



SCIENCE CENTRE



# DNA

Learning Lab

@ Science Centre Singapore

## DNA Lab Programmes 2018



Best Enrichment Experience  
DNA Learning Lab Programmes

Supported by:



Ministry of Education  
SINGAPORE



## About the DNA Lab

**Students and public can now engage in unravelling the secrets of life at the DNA Learning Lab at Science Centre Singapore. This facility allows students (primary to pre-university levels) and public to keep pace with the DNA revolution and advances in the life sciences.**

Read what other teachers say about the programmes on page 25 and 26.

### THE OBJECTIVES OF THE DNA LEARNING LAB ARE TO:

- Give our students a deeper understanding of life sciences topics and issues.
- Stimulate students' interest in taking up careers in the life sciences.
- Educate students to be more scientifically literate and later, as adults have more considered views about life science issues and concerns.

The DNA Learning Lab is one of the centres set up as part of the collaboration between the Ministry of Education and Cold Spring Harbor Laboratory's Dolan DNA Learning Center in New York.

Public programmes are updated on our Facebook page - DNA Learning Lab - Science Centre Singapore.

These classes are only available through school bookings

# PRIMARY SCHOOL PROGRAMMES (PRI 5 - PRI 6)

## Primary school curriculum links

SCHOOL SYLLABUS LINKS	COMMON KEY LEARNING POINTS	DNA LAB PROGRAMMES
Cycles	Characteristics, differences and similarities of animal, plant, bacteria and fungal cells.	Diversity of Cells
	Differences in parts and functions between animal and plant cells.	
	Understanding of inheritance – many characteristics of an organism are passed on from parents to offspring.	Genes and Our Traits
Systems	Function of DNA and its role in the cell system.	DNA Basics
	Identification of animal and plant cell parts and functions.	Diversity of Cells
	Electrical circuit and current flow application in DNA electrophoresis.	DNA Detectives

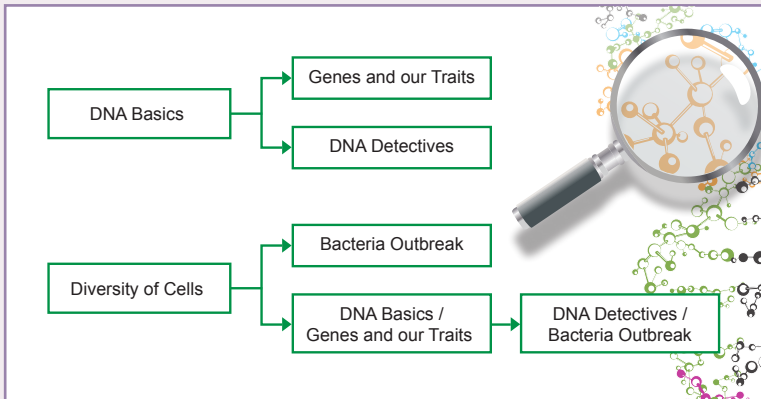
PRIMARY SCHOOL PROGRAMMES (PRI 5 - PRI 6)

Time : 9.30am (Session I) or 2.30pm (Session II)  
 Venue : Science Centre Singapore  
 Capacity : Minimum number - 20 students  
 (Unless otherwise stated) Maximum number - 40 students

*\*(Admission fee to Science Centre applies to non-member International school based in Singapore)*

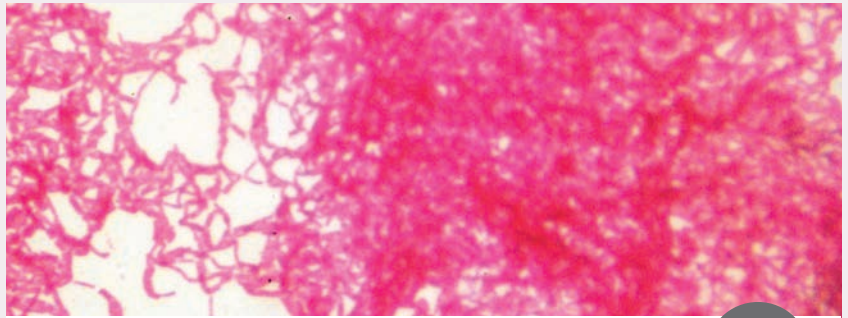
For a complete learning experience, we recommend your students to attend a series of workshops.

Here are suggested lessons that complement each other:



These classes are only available through school bookings

## Practical Lab Sessions



### Diversity of Cells

\*\$7.00 (Inclusive of GST)

2hrs

Earth is an amazing place with a whole variety of life forms and cells are the building blocks of these living things. Do you know that while a bacterium is made up of only one cell, a human being is made up of trillions of cells! Cells are so tiny that about 5000 of them can fit onto the head of a pin and each cell cannot be seen with the naked eye. However, in this lesson we will explore and observe these amazing cells through a microscope and appreciate their significance.

#### OBJECTIVES:

1. Understand what cells are and that there is a diversity of cells on earth.
2. Learn about classification of living things.
3. Identify different parts of the compound microscope and know their functions.
4. Prepare sample slides using simple staining methods and view them under the microscope.
5. Understand the application of using microscope to identify microorganisms or cells.



These classes are only available through school bookings



## DNA Basics

\*\$7.00 (Inclusive of GST)

2hrs

Ever seen how DNA looks like? Why is DNA so important? Be a DNA scientist for the day and join us in this introductory lesson to learn the basics of DNA. See what DNA looks like in real life and make a 3D DNA model to bring home!

