MiniOne MiniLabs Overview & Alignment with HKDSE Biology Syllabus

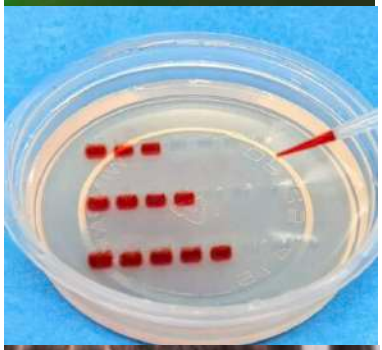
miniOne® SYSTEMS

MiniLabs Overview

- Series of hands-on labs ranging from basic biotech skills (for junior levels) to challenging AP and college-level investigations (for senior levels)
- Real-world applications: forensics, DNA fingerprinting, and human genetics, epidemiology
- Use as a complete curriculum or throughout the year to enhance your lessons.
- Add an inquiry-based and visually engaging connection to modern biotechnology

MiniLabs Overview

M3001
Electrophoresis 101 MiniLab



M3002
Gel Loading Practice MiniLab

M3003
PTC Genetics MiniLab

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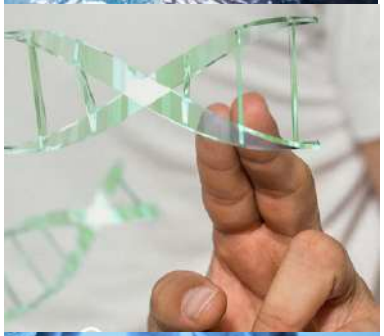
MiniLabs Overview

M3004

DNA Fingerprinting MiniLab



M3005

CSI Forensic MiniLab

M3006

Foodborne Outbreak Investigation MiniLab

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MiniLabs Overview

M3007
Colourful Dye Electrophoresis MiniLab

M3009
Candy Colour Electrophoresis MiniLab

M3010
Hungting the Inheriteance of Huntington;s Disease MiniLab

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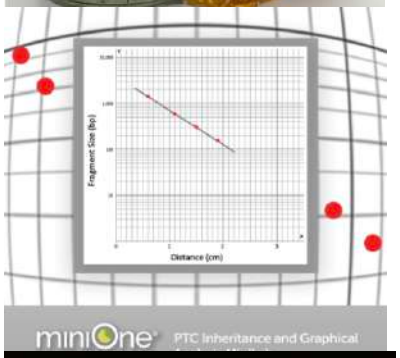
MiniLabs Overview

M3011
Determining the Genetics of a Ca$h Cow MiniLab



M3012
PTC Inheritance and Graphical Analysis MiniLab

M3013
The Dilution Solution MiniLab

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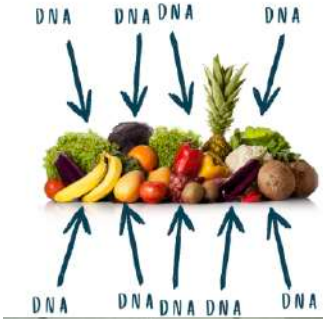
MiniLabs Overview

M3014
Taking Macromolecules to Micro!



M3015
DNA Extraction Toolbox

M3016
What's in the Trunk? An Elephant Ivory Expedition

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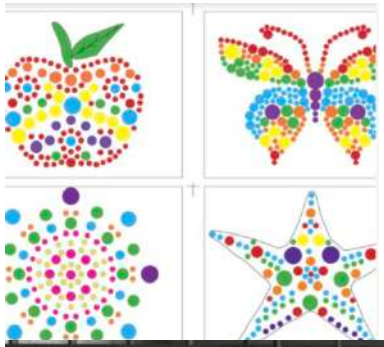
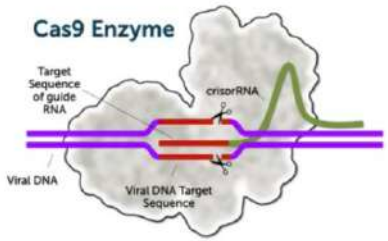
MiniLabs Overview



M3017
Pipette Pointillism

M3018
Molecular Ladder to Freedom – DNA Exoneration MiniLab



M3019
Molecular Masterpieces: Crafting Genetics with CRISPR MiniLab

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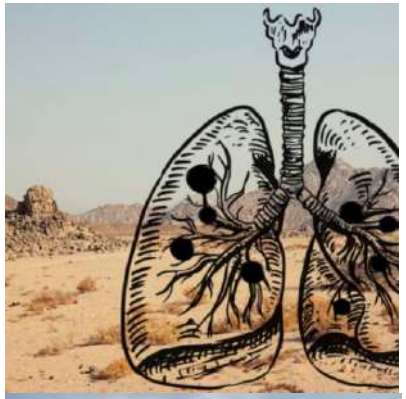
MiniLabs Overview



