



Project-based Consolidation and Redevelopment Work Production of Resource Packages of Biotechnology Education Programme

總結及再發展工作計劃「生物科技教育計劃」教學資源套



Po Leung Kuk Tong Nai Kan Junior Secondary College

Kwan Siu Ming Eddie
Department Head of Science

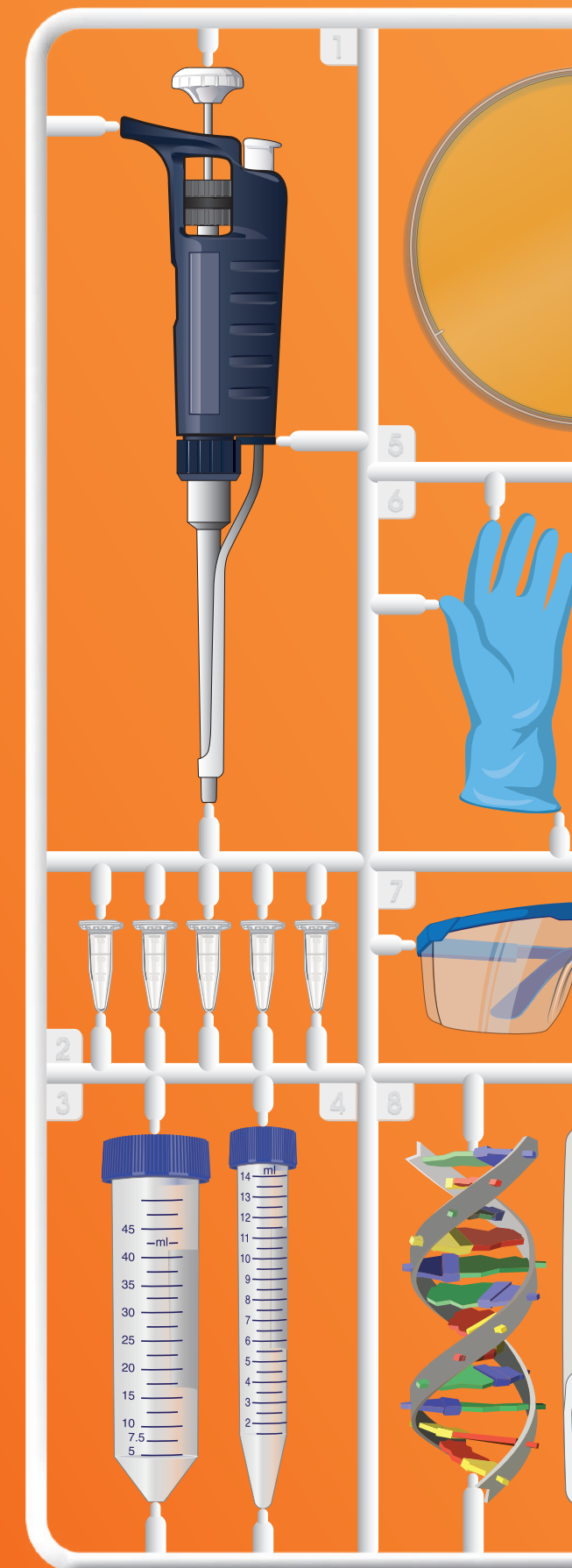
Introduction of the package

STEM-Biotechnology
learning and teaching booklet
(hardcopy)
English and Chinese version

USB included the softcopy
and video demonstration for
all the experiments

BIOTECHNOLOGY EDUCATION PROGRAMME

生物科技教育計劃



This resource package
and keen interest in sc



本教學資源套是為對科學有潛力和濃厚興趣的學生而開發的
延伸學習材料，並需要具有生物科技專業知識的教師教授。

Curriculum arrangement

This curriculum ran in our school for four years.....

Target: Upper primary school students and junior secondary school students

Teaching support

Curriculum

Technique demonstration videos

PowerPoint/keynote presentations

Lesson plan

Extended experiment

AR apps

1

TEACHING SUPPORT

| [Teaching Resources](#)

| [Curriculum](#)

| [Technique demonstration videos](#)

| [PowerPoint/keynote presentations](#)

| [Lesson plan](#)

| [Extended experiment](#)

| [AR apps](#)

Download on Apple App store

This application is mainly used to popularize the application method of scientific tools, and the specific operation method of some experiments.

e.TNKJSC



Compatibility

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- iPhone requires iOS 11.0 or later.
- iPad requires iPadOS 11.0 or later.
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- Mac requires macOS 11.0 or later and a Mac with Apple M1 chip or later.

Curriculum

2

SUGGESTED BIOTECHNOLOGY CURRICULUM

Learning and teaching targets & teaching activities

S1 Bacterial culture & Antibiotics

Introduction of microorganisms

Experiment 1 Growing microorganisms/
bacteria

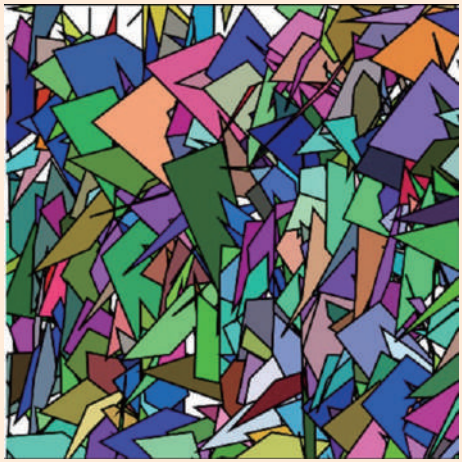


* Experiment 1

(Used in ^ P4-P6 and S1-S3)