### OBJECTIVES:

1. Understand the role of DNA in our lives.
2. Learn about the DNA structure and make a DNA model.
3. Conduct a simple DNA extraction from bacteria cells independently.



## Genes and Our Traits

\*\$7.00 (Inclusive of GST)

2hrs

Have you ever wondered why you look like your parents? Eye colour, gender and free or attached earlobes are examples of physical traits that are determined by our genes. How is it possible that one sibling has brown eyes, while the other sibling has blue eyes? To find out about this and more, join us as we observe our physical traits and learn how we inherit them from our parents!

### OBJECTIVES:

1. Understand what physical traits are and how to identify them.
2. Understand the diversity of genetic traits and that every individual has different genetic makeup.
3. Conduct a simple DNA extraction from wheat germ independently.
4. Learn about the sex chromosomes and how it determines the gender of a baby.
5. Understand that some traits are determined by a pair of genes.



## DNA Detectives

**\*\$7.00** (Inclusive of GST)

**2hrs**

A crime has occurred and they have narrowed it down to a suspect. With the suspect behind bars, the community believed that all was now peaceful in their town. However, a similar crime has occurred again leaving behind a similar type of evidence. Could the crime have been done by a syndicate or did the police arrest the wrong person? Based on a true story, join us as we take on the role of forensic investigators to solve the case using various forensic tools.

### OBJECTIVES:

1. Learn about different types of forensic techniques used.
2. Learn about the structure of DNA and its importance.
3. Learn micropipetting techniques.
4. Understand how DNA is analysed through a technique known as agarose gel electrophoresis.
5. Learn how to interpret DNA analysis results and identify the possible criminal.



## Bacteria Outbreak!

**\*\$7.00** (Inclusive of GST)

**2hrs**

An outbreak has occurred and patients have been sent to the hospital with common symptoms and diarrhoea. Join us as we take on the role of an epidemiologist to identify the cause of the outbreak and the source. Can we stop the spread of the outbreak?

### OBJECTIVES:

1. Understand what outbreaks are.
2. Learn the basic steps taken to investigate a case of food poisoning outbreak.
3. Understand the possible causes of food poisoning outbreaks and how to prevent them through proper hygiene.
4. Learn micropipetting techniques.
5. Learn the basic technique of growing bacteria.
6. Identify the basic shapes of bacteria.

These classes are only available through school bookings

## SECONDARY SCHOOL PROGRAMMES (SEC 1 - SEC 4/5)

### Secondary school curriculum links

SCHOOL SYLLABUS LINKS	COMMON KEY LEARNING POINTS	DNA LAB PROGRAMMES
<b>Lower Secondary</b>		
Diversity of living things	Awareness that bacteria could have beneficial or harmful effects.	Bacteria and Health/ Food Microbiology
Human digestive system	Importance of hygiene habits and food handling practices to prevent food-borne diseases.	Bacteria and Health
	Role of amylase in digestion.	Proteins Revealed and Reviewed
<b>Food and Consumer Education</b>		
Food and kitchen safety	Hygienic practices when handling food.	Bacteria and Health
<b>O Level Biology</b>		
Cell structure and organisation	Identify cell structures and organelles of different organisms.	Life in Micro
	Relationship between cell function (transport of oxygen) and cell structure (red blood cells).	Genetic Diseases
Biological molecules - proteins	Biuret test.	Proteins Revealed and Reviewed
	Effects of temperature on rate of enzyme reaction.	
	Enzyme mode of action, key components involved in a catalytic reaction.	Amazing Enzymes
	Effects of substrate concentrate on rate of enzyme reaction.	
Nutrition in humans	Function of amylase in digestion.	Proteins Revealed and Reviewed
Transport in humans	Role of red blood cells in oxygen transport and diseases (thalassaemia and sickle cell anaemia).	Genetic Diseases
	Different ABO blood groups and possible combinations for donor and recipient in blood transfusions.	DNA and Life
Coordination and response in humans	Function of the brain and neurons.	The Brain Connection
	Function of the brain and spinal cord in producing a coordinated response.	

SECONDARY SCHOOL PROGRAMMES (SEC 1 - SEC 4/5)

These classes are only available through school bookings

SCHOOL SYLLABUS LINKS	COMMON KEY LEARNING POINTS	DNA LAB PROGRAMMES
Cell Division	Identify the main stages of mitosis and meiosis.	Life in Micro
Molecular genetics	Structure of DNA, complementary base pairing rule.	DNA and Life/ DNA in Forensic Science/ Genetic Diseases/ Finding the Lost Princess/ DNA: Cracking the Code of Life/ Developing a Scientist Skillset
	Relationship between DNA, genes and chromosomes.	DNA and Life/ Genetic Diseases/ DNA: Cracking the Code of Life
	DNA is used to carry the genetic code, which is used to synthesise specific polypeptides.	DNA: Cracking the Code of Life
	Transfer of genes between organisms. Applications of genetic engineering (such as insulin production).	Bacteria Transformation
	Ethical and social implications of genetic engineering.	Bacteria Transformation/ Science and Society
Inheritance	Define a gene and distinguish between gene and allele. Understand the terms dominant, recessive, homozygous, heterozygous, phenotype and genotype. Predict the results of simple crosses using genetic diagrams involving monohybrid inheritance.	Genetic Diseases
	Inheritance of the ABO blood group phenotypes.	DNA and Life
	Inheritance of genetic information from parent to offspring.	Genetic Diseases/ Finding the Lost Princess
	Explain the determination of gender in humans.	DNA and Life/ Genetic Diseases
	Mutation of a gene that results in a change in structure.	Genetic Diseases (sickle cell anaemia)/ DNA: Cracking the Code of Life
<b>N(T) Science</b>		
Nutrients from food	Role of enzymes in the digestion of food.	Proteins Revealed and Reviewed
Food health and safety	Sources of proteins. Food tests for starch and protein.	Proteins Revealed and Reviewed
	Beneficial action of microbes on food.	Food Microbiology
Digestion	Effect of temperature on the rate of enzyme reaction	Proteins Revealed and Reviewed