M3020

The Fungus Among Us: Valley Fever MiniLab

M3021

Urine Trouble! MiniLab

M3022

Show Me the Moo-ney! MiniLab

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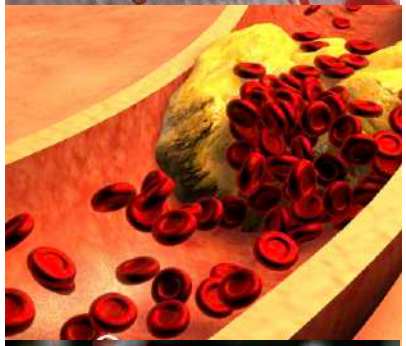
MiniLabs Overview

M3050
Sickle Cell MiniLab



M3051
Hypercholesterolemia MiniLab

M3053
Analyzing a Crime Scene with DNA Reagent Pack

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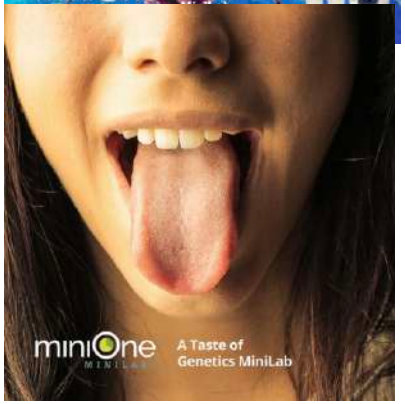
MiniLabs Overview

M3054

BRCA Chronicles: Breast Cancer Genetics MiniLab

M6001

PCR 101 and Gel Electrophoresis MiniLab



M6010

A Taste of Genetics MiniLab

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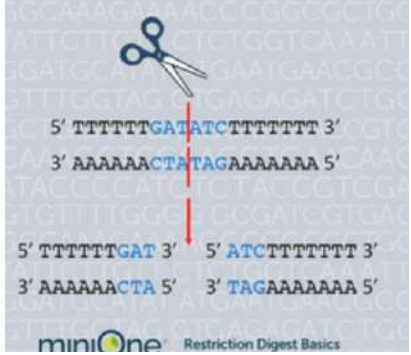
MiniLabs Overview

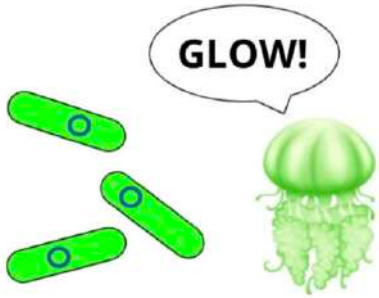
M6030

Who Has The Flu? Tracing Transmission with ELISA and PCR MiniLab



M6050

Restriction Digest Basics MiniLab



M6300

Let it Glow™ Bacterial Transformation MiniLab

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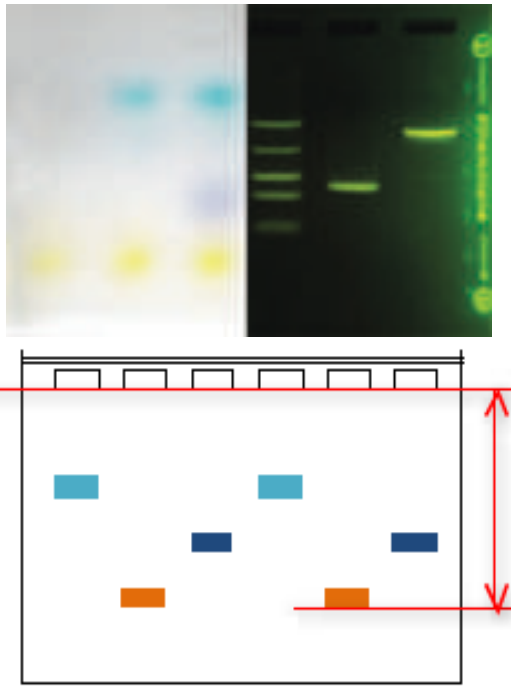
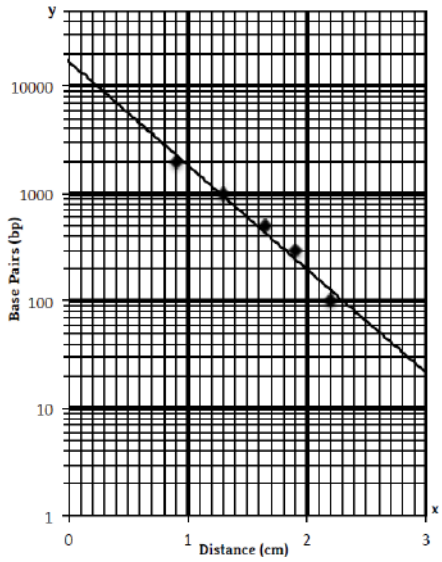
M3001: Electrophoresis 101 MiniLab