Introduction of antibiotics

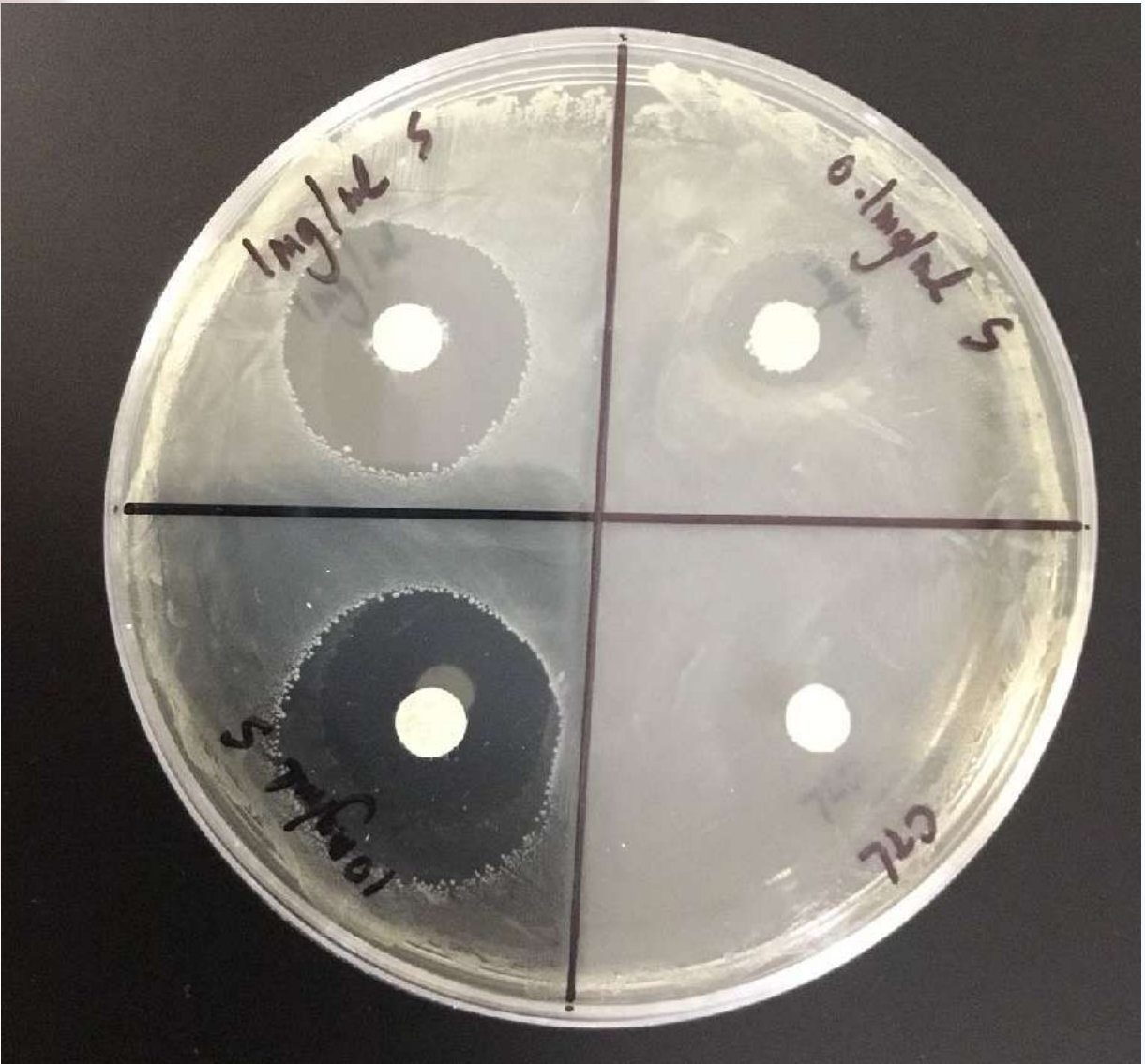
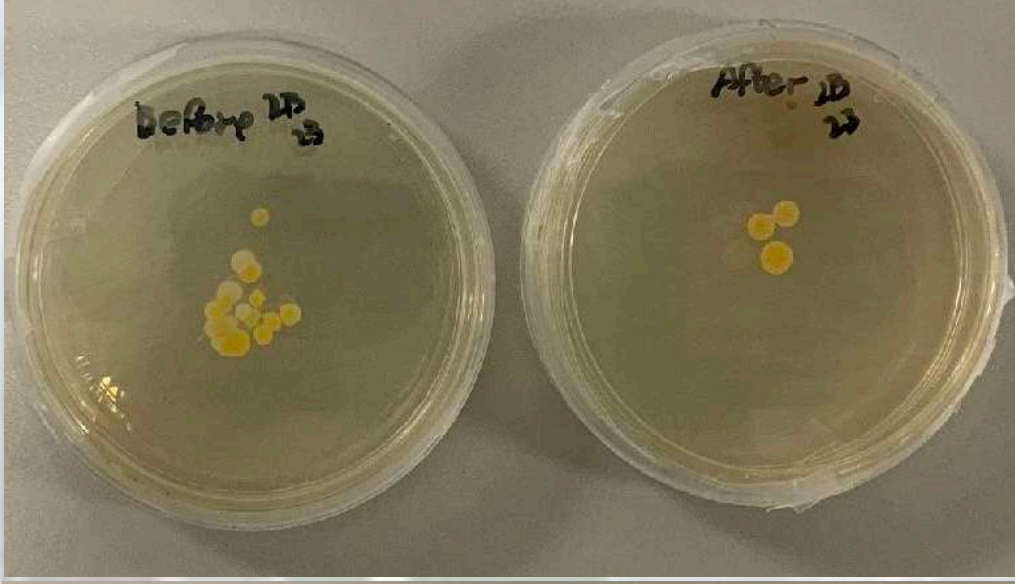
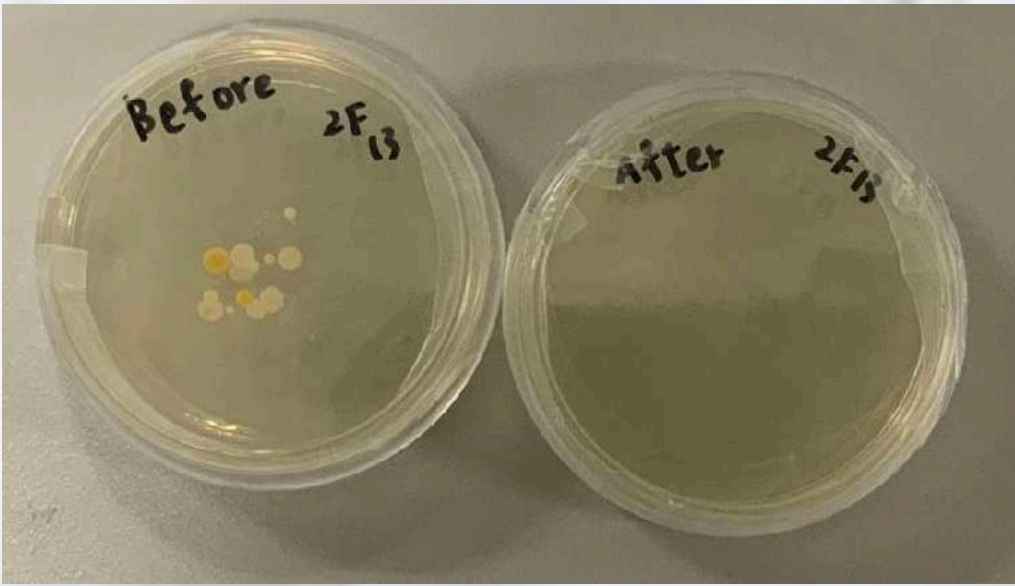
Experiment 2 How the concentration
of antibiotics affects
bacterial growth