These classes are only available through school bookings

SCHOOL SYLLABUS LINKS	COMMON KEY LEARNING POINTS	DNA LAB PROGRAMMES
Staying healthy	Bacteria and antibiotic resistance.	Bacteria and Health
	Inheritance of thalassaemia from parents.	Genetic Diseases
<b>History</b> Soviet Union and Eastern Europe	Events within Russia in 1917 – the Romanov family.	Finding the Lost Princess

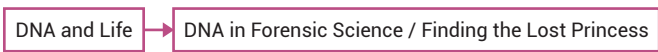
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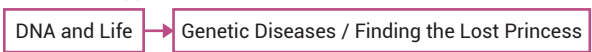
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Here are suggested lessons that complement each other:

**DNA and its application (in forensic science)**



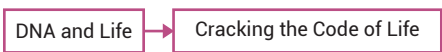
**DNA and its application (in diseases)**



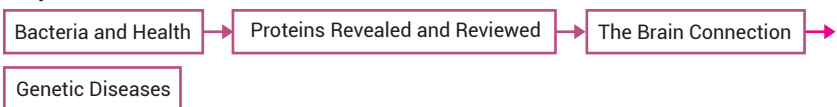
**DNA and ethical concerns**



**DNA code**



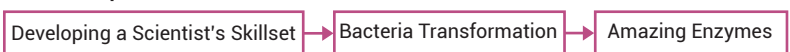
**Body and health**



**All about Bacteria**



**Lab Techniques**



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These classes are only available through school bookings

## Interactive Lecture Demo

### DNA: Cracking the Code of Life

Lecture Demo (Sec 3 to Sec 4/5 - Intermediate<sup>+</sup>)

\*\$2.00

2hrs

Our DNA is a very long molecule which contains important information for all living things. How is this information decoded to give rise to our various traits? How does a seemingly tiny change in DNA results in significant life-changing impacts? Mysterious isn't it? Join us for this fun-filled lecture demo with games and activities to unravel the DNA code!

#### OBJECTIVES

1. Understand the relationship between cells, chromosomes, DNA, genes and proteins.
2. Learn about the structure of DNA and its importance.
3. Learn how information in DNA is decoded to give rise to various traits through the process of transcription and translation.
4. Understand more about mutations and how they can affect life.

Capacity: 40 Students (minimum), 80 Students (maximum)

## Practical Lab Sessions

### DNA & Life

(Sec 1 to Sec 2 - Beginner <sup>+</sup>)

\*\$7.00 (Inclusive of GST)

2hrs

DNA is often described as the most important molecule of life which determines how living things look like and how they function. Ever wanted to see this extraordinary molecule? Join us in this lesson to view DNA without a microscope. At the same time, come and help us in an interesting case study to determine the baby's biological parents and solve a major family confusion!

#### OBJECTIVES:

1. Learn the structure of DNA and its importance.
2. Conduct a simple DNA extraction from bacteria and plant cells.
3. Learn the basics of blood typing and how DNA determines blood type of individuals.
4. Perform simple karyotyping, blood typing and DNA analysis to solve a case study.



### DNA in Forensic Science

(Sec 1 to Sec 2 - Beginner <sup>+</sup>)

\*\$7.00 (Inclusive of GST)

2hrs

A trace is left in every crime scene but do they always lead to the right criminal? A double murder has been committed and a prime suspect has been identified. However, was he the one who committed the murders? Join us in this exciting roller coaster journey to uncover the truth of a real life story and learn how contradicting evidence can complicate a crime.

#### OBJECTIVES:

1. Learn about different types of forensic techniques used.
2. Learn about the structure of DNA and its importance.
3. Learn micropipetting techniques.
4. Learn the importance of preventing evidence cross-contamination.
5. Understand how DNA is analysed through a technique known as agarose gel electrophoresis.
6. Learn how to interpret DNA analysis results and identify the possible criminal.

Revised



## Bacteria and Health

(Sec 1 to Sec 2 - Beginner<sup>+</sup>)

**\*\$7.00** (Inclusive of GST)

2hrs

Abdominal pain, nausea, diarrhoea and vomiting... More patients are turning up at the hospital with similar symptoms. It seems like a case of foodborne outbreak. What is the source of the outbreak? Which type of bacteria is causing the outbreak? Take on the role of a medical investigator and help us in this race against time to solve the outbreak before more people are infected!

### OBJECTIVES:

1. Understand how bacteria can affect our lives in both positive and negative ways.
2. Identification of bacteria through its shapes and arrangements.
3. Learn micropipetting techniques.
4. Learn how to grow bacteria via plating.
5. Learn about antibiotics, how they came about and how antibiotic resistance affects our lives.
6. Learn how antibiotic resistance test is carried out to determine the effectiveness of an antibiotic.

