR).*

Why is this relevant for your learners?

PCR is widely considered one of the most powerful tools used in biological research. It allows us, as scientists, to amplify single copies of DNA and generate many millions of copies. It can be used for cloning, diagnosis of diseases such as heart disease and infectious diseases, functional analysis of genes and much more.

In this investigation learners will use specialist scientific equipment to extract chloroplast DNA from plant tissue to be amplified using PCR with the possibility of describing evolutionary relationships between different species of plants.

How this practical meets specification requirements.

- Structure of the chloroplast.
- The principles of PCR and its application.
- Analysis of DNA fragments cloned by PCR.
- The principles and uses of electrophoresis for separating nucleic fragments or proteins.
- Opportunity for practical use of electrophoresis.
- Ethical issues relating to genetic manipulation of animals, plants and microorganisms.

Organic synthesis (Alkenes): *The conversion of a cyclic anhydride into a dicarboxylic acid.*

Why is this relevant for your learners?

Organic synthesis is the key science in the manufacture of medicinal drugs, flavourings, perfumes, agrochemicals, pheromones, dyes, monomers and polymers, optoelectronic devices and many other everyday materials. Maleic anhydride is at the centre of a multi-million pound polyester business with a vast range of uses in polymer science such as polymers for boat-hulls, shower cubicles and kitchen work-surfaces.

In this investigation learners will have the opportunity to use specialist scientific equipment to convert maleic anhydride to maleic acid (a key intermediate in the synthesis of fumaric acid which is critical in the citric acid cycle and used as a food and medicine stabiliser.

How this practical meets specification requirements.

- General formula of alkenes.
- Use balanced equations to calculate percentage yields.
- Properties of alkenes and polymers from alkenes.
- Interpretation and use of the terms general, structural and displayed formula.
- Communication using organic chemical structures; selecting the appropriate formula for the context.
- Explanation of structural isomers and determination of structural formulae of an organic molecule, given its molecular formula.
- Drawing different forms of isomers.
- Understand the addition reactions of alkenes.

Chemical Reactors.

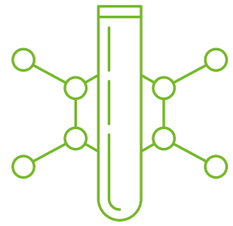
Why is this relevant for your learners?

Reactors are the heart of the operations in a chemical processing plant since they are the location where the product is formed from the reaction that takes place between the reactants. When examining a reactor, it is important to assess the impact that different operational parameters or design decisions might have to the amount of reactant(s) used.

In this practical your learners will work on a reactor and study: (a) if and how the flow rate affects the conversion of the reactants in a tubular reactor; and (b) if and how the addition of baffles affects the conversion of the reactants in a stirred tank reactor. They will also learn how to handle chemicals safely and understand the risks involved.

How this practical meets specification requirements.

- Use volumetric flask, including accurate technique for making up a standard solution.
- Safely and carefully handle solids and liquids.
- Calculate rates of reaction.
- Investigate which parameters might affect the reactant consumption.



Chemistry A Level Practicals www.hud.ac.uk/science-outreach-practicals

> *"I mostly enjoyed learning how to operate an infrared spectrometer and read data to discover the hidden powder. I've been able to explore more about forensic science and what jobs I could do in the future."*
>
> Student's feedback, from Ashton Sixth Form College-Greater Manchester, about crime scene investigation and testing forensic evidence in the laboratory, Chemistry Taking it Further Practicals.

Colorimetric Analysis: *Aspirin overdose?*

Why is this relevant for your learners?

Aspirin (acetylsalicylic acid) is a common analgesic (pain reliever). A body has been found in the laboratory, and the deceased (Dr Bunsen) was known to take aspirin (acetyl salicylic acid). In this experiment your learners will use UV/vis spectroscopy to determine whether or not there was sufficient aspirin present in the body to be the cause of death.

The practical will involve preparation of standard salicylate calibration solutions, their reaction with ferric chloride, and analysis using a UV/vis spectrometer.

How this practical meets specification requirements.

- Use volumetric flask, including accurate technique for making up a standard solution.
- Safely and carefully handle solids and liquids.
- Use appropriate apparatus to record a range of measurements.
- Formation of coloured ions.

Paper chromatography: *Analysis of fountain pen ink by paper chromatography.*

Why is this relevant for your learners?

The owner of a large company has left a signed handwritten will, found amongst his papers shortly after his death, detailing his wishes concerning the disposition of the company. The first section of the document appears to pass control of the company solely to his eldest son. However, a short codicil (amendment) at the end, possibly rather squeezed in before the signature, seems to imply that management should be shared equally with a younger son.