* Experiment 2

^ Required appropriate training for upper primary school teachers

* Please scan the AR marker with the AR apps “e.TNKJSC”



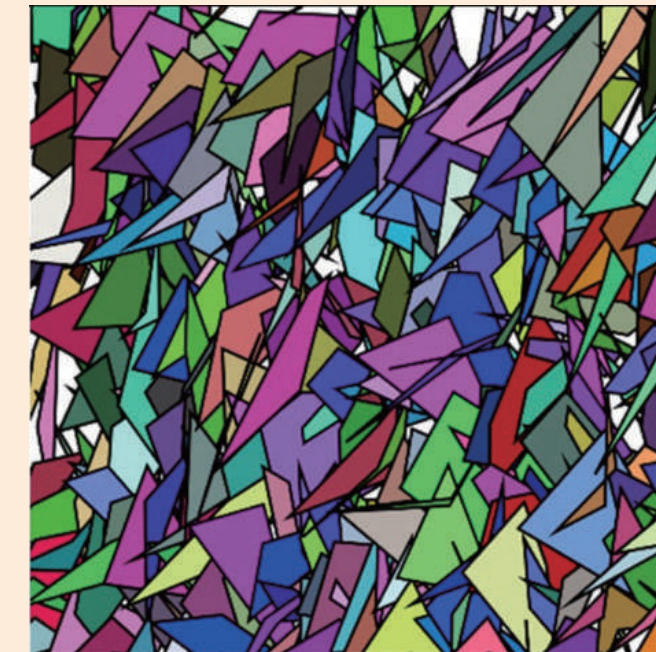
Curriculum

S2 DNA Extraction & DNA fingerprint

Introduction of genetic materials – DNA

Experiment 3 DNA extraction from strawberry

(Used in ^ P4-P6 and S1-S3)

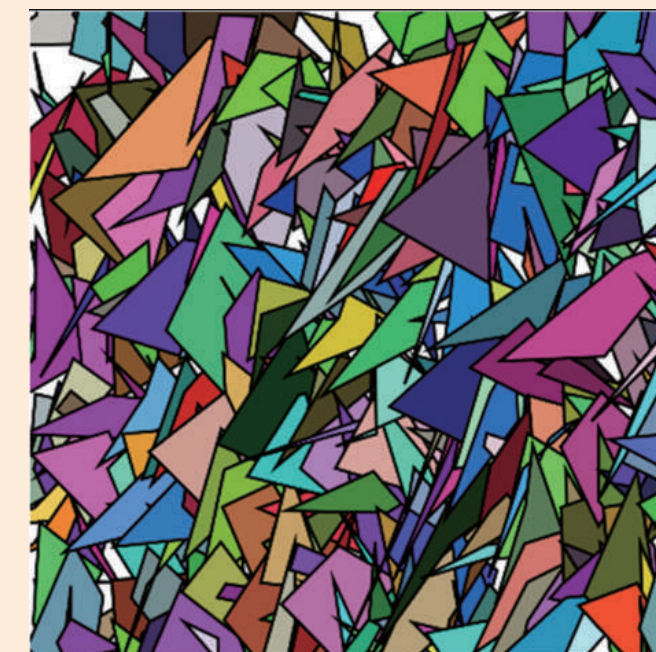


* Experiment 3

Application of DNA technology

Experiment 4 DNA fingerprint

(Used in S2-S3)