## Food Microbiology

(Sec 1 to Sec 2 - Beginner<sup>+</sup>)

**\*\$7.00** (Inclusive of GST)

2hrs

Why does bread rise? How does milk become cheese? What do these foods, as well as wine and yoghurt, have in common? They are produced with the help of microorganisms! For thousands of years, humanity has relied on processes such as fermentation to preserve our food from spoilage. Microorganisms can also prevent foodborne disease by inhibiting the growth of pathogens. Join us as we discover the miniscule helpers that are responsible for the delicious food we eat!

### OBJECTIVES:

1. Learn how microbial food cultures preserve food through fermentation.
2. Perform simple experiments to understand the role of fermentation in making various food products.
3. Prepare sample slides of microbes using simple staining methods and view them under the microscope.
4. Learn how microbial food cultures help to improve food safety through the inhibition of pathogens.

## Proteins Revealed and Reviewed

(Sec 1 to Sec 2 - Beginner<sup>+</sup>)

**\*\$7.00**

(Inclusive of GST)

2hrs

Proteins are the most abundant biological macromolecules. They exist in varied amounts in our body and in a myriad of products we encounter daily. Is it true that eating lots of proteins will give you more muscles? Learn the importance of proteins in our diet and discover the chemical techniques that determine its presence in our food. As you investigate the proteins in your food, find out how different proteins perform specialised functions in the body.

### OBJECTIVES:

1. Learn micropipetting techniques.
2. Perform an experiment to identify the presence of proteins in unknown samples.
3. Compare the differences between Bradford test and Biuret test.
4. Predict the presence of proteins in unknown samples and verify the predictions.
5. Investigate the function of proteins as biological enzymes through amylase-starch reaction.
6. Learn to critically review information and ensure their scientific accuracy.
7. Learn to make scientifically informed decisions on dietary choices.

These classes are only available through school bookings

Revised

## Science and Society (Workshop + Exhibition)

(Sec 1 to Sec 4/5 – Beginner +)

\*\$7.00 (Inclusive of GST)

2.5hrs

Technological advancements have made what used to be improbable possible. We have the ability to grow pest-resistant crops, prolong lives and treat infertility. However, are we twisting and bending the moral fabric of society as we push the boundaries of science? Are we defying Nature?

This thought-provoking workshop combines simple lab experiments and discussion on current topics to demonstrate the ethical dilemmas that arise from biomedical advances.

### OBJECTIVES:

1. Demonstrate respect towards people with diverse views.
2. Perform agarose gel electrophoresis and utilise the results to demonstrate critical-thinking skills.
3. Analyse real life cases such as Mitochondrial Replacement Therapy where ethical decisions are required.

## The Brain Connection

(Sec 3 to Sec 4/5 - Beginner +)

(1.5hrs Workshop + 0.5hr Exhibition)

\*\$7.00 (Inclusive of GST)

2hrs

How is it possible that every action and thought in our human body is controlled by a small organ weighing about 1.5kg? Does the size matter in determining intelligence? Apparently not! The amount of connections in the brain is more critical and we have about 100 billion neurons in our brain that are essential for our memory, daily activities and more. Be amazed by how these connections contribute to the brain's function and how damage to the network can create life-changing repercussions.

### OBJECTIVES:

1. Learn different parts of the brain and their function.
2. Participate in brain exercises to appreciate the function of the brain.
3. Understand the role of neural connection in the brain.
4. Observe mouse brain specimen under the microscope.
5. Learn about disorders that are related to the brain.



## Genetic Diseases

(Sec 3 to Sec 4/5 - Intermediate<sup>+</sup>)

**\*\$7.00** (Inclusive of GST)

2hrs

Thalassaemia is the most common inherited single-gene disorder in the world and is prevalent in Southeast Asia. Klinefelter syndrome affects males while Turner syndrome affects females. Both syndromes are due to chromosome mutations. What is the difference between a gene disorder and a chromosomal disorder? How can we predict the probability that an unborn child would have a genetic disorder? To know these answers and more, join us in this activity-filled lesson.

### OBJECTIVES:

1. Understand about genetic diseases such as chromosomal disorders and single gene disorders.
2. Define genes, alleles and genotype.
3. Learn how to predict results of simple crosses using a genetic diagram.
4. Learn micropipetting techniques.
5. Understand how DNA is analysed through a technique known as agarose gel electrophoresis.

## Life in Micro

(Sec 3 to Sec 4/5 - Intermediate<sup>+</sup>)

**\*\$7.00** (Inclusive of GST)

2.5hrs

A drop of water may look clear but is there microorganisms living within? Some organisms are so tiny that they cannot be seen with the naked eye, but that does not mean they do not exist. Through more advance microscopy techniques, observe bacteria under oil immersion and different stages of cell division of an onion root tip. Come explore the microscopic world in a fun and enriching way!

### OBJECTIVES:

1. Revision of microscopy techniques.
2. Perform oil immersion technique and diaphragm adjustments to enhance viewing of the specimens.
3. Understand mitosis and meiosis.
4. View pond organisms and bacteria specimens.
5. View the main stages of mitosis and meiosis under the microscope.