Fundamentals of DNA analysis





Difficulty Level: ★★☆☆☆

Materials included:

- 3 dyes samples
- 2 DNA samples (unknown sizes)
- 1 DNA Marker
- Agarose Gel Cups
- Running buffer
- Pipette tips
- Microcentrifuge tubes

Major HKDSE-related chapters:

1. DNA fingerprinting

- Develop an understanding of the principles of gel electrophoresis
- Observe the migration of color dyes and DNA samples
- Plot a standard curve on semi-log graph paper
- Calculate the sizes of unknown molecules from given information and experimental data
- **Lab Techniques involved: Pipetting, Gel Electrophoresis, Graph Drawing**

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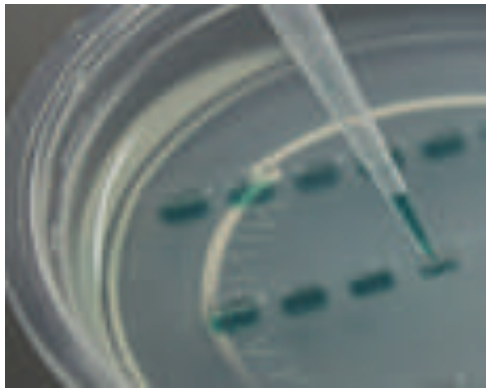
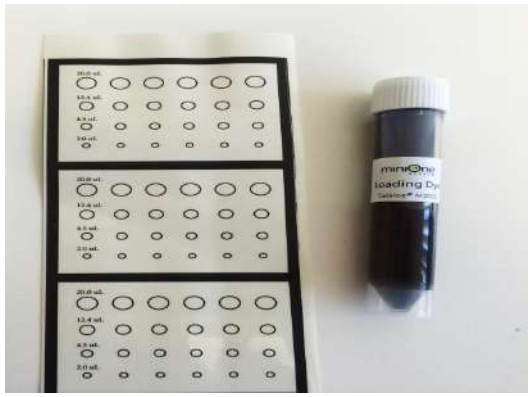
M3002: Practice Pipetting and Gel Loading

Master the most important skill

Difficulty Level: ★ ☆ ☆ ☆ ☆





Materials included:

- 20 practice pipetting cards
- 20 practice gels
- Two practice dyes (red & blue)
- Pipette tips
- Microcentrifuge tubes

Major HKDSE-related chapters:

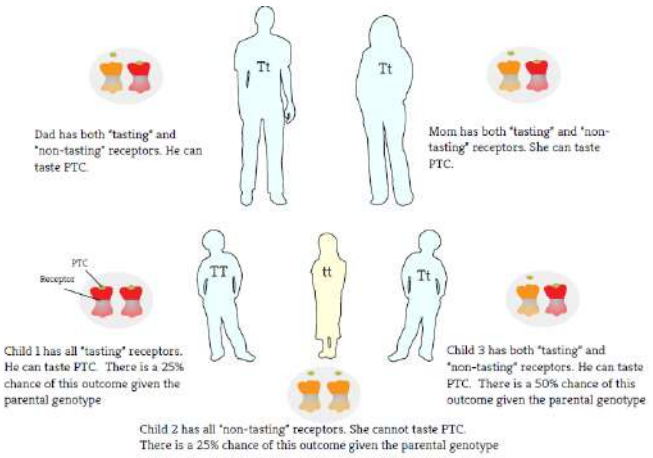
1. DNA fingerprinting

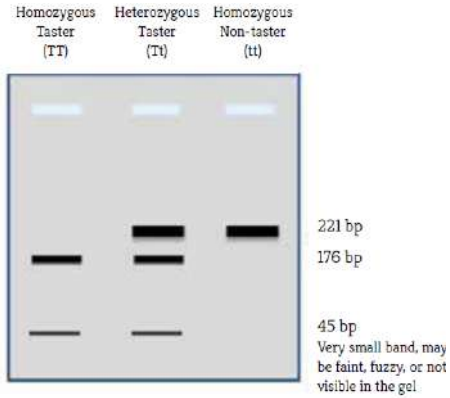
- Mastering the use of an adjustable volume micropipette is the key to delivering accurate and reproducible results in biotechnology works
- Target-practice cards reinforce the method of volume adjustment and precision measurement
- Agar gels give the feel of loading a real gel, building competency and confidence
- Allow students to practice until they have the skills to load small volumes of DNA samples onto an agarose gel
- **Lab Techniques involved: Pipetting, Gel Loading**