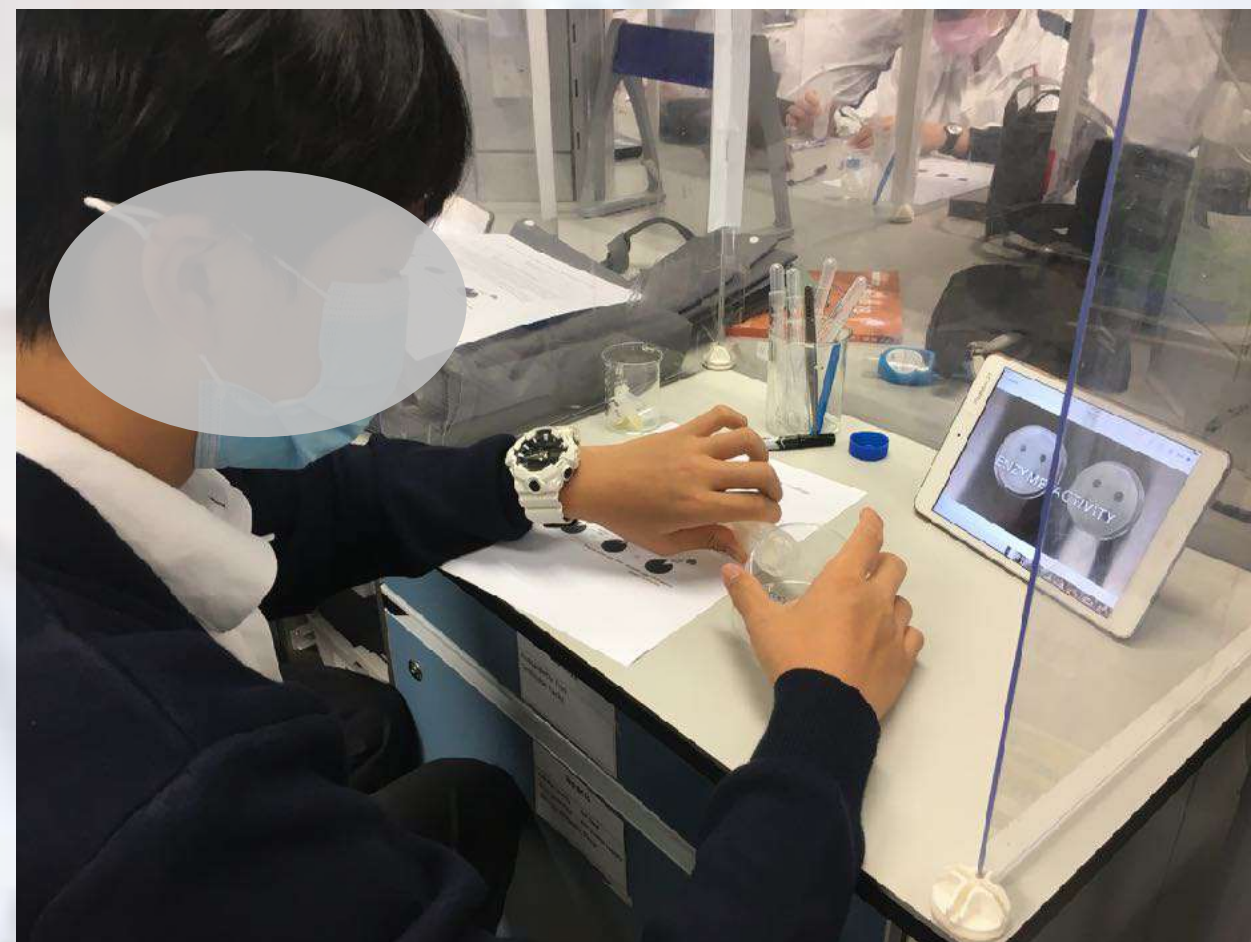


* Experiment 4



Curriculum

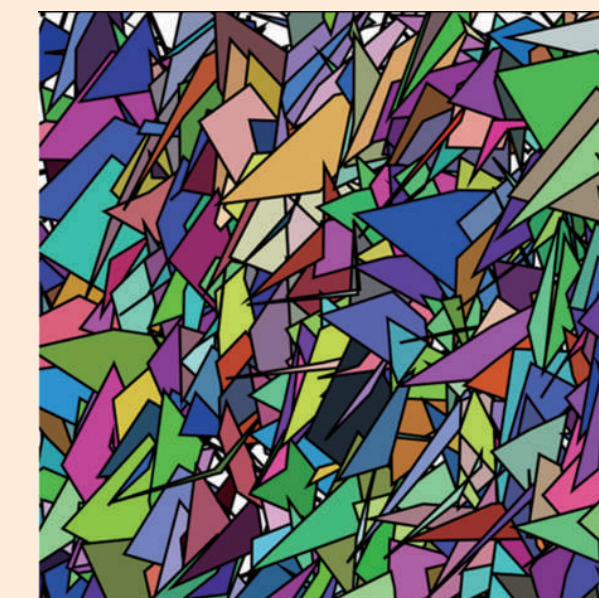
S3 Genetically Modified Organisms & Biological Catalysts in daily life and Biotechnology



Application of biotechnology- Introduction of Genetically Modified Organisms

Experiment 5 Determination of
genetically modified food

(Used in S3)



* Experiment 5

Biological catalysts in daily life and biotechnology

Experiment 6 Catalytic reaction of
enzyme

(Used in ^ P4-P6 and S1-S3)