## Finding the Lost Princess – A Forensic Approach

**\*\$9.00**  
(Inclusive of GST)

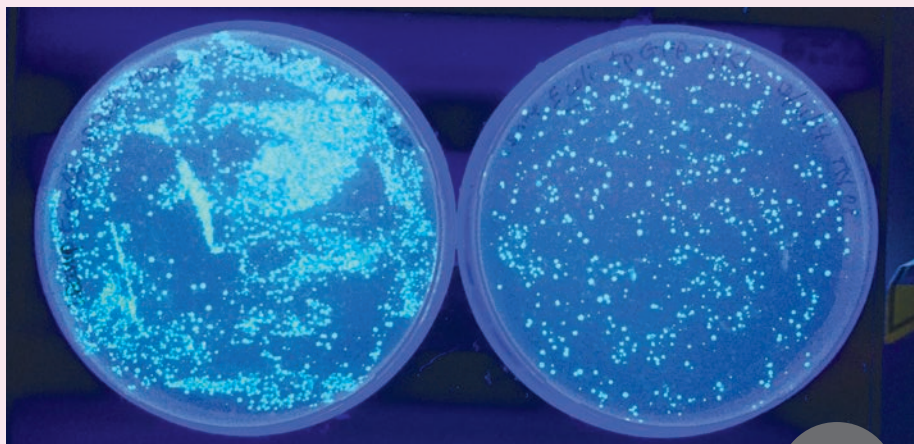
**2.5hrs**

(Sec 3 to Sec 4/5 - Intermediate<sup>+</sup>)

Princess Anastasia was the youngest daughter of the last imperial family of Russia. When her family was killed by the Red Army firing squad, many thought that she had escaped and became the last surviving member of the Romanov family. The appearance of Anna Anderson, a woman with an uncanny resemblance to Anastasia, strengthened the belief that she had survived. Was Anna Anderson telling the truth when she claimed to be Princess Anastasia? How is it that a genetic disease could have indirectly contributed to the downfall of the Romanov legacy? In a captivating class that combines modern world history and forensic analysis, join us to learn the fate of Princess Anastasia and how the haemophilia gene became prominent in the European royal family.

### OBJECTIVES:

1. Learn that haemophilia is a sex-linked recessive genetic disorder and how it is inherited in a family.
2. Learn that DNA is inherited from parents and how it can be used to trace a person's lineage.
3. Understand how science is interconnected to other disciplines of study.
4. Identify the difference between subjective and objective evidence.
5. Learn micropipetting techniques.
6. Understand how DNA is analysed through a technique known as agarose gel electrophoresis.



## Bacteria Transformation

**\*\$9.00**  
(Inclusive of GST)

**2.5hrs**

(Sec 3 to Sec 4/5 - Intermediate<sup>+</sup>)

To help diabetic patients, human insulin has been mass produced by genetically engineered bacteria for many years. Genetic engineering may be controversial, yet it has its benefits. The thought of being able to genetically transform an organism is exciting yet intriguing at the same time. What exactly is genetic engineering? Come and immerse yourself in the magnificent world of genetic engineering and genetically transform bacteria to glow green (fluoresce)!

### OBJECTIVES:

1. Learn the general structure of bacteria and the importance of plasmid.
2. Learn micropipetting techniques.
3. Conduct a bacteria transformation experiment using the heat shock method.
4. Understand more about the GFP protein and its uses.
5. Understand other types of genetic transformation.
6. Grow bacteria via plating and observe the results.
7. Learn the sterile techniques required when working with bacteria.

These classes are only available through school bookings

## Amazing Enzymes – The Important Catalysts of Life

\*\$9.00  
(Inclusive of GST)

2.5hrs

(Sec 3 to Sec 4/5 - Intermediate<sup>+</sup>)

Enzymes are life's work horses. They help the human body in food digestion, speed up biochemical reactions and many other important processes. A new enzyme has just arrived in the lab and we need your help to determine its optimum working conditions. Through the use of a simple game and real time experiments, come and learn how certain factors can affect the rate of enzyme reaction.

### OBJECTIVES:

1. Learn about enzymes and their roles in everyday life.
2. Understand the different conditions that affect enzymatic reactions.
3. Learn micropipetting techniques.
4. Use the spectrophotometer to perform a quantitative enzyme assay analysis.

- + Beginner – This is suitable for students without prior knowledge of the subject
- + Intermediate – Some prior knowledge of the subject is required to better appreciate the content of the lesson.



## EXPERIENTIAL LEARNING

(Sec 1 to Sec 5 – Content will be adjusted according to the group)

The experiential learning workshops aim to equip students embarking on Science research projects with molecular biology lab techniques and experimental design skills.

### Developing a Scientist's Mind

**\*\$99.00**  
(Inclusive of GST)

**DAY 1-2**  
9am - 4.30pm

**DAY 3**  
9am - 12pm

(Includes lunch break, food not provided)

All scientists follow a procedure known as the scientific method to ensure that their experiments are fair and accurate. In this workshop, students will be guided through the key steps of scientific research methodology. Come experience what scientists do by designing, conducting and presenting your own experiment.

#### OBJECTIVES:

1. Learn lab techniques such as micropipetting, bacteria spread plate method, streak plate method and aseptic techniques.
2. Learn and apply the scientific method by designing an experiment.
3. Conduct a self-designed lab experiment.
4. Learn to present and review experiment methodology and results.

Capacity: 16 students (minimum), 24 students (maximum).

Class size is kept small so that there is closer interaction between instructor and students.

### Developing a Scientist's Skillset

**\*\$70.00**  
(Inclusive of GST)

**2 DAYS**  
9am - 4.30pm

(Includes lunch break, food not provided)

Just like a carpenter needs his toolbox, a scientist uses many equipment in research. Come learn some tools of the trade in molecular biology research. Learn various molecular biology and microbiology techniques and understand some of their real life applications.