M3003: PTC Genetics MiniLab

Mendelian inheritance of an observable trait

Difficulty Level: ★★★☆☆





Materials included:

- PTC test strips
- 6 DNA samples
- GreenGel Cups
- Running buffer
- Pipette tips
- Microcentrifuge tubes

- For students familiar with electrophoresis- expand their knowledge of genetic principles and Mendelian inheritance
- Develop a hypothesis about the genetic basis of observed phenotypic traits and run an experiment to test it
- Use a Punnett square to explain experimental results
- Construct a family tree to explain inheritance of a trait
- **Lab Techniques involved: Pipetting, Gel Electrophoresis**

Major HKDSE-related chapters:

1. Detecting the Environment
2. Mendelian Inheritance
3. Human Inheritance (Pedigree)
4. Recombinant DNA (Restriction enzyme)
5. DNA fingerprinting

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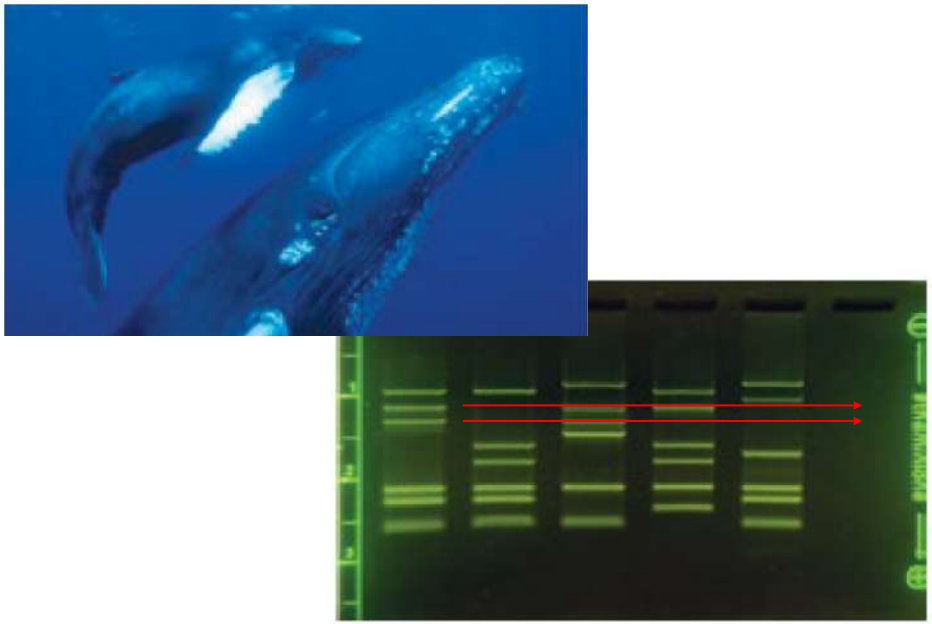
M3004: DNA Fingerprinting MiniLab

Tracing ancestry with genetics



Difficulty Level: ★★★☆☆

Materials included:

- DNA samples from baby whale (Luna), mother, three potential fathers
- GreenGel Cups
- Running buffer
- Pipette tips
- Microcentrifuge tubes

- Use DNA fingerprinting to help scientists determine the parentage of a humpback whale calf
- Challenge your pattern analysis skills to find the bands that must have been contributed by the father
- Apply logic and knowledge of mammalian genetics to infer a pattern of inheritance
- **Lab Techniques involved: Pipetting, Gel Electrophoresis**

Major HKDSE-related chapters:

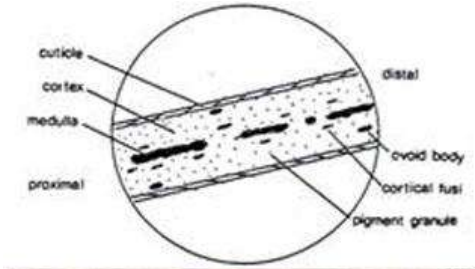
1. Recombinant DNA (Restriction enzyme)
2. DNA fingerprinting

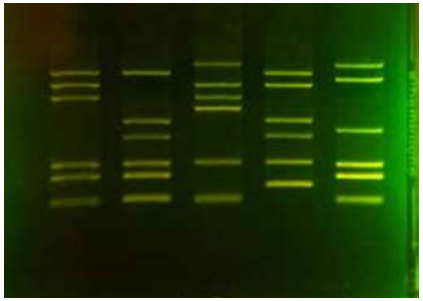
Electives:

1. PCR

M3005: CSI Forensics MiniLab

Who killed Dr. Ward?