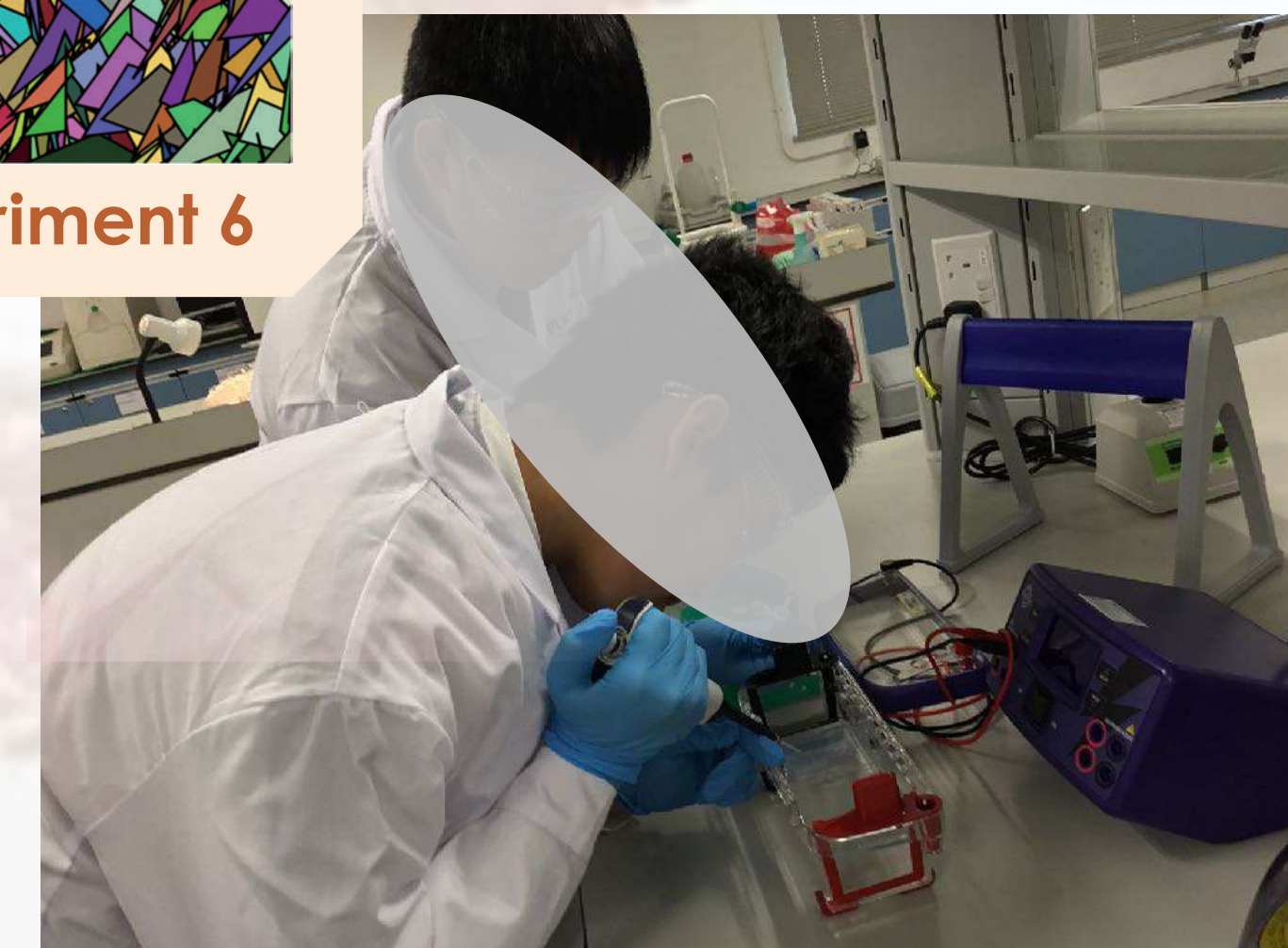
* Experiment 6

^ Required appropriate training for upper primary school teachers

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BIOTECHNOLOGY EDUCATION PROGRAMME



Apps e.TNKJSC

1. Download from App Store

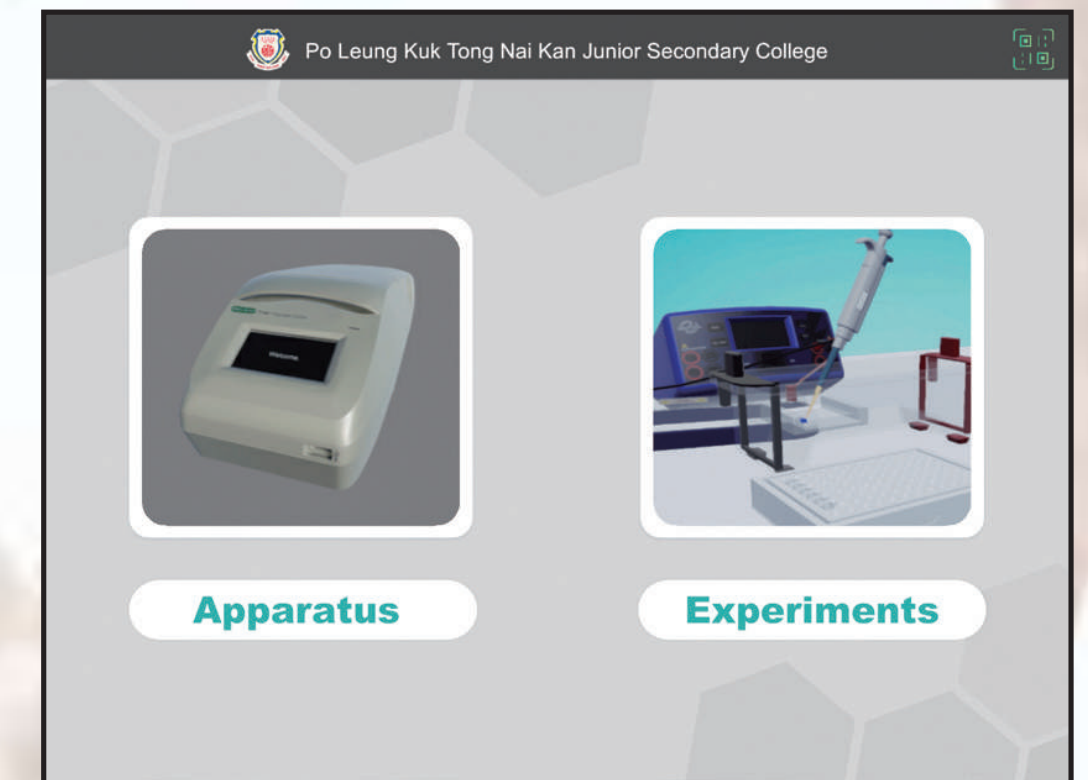
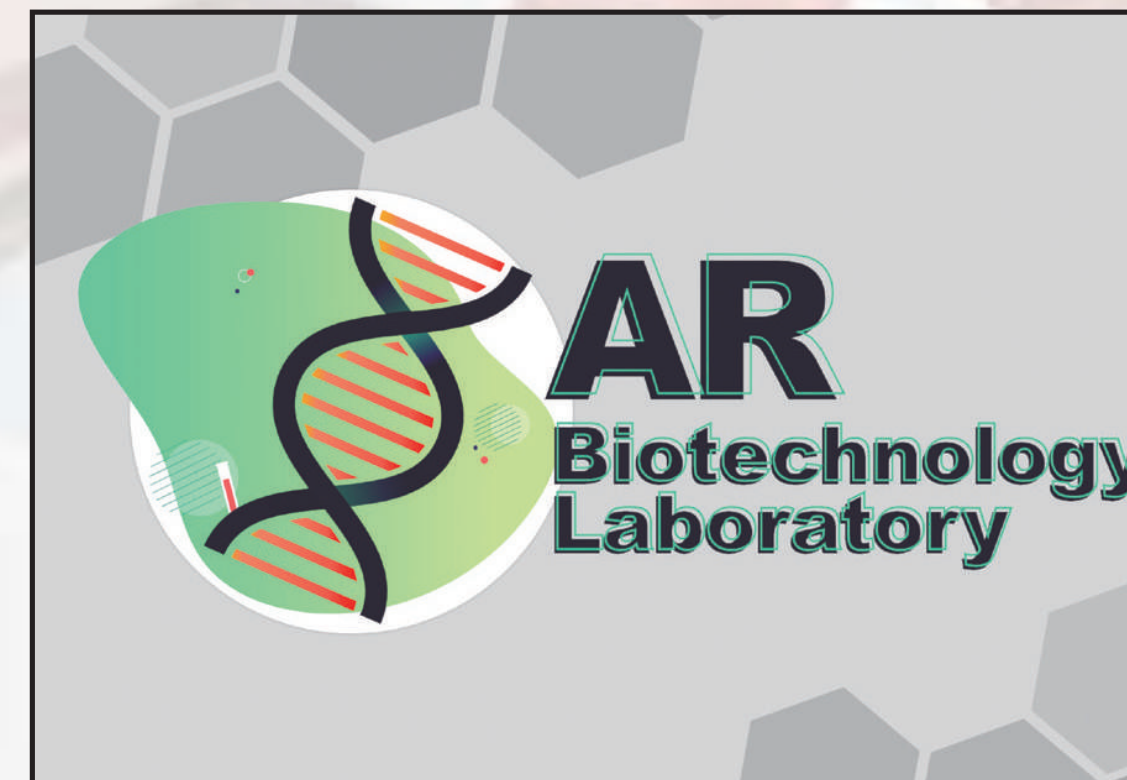