#### OBJECTIVES:

1. Learn micropipetting techniques.
2. Understand the general structure of bacteria.
3. Learn aseptic techniques when working with bacteria.
4. Grow bacteria via spread plate method and observe the results.
5. Stain bacteria cells using the Gram Staining method and view them under the microscope.
6. Understand the application of using microscope to identify microorganisms such as bacteria.
7. Learn about the structure of DNA and its importance.
8. Understand how DNA is analysed through a technique known as agarose gel electrophoresis.
9. Learn how to interpret DNA fingerprint results.
10. Understand and appreciate the key steps of scientific research methodology.





# ABE

## AMGEN® Biotech Experience

### Scientific Discovery for the Classroom

Singapore

ABE is an innovative science education programme which provides teachers with the loan of research-grade equipment, supplies, curriculum and professional development. There are 6 labs involved for students to appreciate the genetic engineering process and its use in biotechnology and drug discovery. Alternatively, Science Centre has put together a series of workshops comprising some of the labs and our Science Educators will conduct the ABE Express Genetic Engineering Workshops for your students.

Possible ways to implement this programme:

1. Teachers borrow kit and conduct on their own (Cost: Free)
2. Science Centre educator conducts programme in your school (Cost: \$9/lab/pax)
3. Science Centre educator conducts programme in Science Centre Singapore (Please refer to ABE Express on the next page)

For more information on the labs and how to implement, please visit [www.science.edu.sg/schoolprogrammes/pages/amgenbiotechexperience.aspx](http://www.science.edu.sg/schoolprogrammes/pages/amgenbiotechexperience.aspx).



## ABE Express: Genetic Engineering Beginner

(Sec 1 to Sec 2)

**\*\$20.00**  
(Inclusive of GST)

**1 DAY**  
9am - 4.30pm

(Includes lunch break, food not provided)

Have you wondered how human insulin is produced in the lab? This is done by genetically engineering bacteria to produce insulin. Since its innovation in 1973, genetic engineering has been applied in many fields such as producing genetically modified food, genetic treatments and medicines. Come and learn the basics of Genetic Engineering.

### OBJECTIVES:

1. Define genetic engineering and recombinant DNA cloning.
2. Learn micropipetting techniques.
3. Perform an experiment on recombinant DNA cloning including digestion of DNA with restriction enzyme, ligation of desired vectors and verification using agarose gel electrophoresis.
4. Understand what happens during restriction digest and ligation through a simple paper activity.
5. Learn more about the applications of genetic engineering.

## ABE Express: Genetic Engineering Intermediate

(Sec 3 to Sec 5)

**\*\$30.00**  
(Inclusive of GST)

**DAY 1**  
9.30am - 5pm

**DAY 2**  
9.30am -  
12.30pm

(Includes lunch break, food not provided)

Have you wondered how human insulin is produced in the lab? This is done by genetically engineering bacteria to produce insulin. Since its innovation in 1973, genetic engineering has been applied in many fields such as producing genetically modified food, genetic treatments and medicines. Come and have a first-hand experience of conducting these authentic biotechnological experiments used by researchers around the world!

### OBJECTIVES:

1. Define genetic engineering and recombinant DNA cloning.
2. Learn micropipetting techniques.
3. Perform an experiment on recombinant DNA cloning including digestion of DNA with restriction enzyme, ligation of desired vectors, bacteria transformation, selection for transformed bacteria, agarose gel electrophoresis\* and purification of protein product using column chromatography\*.
4. Learn more about the applications of genetic engineering.
5. Explore different perspectives on the effect of genetic engineering.

\* Also available as a 1-day workshop upon request. Items with # will not be covered for 1-day workshop.



These classes are only available through school bookings

## PRE-UNIVERSITY SCHOOL PROGRAMMES (GCE 'A' LEVEL)

### Secondary school curriculum links

SCHOOL SYLLABUS LINKS	COMMON KEY LEARNING POINTS	DNA LAB PROGRAMMES
<b>H1 Biology Core Topics:</b>		
Cellular functions	Mode of action of enzymes Effect of substrate concentration on rate of reaction	Amazing Enzymes
DNA and genomics	Structure and role of DNA	Bacteria Transformation/ PTC/ Forensic Analysis
	Change in DNA sequence affects phenotype	PTC/ Bacteria Transformation
Evolution	Variation and natural selection	PTC
<b>H2 Biology Core Topics:</b>		
Cellular functions	Mode of action of enzymes Effect of substrate concentration on the rate of enzyme-catalysed reaction.	Amazing Enzymes
Genetics and inheritance	Structure and role of DNA	Bacteria Transformation/ PTC/ Forensic Analysis/ Genetic Engineering
	Structure of prokaryotic and eukaryotic genomes	Bacteria Transformation/ Genetic Engineering
	Regulation of gene expression with operons	Genetic Engineering
	Principles and procedures of PCR and gel electrophoresis	PTC/ Forensic Analysis/ Genetic Engineering
	How genotype is linked to phenotype	Bacteria Transformation/ PTC
Biological evolution	Variation and natural selection	PTC
<b>H2 Biology Extension Topics:</b>		
Infectious Diseases	The immune system Role of memory B cells in secondary infection Vaccination	Understanding our Hero
<b>H3 Biology – Proteomics</b>		
Analytical techniques	Use of UV absorbance spectroscopy	Amazing Enzymes
	Application of bioinformatics to perform nucleotide homology searches	PTC
Protein structure and function	Mechanism of enzyme action	Amazing Enzymes

These classes are only available through school bookings

Time	: 9.30am (Session I) or 2.30pm (Session II)
Venue	: Science Centre Singapore
Capacity (Unless otherwise stated)	: Minimum number - 20 students Maximum number - 40 students

*\*(Admission fee to Science Centre applies to non-member International school based in Singapore)*

## Practical Lab Sessions

Revised

### Science and Society (Workshop + Exhibition)

**\*\$7.00** (Inclusive of GST) **2.5hrs**

Technological advancements have made what used to be improbable possible. We have the ability to grow pest-resistant crops, prolong lives and treat infertility. However, are we twisting and bending the moral fabric of society as we push the boundaries of science? Are we defying Nature?