Difficulty Level: ★★☆☆☆

Materials included:

- 6 DNA samples
- GreenGel Cups
- Running buffer
- Pipette tips
- Microcentrifuge tubes

Major HKDSE-related chapters:

1. DNA fingerprinting

- Engaging scenario introduces popular forensic topics
- Students examine hair, fingerprints, and DNA to link one of the suspects with the crime scene
- Students must integrate multiple lines of evidence and apply logical reasoning to solve the crime
- Exercise culminates with hands-on electrophoresis experiment with DNA from crime scene, victim, and three suspects
- **Lab Techniques involved: Pipetting, Gel Electrophoresis**

M3006 : Foodborne Outbreak Investigation

Forensic science for public health investigation

Party-Goer	What did he/she eat?	Sick?
1	Tortilla chips, guacamole, a burger, five layer bean dip, deviled eggs, coleslaw, and chicken tacos.	Yes
2	Potato chips with French onion dip, tortilla chips with salsa, potato salad, a burger, and deviled eggs.	
3	Potato chips with buttermilk ranch, tortilla chips with salsa, a burger, five layer bean dip, garden salad with buttermilk ranch dressing, deviled eggs, and coleslaw.	
4	Potato chips with French onion dip, tortilla chips with	

Difficulty Level: ★★★★☆

Materials included:
- 11 DNA samples
- GreenGel Cups
- Running buffer
- Pipette tips
- Microcentrifuge tubes

Major HKDSE-related chapters:

1. Infectious Disease
2. Recominant DNA (Restriction enzyme)
3. DNA fingerprinting

Electives:

1. Microorganisms
2. PCR

- Based on a real-life Shigella outbreak from yr. 2000
- Includes a pencil and paper exercise and a student-designed gel electrophoresis experiment
- Use a cohort study and molecular assays to trace an outbreak to its source
- Demonstrate the need for positive and negative controls in molecular biology experiments
- Expose your students to career pathways in public health
- **Lab Techniques involved: Pipetting, Gel Electrophoresis**

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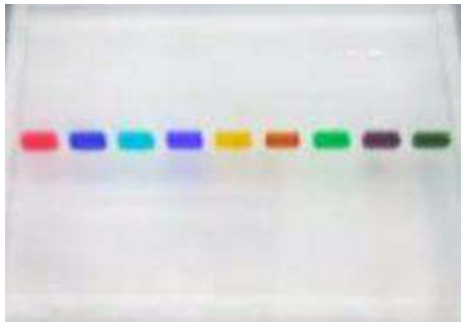
M3007: Colorful Dye Electrophoresis

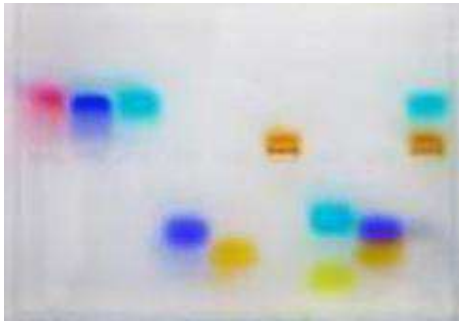
Visual introduction to STEM concepts

Difficulty Level: ★★☆☆☆



Start

10 minutes
run time



End

Materials included:

- Nine color dye samples
- Agarose Gel Cups
- Running buffer
- Pipette tips
- Microcentrifuge tubes

- Students predict how dyes will migrate in an electric field based on their molecular weight and electric charge
- Learn foundational concepts from physics and chemistry: electric fields and voltage, properties of molecules, chemical basis of color
- Prepares students technically and conceptually for DNA electrophoresis experiments
- **Lab Techniques involved: Pipetting, Gel Electrophoresis**

Major HKDSE-related chapters:

1. DNA fingerprinting

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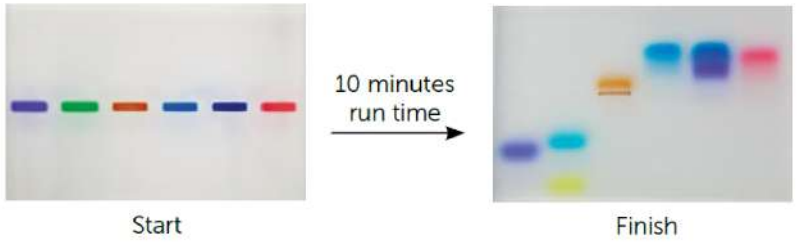
M3008 : NGSS-Aligned Color Dyes and Gel Electrophoresis