AR apps

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Apps e.TNKJSC

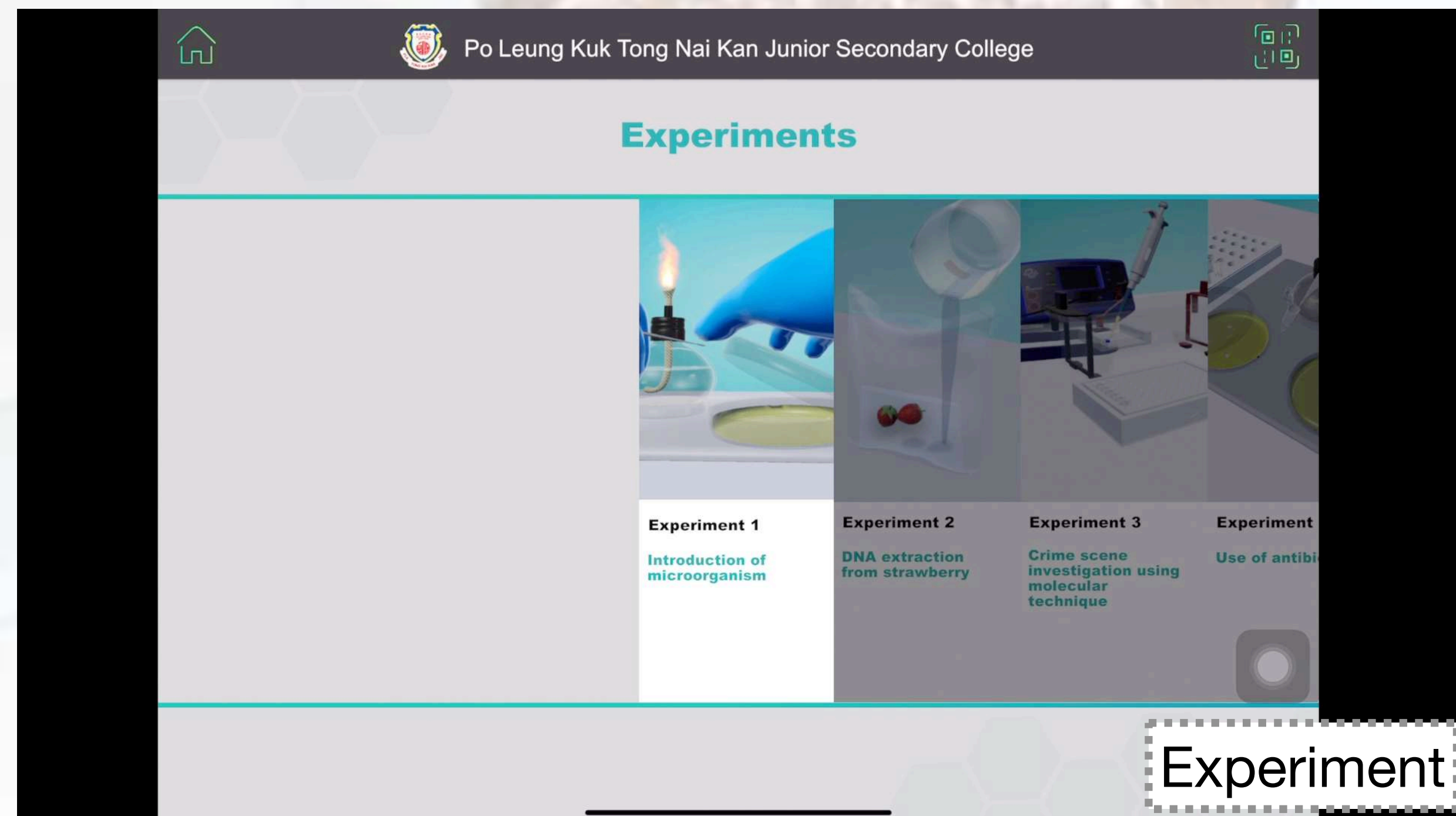
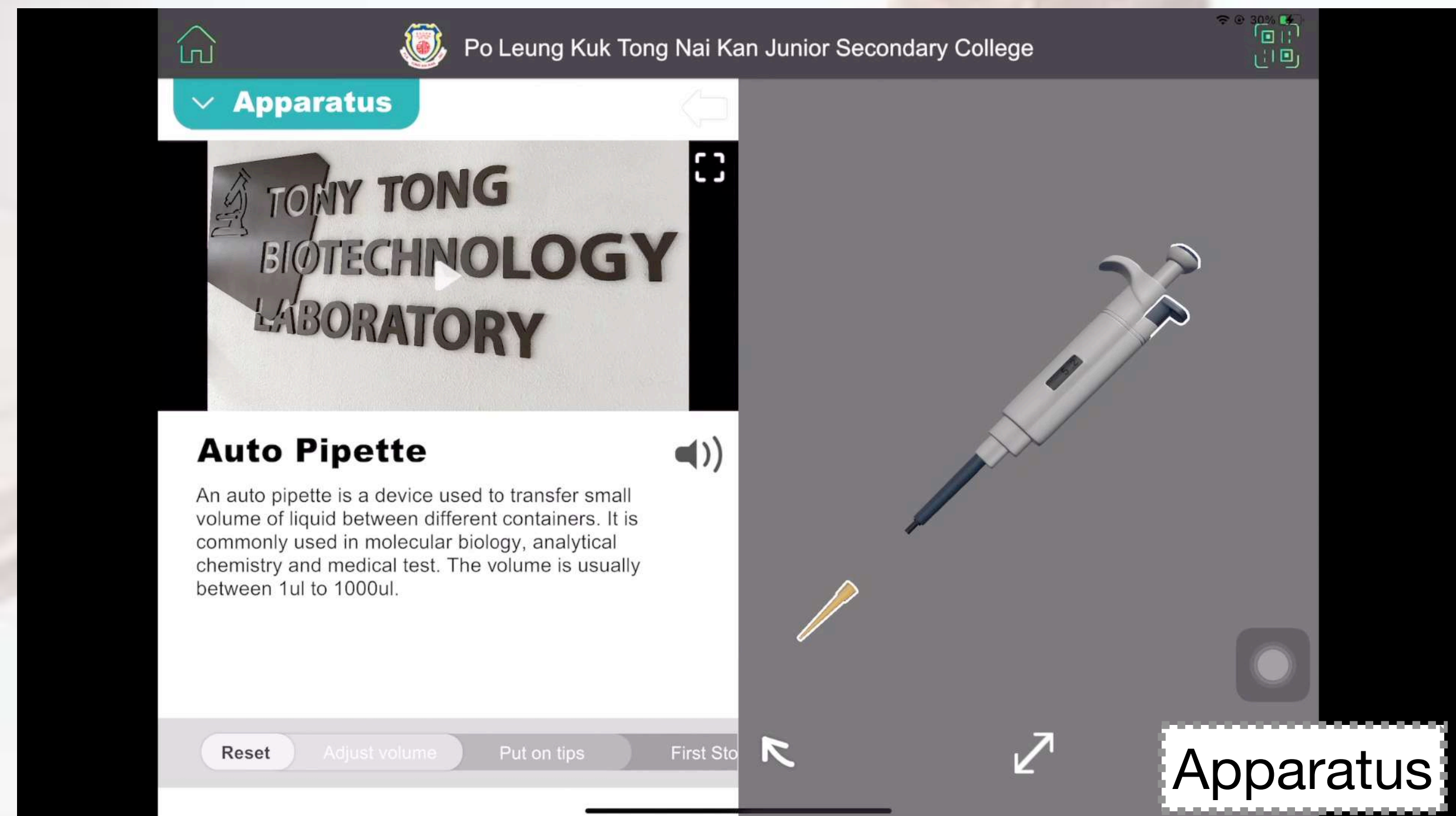