This thought-provoking workshop combines simple lab experiments and discussion on current topics to demonstrate the ethical dilemmas that arise from biomedical advances.

#### OBJECTIVES:

1. Demonstrate respect towards people with diverse views.
2. Perform agarose gel electrophoresis and utilise the results to demonstrate critical-thinking skills.
3. Analyse real life cases such as Mitochondrial Replacement Therapy where ethical decisions are required.

### Bacteria Transformation

**\*\$9.00** (Inclusive of GST) **2hrs**

To help diabetic patients, human insulin has been mass produced by genetically engineered bacteria for many years. Genetic engineering may be controversial, yet it has its benefits. The thought of being able to genetically transform an organism is exciting yet intriguing at the same time. What exactly is genetic engineering? Come and immerse yourself in the magnificent world of genetic engineering and genetically transform bacteria to glow green (fluoresce)!

#### OBJECTIVES:

1. Learn the general structure of bacteria and the importance of plasmid.
2. Learn micropipetting techniques.
3. Conduct a bacteria transformation experiment using the heat shock method.
4. Understand more about the GFP protein and its uses.
5. Understand other types of genetic transformation.
6. Grow bacteria via plating and observe the results.
7. Learn the sterile techniques required when working with bacteria.



## Amazing Enzymes – The Important Catalysts of Life

\*\$13.00 (Inclusive of GST)

2.5hrs

Enzymes are life's work horses. They help the human body in food digestion, speed up biochemical reactions and many other important processes. A new enzyme has just arrived in the lab and we need your help to determine its optimum working conditions. Through the use of a simple game and real time experiments, come and learn how certain factors can affect the rate of enzyme reaction.

### Objectives:

1. Learn about enzymes and their roles in everyday life.
2. Understand the different conditions that affect enzymatic reactions.
3. Learn micropipetting techniques.
4. Use the spectrophotometer to perform a quantitative enzyme assay analysis and understand enzyme kinetics.

NEW

## Understanding our Hero – Our Defence System

\*\$20.00 (Inclusive of GST)

2.5hrs

Have you ever wondered how a disease is detected? Why are some disease treatable while others are not? Ever been intrigued by how our immune systems miraculously work to keep foreign organism at bay? Join us in discovering the world of immunology and understanding vaccination through the use of a real-life diagnostic tool!

### OBJECTIVES:

1. Learn micropipetting techniques.
2. Understand the role of memory B cells in secondary infection.
3. Understand antigen-antibody interaction and learn its application in disease detection.
4. Investigate and track whether a patient has been infected by bacteria through serum analysis.
5. Perform Enzyme-linked immunosorbent assay (ELISA) and explain the use of ELISA in disease diagnosis.
6. Understand and learn how ELISA can help in identifying vaccinated from unvaccinated patients.
7. Discuss how vaccination can control disease, benefits and risks of vaccination.



## Full-day workshops

9.30am-11.30am and 12.30pm-3pm  
(includes lunch break- food not provided)

### PTC

## – The 'Bitter' Life of Super-tasters

\*\$22.00 (Inclusive of GST)

4.5hrs

Are your friends frustrated with you for being a fussy eater? Maybe it is because you are a super-taster! Find out how a single gene in our DNA can affect the ability to taste phenylthiocarbamide (PTC), a harmless bitter tasting chemical and how it may also affect our sensitiveness to other bitter compounds! Join us in this ultimate self-discovery hands-on workshop to find out who among us have this PTC taste receptor gene!

#### OBJECTIVES:

1. Learn micropipetting techniques.
2. Perform DNA extraction from cheek cells<sup>^</sup> and polymerase chain reaction to amplify DNA.
3. Digest DNA with restriction enzyme.
4. Cast agarose gel and analyse DNA through a technique known as agarose gel electrophoresis.
5. Introduce Bioinformatics tools used in DNA analysis.

### Forensic Analysis DNA Profiling

\*\$22.00 (Inclusive of GST)

4.5hrs

DNA profiling is currently considered the gold standard in forensic science and has been highly popularised by crime related programmes on the media. Although the current state of the art DNA profiling uses 13 to 16 short tandem repeat (STR) loci in a multiplex PCR format, this experiment pursues the amplification of a single variable number of tandem repeat (VNTR) locus, D1S80. Come and experience the work of a forensic scientist in analysing DNA profiles and learn techniques used in forensic science.

#### OBJECTIVES:

1. Understand the importance of DNA as evidence of a crime.
2. Learn the application of STR and VNTR in DNA profiling.
3. Learn micropipetting techniques.
4. Perform DNA extraction from cheek cells<sup>^</sup> and polymerase chain reaction to amplify DNA.
5. Cast agarose gel and analyse DNA through a technique known as agarose gel electrophoresis.
6. Learn how to collect fingerprint evidence using actual forensic fingerprint dusting tools.