The eldest son disputes the second part of the document saying it is a later forgery while the younger son insists it is genuine. The document is submitted for examination, but analysis of the handwriting proves inconclusive. Can an analysis of the ink used to write the document throw any light on the case? In this investigation learners will have the opportunity to use specialist scientific equipment to carry out laboratory techniques used by forensic scientists.

How this practical meets specification requirements.

- Chromatography as a way of separating and identifying components in a mixture.
- Paper chromatography.
- Solve problems set in a practical context.
- Use of paper chromatographic system.

“The whole time in the lab was great, engaging and gave the students opportunities they wouldn’t have in school. Thank you!”

Teacher’s feedback, from Trinity Academy-Doncaster, about microbiological techniques: bacterial transformation, Biology A Level Practical.

Biology Taking it Further Practicals www.hud.ac.uk/science-outreach-practicals

Functions of the Lungs: *Respiratory sinus arrhythmia.*

Why is this relevant for your learners?

The autonomic nervous system plays a vital role in the interaction of the respiratory and circulatory systems. Respiratory sinus arrhythmia (RSA) refers to the naturally-occurring synchronous fluctuations in heart rate that are linked to respiration. Heart rate increases during inspiration and decreases during expiration. The origin and regulation of RSA is not completely understood, but it is believed RSA improves pulmonary gas exchange efficiency by better matching alveolar ventilation and capillary perfusion throughout the respiratory cycle. Learners will investigate RSA in normal respiration and forced, slow breathing using specialist equipment; PowerLab and LabChart and life science data acquisition systems that can provide real time feedback from physiological occurrences, to record and evaluate their own RSA.

The Electrocardiogram (ECG) and heart sounds.

Why is this relevant for your learners?

The ECG is one of the most significant tools used by cardiologists in our hospitals and all over the world. Monitoring the activity of the human heart, it allows for the diagnosis of a large number of heart related diseases. The beating of the heart is accompanied by both electrical activity and sound. The pattern of electrical activity produced by each heart beat cycle is called the electrocardiogram or ECG. In this practical learners will have the opportunity to use ECG equipment to record and analyse an ECG, from a willing volunteer, and examine the relationship between the ECG and the characteristic sounds of the heart.

IR analysis of drugs *(with optional NMR extension).*

Why is this relevant for your learners?

A suspect has been arrested on suspicion of drug dealing, and an unlabelled white powder was found in their pocket. It is impossible to determine by visual examination what the powder contains, so specialist scientific tests must be carried out.

You have been hired to establish whether the powder is a simple headache remedy as the suspect claims, or an illegal drug. Learners will identify the compounds present in the powder by determining the functional groups using IR analysis and comparing the melting points of the compounds. They will then draw conclusions to determine the legality of the powder.

Crime scene investigation.

Why is this relevant for your learners?

A crime scene is of vital importance and, if handled carefully, it can provide crucial, physical evidence needed to build a criminal case against a suspect. The evidence recovered from a crime scene can be used in many ways, some of which include; establishing if a crime has even occurred, identifying any evidence that could help to identify the victim, offender and any other persons involved in the crime and to corroborate or refute statements. In this activity, learners will cover essential crime scene science principles and techniques as applied to a crime scenario, such as:

- Introduction to a crime scene and collection of evidence.
- Scene survey, collection, packaging and labelling of evidence.

Please note this practical will take place in our crime scene facility which can accommodate a maximum of 10 learners.

Testing forensic evidence in the laboratory.

Why is this relevant for your learners?

This practical will cover systematic understanding of evidence evaluation. Your learners will discover how to critically evaluate chemical and/or biological forensic evidence, as well as how to interpret their findings. You can choose two from any of the following activities:

- Marks and impressions.
- Bodily fluid identification.
- Bloodstain Pattern Analysis.
- Forensic Entomology.

Please note this practical is for a maximum of 20 learners.

The important role of seaweed in the treatment of gastro-oesophageal reflux disease.

Why is this relevant for your learners?

Gastro-oesophageal reflux disease (GORD) refers to a common condition in which gastric contents reflux into the distal oesophagus, causing the oesophageal mucosa to be attacked by acid and pepsin. The action of acid and pepsin may result in oesophagitis, with inflammation of the mucosa of the lower oesophagus, erosions and even ulceration. Heartburn, felt as a burning sensation behind the sternum or breastbone, either as a spasm or a sharp pain, is the predominant symptom of GORD and it usually occurs as a result of reduced pressure and inappropriate relaxation of the lower oesophageal sphincter.

This practical looks at how a natural polysaccharide polymer, harvested from seaweed, can react with acid in the stomach to prevent the stomach contents causing damage to the delicate lining of the oesophagus.

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