Comprehensive, inquiry-based MiniLabs follow the 5E lesson model



Difficulty Level: ★★☆☆☆

Materials included:

- 5E approach lesson plans
- Paper chromatography activity
- Six color dye samples
- Agarose Gel Cups
- Running buffer
- Plastic accessories

The 5E Model:

Engage: students consider different methods for separating various mixtures & solutions

Explore: students use gel electrophoresis to separate solutions containing different dyes and work to figure out how & why the dyes separate as they do

Explain: students make claims supported by evidence

Elaborate: Students extend their understanding of gel electrophoresis to include common use in biotechnology

Evaluate: Students complete a summative assessment - then followed by intervention

Major HKDSE-related chapters:

1. DNA fingerprinting

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M3009: Candy Color Electrophoresis

Visual introduction to STEM concepts

Difficulty Level: ★★☆☆☆

Food Colorings

- Students prepare a colored extract from familiar candies, or food
- Cast, load, and run an agarose gel to analyze dye mixtures
- Interpret an electrophoresis gel using the concept that migration speed is determined by molar mass and electric charge
- Perform simple calculations on molar mass and electric charge
- **Lab Techniques involved: Pipetting, Gel Electrophoresis**

Materials included:

- Candies in six different colors
- Dye extraction buffer
- Dye extraction trays
- Agarose Gel Cups
- Running buffer
- Pipette tips
- Microcentrifuge tubes

Major HKDSE-related chapters:

1. DNA fingerprinting

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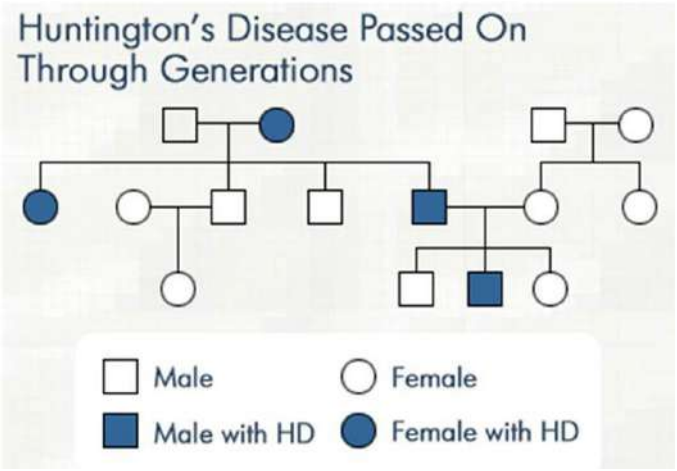
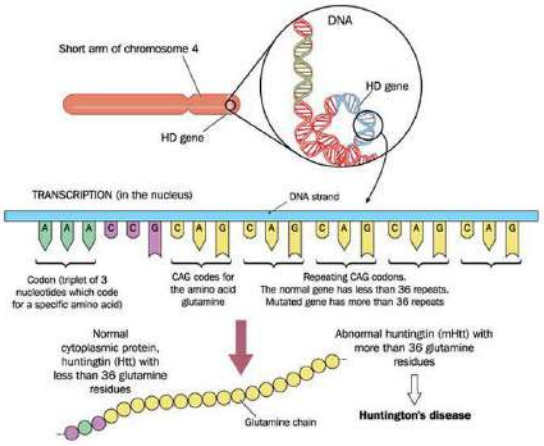
M3010 : Hunting the Inheritance of Huntington's Disease

Understanding Mendelian genetics & constructing pedigree





Difficulty Level: ★★★★☆

Materials included:

- Pedigree Frame & name cards
- 5 DNA samples
- GreenGel Cups
- Running buffer
- Pipette tips
- Microcentrifuge tubes

- Study Mendelian genetics by using a real-life example of the inheritance of Huntington's Disease (an autosomal dominant genetic disease)
- Students form groups to construct a family pedigree and use the pedigree to observe disease patterns and make predictions about the inheritance of HD
- To develop an understanding of gel electrophoresis to confirm predictions & explain patterns observed using scientific data
- Extension activities: role play as genetic counselors, debate on genetic testing, construct a standard curve to find out the gene fragment sizes
- **Lab Techniques involved: Pipetting, Gel Electrophoresis**