<sup>^</sup>Participants will need to provide their own DNA sample from cheek cells.

<sup>\*</sup>(Admission fee to Science Centre Singapore applies to non-member International school based in Singapore)

ABE

## AMGEN® Biotech Experience

### Scientific Discovery for the Classroom

Singapore

ABE is an innovative science education programme which provides teachers with the loan of research-grade equipment, supplies, curriculum and professional development. There are 6 labs involved for students to appreciate the genetic engineering process and its use in biotechnology and drug discovery. Alternatively, Science Centre has put together a series of workshops comprising some of the labs and our Science Educators will conduct the ABE Express Genetic Engineering Workshops for your students.

Possible ways to implement this programme:

1. Teachers borrow kit and conduct on their own (Cost: Free)
2. Science Centre educator conducts programme in your school (Cost: \$9/lab/pax)
3. Science Centre educator conducts programme in Science Centre Singapore (Please refer to ABE Express on the next page)

For more information on the labs and how to implement, please visit [www.science.edu.sg/schoolprogrammes/pages/amgenbiotechexperience.aspx](http://www.science.edu.sg/schoolprogrammes/pages/amgenbiotechexperience.aspx).



## ABE Express: Genetic Engineering Advance

**\*\$35.00**  
(Inclusive of GST)

**2 DAYS**  
9.30am - 5pm

(Includes lunch break, food not provided)

Have you wondered how human insulin is produced in the lab? This is done by genetically engineering bacteria to produce insulin. Since its innovation in 1973, genetic engineering has been applied in many fields such as producing genetically modified food, genetic treatments and medicines. Come and have a first-hand experience of conducting these authentic biotechnological experiments used by researchers around the world!

### OBJECTIVES:

1. Define genetic engineering and recombinant DNA cloning.
2. Learn micropipetting techniques.
3. Perform an experiment on recombinant DNA cloning including digestion of DNA with restriction enzyme, ligation of desired vectors, bacteria transformation, selection for transformed bacteria, agarose gel electrophoresis\*, purification of protein product using column chromatography\* and colony polymerase chain reaction\*.
4. Learn more about the applications of genetic engineering.
5. Explore different perspectives on the effect of genetic engineering.

\* Also available as a 1-day workshop upon request. Items with \* will not be covered for 1-day workshop.

*This workshop will only be available from July 2018.*





With a strong focus on STEM education, our workshops provide real world applications on various Science concepts. Students get to experience authentic learning by using the equipment and techniques used by Scientists in research labs. Many workshops are interdisciplinary, combining both social and ethical issues with science and technology.

## Here's what teachers say about our programmes

### BACTERIA OUTBREAK

"Good exposure to students as real life scenarios were discussed."

### DNA AND LIFE

"Provides learning beyond textbook."

### BACTERIA AND HEALTH

"Simplified explanation for people who totally did not know about bacteria."

### BACTERIA TRANSFORMATION

"The discussion on the use of GMO, its issues and implications were very interesting and helped to inject a real life application."

### GENES AND OUR TRAITS

"Pupils are able to see DNA; they are able to see the relation between what they learn in school and how it affects in real life."

### DNA DETECTIVES

"Very authentic case that is able to engage the pupils and evoke their curiosity."

### LIFE IN MICRO

"The hands-on activities were helpful for the students to see more than what there is in their textbooks."

### GENETIC DISEASES

"Covered real life diseases which students can relate to."

### THE BRAIN CONNECTION

"Learning about the brain in greater detail."

### DNA BASICS

"Interesting info shared with the pupils and the hands-on activities were engaging and appropriate for their age group."

"DNA model making helped them visualise the DNA structure better."

### FINDING THE LOST PRINCESS

"Interesting story that captivated the students' attention. Applicable to Sec 4 syllabus."

### DNA IN FORENSIC SCIENCE

"Helpful in sparking students' interest in the science."

"Students enjoyed casting the gel and solving the crime. It was engaging for the students and created awareness among them about the different techniques involved in forensic science."

## OUR EDUCATORS

"The instructor was EXCELLENT, very informative, patient and organised."

"The instructor was knowledgeable and infused the lesson with many stories related to today's lesson. This piqued the pupils' interest in Science."

"Instructions given were very clear, simple and direct. In-depth learning and clarity of explanation by instructor."

"Very good instructor - very enthusiastic!"

"Engaging, organised, good classroom management, humorous yet firm."

"The scaffolding questions and clear voice projection, together with timely comments on observations, helped the students learn better."

## FORENSIC ANALYSIS DNA PROFILING

"Many topics were covered and these could serve as introductory courses for the students who are in JC1, eg. micropipetting skills, VNTR vs STR, PCR."

## PTC-THE "BITTER" LIFE OF SUPER-TASTERS

"Fantastic facilities and equipment. Hard to do PCR in school!"

"Fit IB diploma syllabus for Biology."



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To book for Experiential Learning and ABE Workshops,  
please email  
**[dnalab@science.edu.sg](mailto:dnalab@science.edu.sg)**.

For all other classes, please book online at  
**<https://obs.science.edu.sg/login>**

The information is accurate at the time of printing and is subjected to changes. For the latest updates, please log on to **[www.science.edu.sg](http://www.science.edu.sg)** (DNA Learning Laboratory) or scan the QR code.



Like our Facebook page "DNA Learning Lab – Science Centre Singapore" to receive latest updates and share your experiences in the DNA lab.