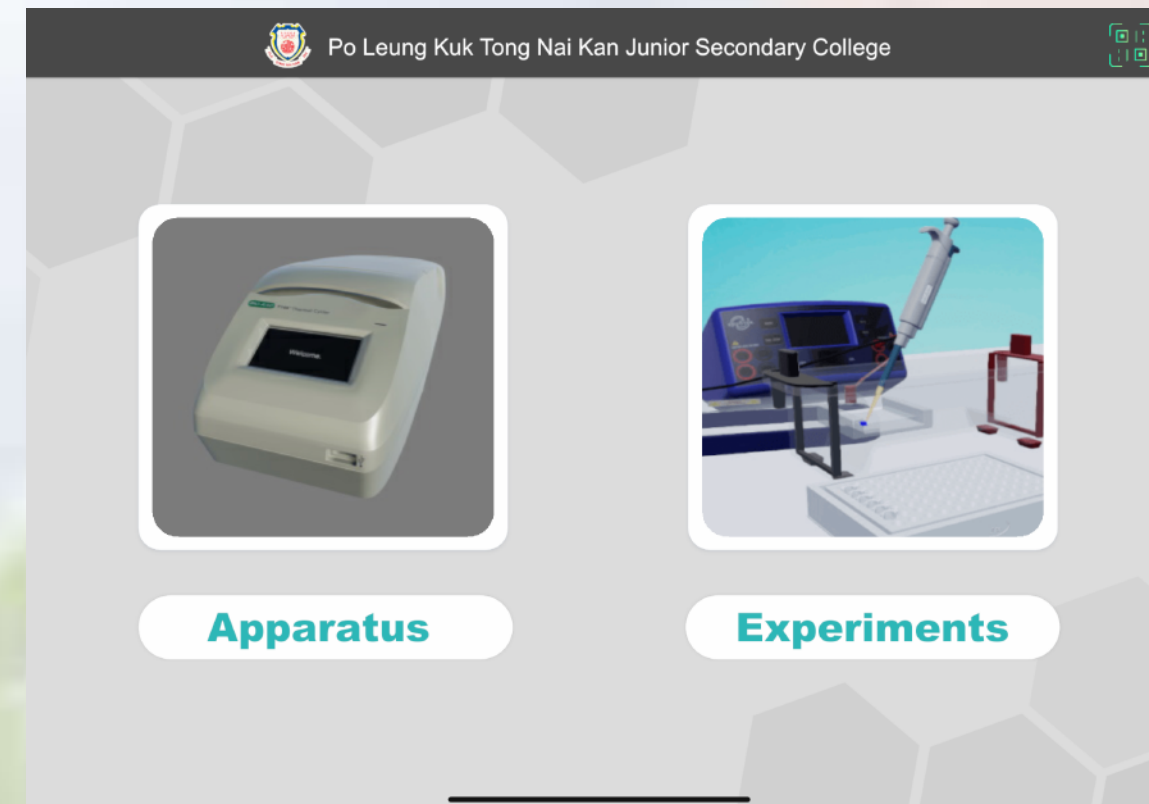
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Augmented Reality (AR) App