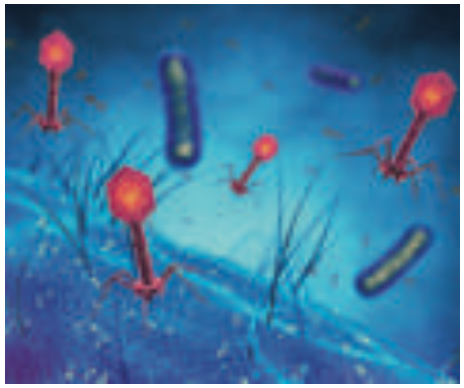
Major HKDSE-related chapters:

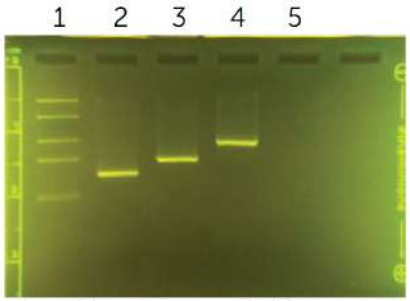
1. Carrier of Genetic information - DNA
2. Mendelian Inheritance
3. Human Inheritance (Pedigree)
4. DNA fingerprinting
5. PCR

M6001 : PCR 101 MiniLab

Go viral with the lambda phage genome

Difficulty Level: ★★★☆☆





Example results from PCR System validation kit

Lane 1: MiniOne DNA marker (see page 34)
Lane 2: PCR fragment 1
Lane 3: PCR fragment 2
Lane 4: PCR fragment 3
Lane 5: negative control

Materials included:

- FastTaq PCR MasterMix
- 3 primer sets
- Lambda phage DNA
- Other reagents
- Running buffer
- GreenGel Cups
- Thin-walled PCR tubes

- Students will learn the molecular mechanisms of PCR & how gel electrophoresis is used to analyze PCR products
- Set up four PCR reactions with three primer sets and one negative control
- Predict the sizes of the PCR products from the genomic sequence and primer sequence
- Test the prediction by running an agarose gel
- **Lab Techniques involved: Pipetting, Gel Electrophoresis**

Major HKDSE-related chapters:

1. Recombinant DNA (Restriction enzyme)
2. DNA fingerprinting
3. PCR

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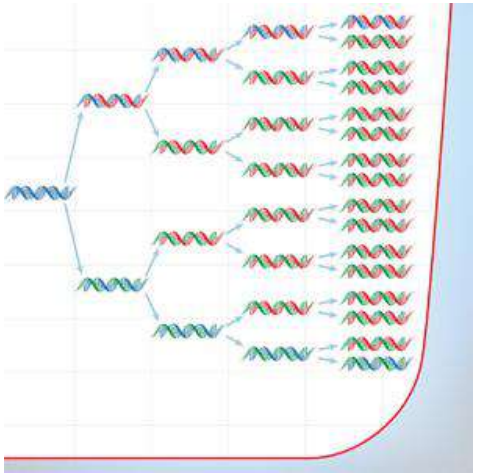
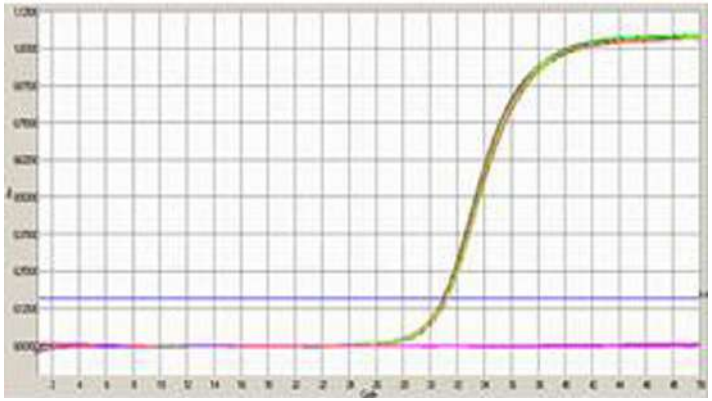
M6005 : PCR Cycle Number Analysis

The amazing of duplicating exponentially!

Difficulty Level: ★★★★☆





- Apply exponential math to understand how PCR produces billions of copies of a DNA fragment.
- How many PCR cycles does it take to see a band on the MiniOne agarose gel?
- Set up PCR reactions and remove the tubes after 10, 15, 20, 25 cycles and run on a gel to see when the band appears.
- Observe increase in fluorescent intensity of the band with increasing cycle number, while speed of migration stays the same, reinforcing basic electrophoresis concepts.

Materials included:

- FastTaq PCR MasterMix
- Primer set & reagents
- Lambda phage DNA
- Running buffer
- GreenGel Cups
- thin-walled PCR tubes

Major HKDSE-related chapters:

1. Recombinant DNA (Restriction enzyme)
2. DNA fingerprinting
3. PCR

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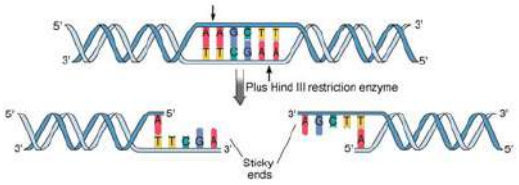
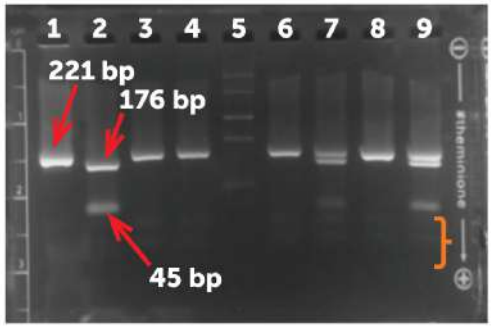
M6010 : A Taste of Genetics PTC PCR

Test your own DNA to find your PTC taster genotype





Difficulty Level: ★★★★★

- Introduction to genotyping and personal genetics for students who already have experience with PCR and electrophoresis
- Students taste the PTC paper to determine whether they are a taster or a non-taster
- Three-part lab over 3-4 days: DNA extraction, PCR amplification of PTC gene, restriction digest to determine genotype, gel electrophoresis
- Interpreting DNA bands amplified from their own genome is a great way to introduce real-world data interpretation into a biotech curriculum
- **Lab Techniques involved: Pipetting, DNA Extraction, PCR, Restriction Digest, Gel Electrophoresis**

Materials included:

- PTC Test Trips
- DNA extraction
- DNA amplification by PCR
- Restriction Enzyme
- Running buffer
- GreenGel Cups
- Thin-walled PCR tubes

Major HKDSE-related chapters:

1. Detecting the Environment
2. Carrier of Genetic information – DNA
3. Mendelian Inheritence
4. Human Inheritence (Pedigree)
5. From DNA to Proteins
6. Mutations
7. Recominant DNA (Restriction enzyme)
8. DNA fingerprinting
9. PCR

M6050/53 : Restriction Digest of DNA

See the power of molecular scissors!

	M6050	M6053
MiniLab	Restriction Digest Basics	Restriction Analysis of DNA
Students set up restriction digest?	No (pre-digested samples are provided)	Yes (Set up single and double restriction digests)
Students run gel?	Yes	Yes
Number of days	1	2
Difficulty	General Bio	General Bio or Honors
Inquiry level	*	**
Description of activities	• Predict fragment sizes from map • test prediction by running pre-digested fragments	• Find digest sites and predict fragment sizes from DNA sequence • Set up restriction digests • Run digests to test prediction

Junior Levels (S1 - S3)

Simple MiniLabs that can let junior level students to have an experience on DNA fingerprinting without requiring much prior knowledge:

Basic Labs for S1 to S3:

- M3002 Gel Loading Practice
- M3007 Colorful Dye Electrophoresis
- M3009 Candy Color Electrophoresis
- M3008 NGSS-Aligned Color Dyes & Gel Electrophoresis

Advance Labs for S1 to S3:

- M3001 Gel Electrophoresis 101
- M3004 DNA Fingerprinting
- M3005 CSI Forensics

HKDSE Syllabus:

- DNA Fingerprinting
- Recombinant DNA
- PCR
- DNA Fingerprinting

Senior Levels (S4 - S6)

Advanced MiniLabs require more prior knowledge and are ideal for senior level students:

Basic Labs for S4 to S5:

- M3004 DNA Fingerprinting
- M3005 CSI Forensics
- M3001 Gel Electrophoresis 101
- M3003 PTC Genetics
- M6050 Restriction Digest Basics
- M3006 Foodborne Outbreak Investigation
- M3010 Hunting the Inheritance of Huntington's Disease
- M3011 Determining the Genetics of a Ca$H Cow

Advance Labs for S4 to S6:

- M6001 PCR 101 and Gel Electrophoresis
- M6010 A Taste of Genetics
- M6005 PCR Cycle Numbeer Analysis
- M6053 Restriction Analysis of DNA
- M6010 A Taste of Genetics PTC PCR
- M6020 Mad Cow Disease (Bovine Spongiform Encephalopathy, BSE) by PCR

HKDSE Syllabus:

- Detecting the environment
- Infectious Disease
- Basic Genetics (Mendelian Inheritance)
- Molecular Genetics (Mutations)
- Biotechnology (DNA Fingerprinting)
- Biotechnology (DNA fingerprinting)

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