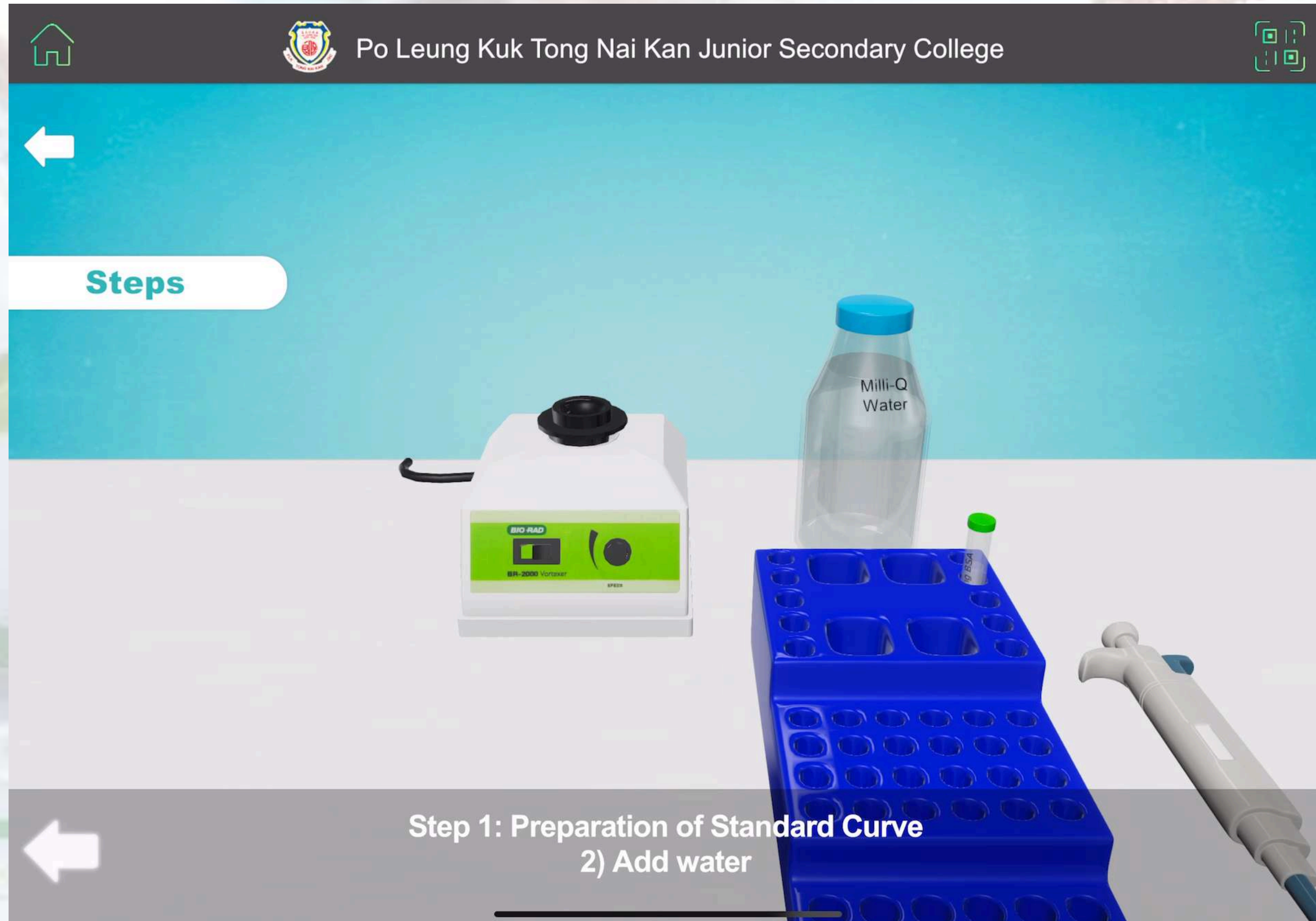


X.TNKJSC



Augmented Reality (AR) learning kits will be designed and produced to facilitate the learning and teaching of the biotechnology lessons, gifted education school research team research and workshops for secondary and primary school students before, during and after they learn the biotechnology experiments and skills in the lessons. Through the AR learning kits, 3D models of demonstration of the uses of the apparatus and the experiments processes will be displayed interactively. Students can flip the lesson before lesson or learn during the lesson or even after many times so as to be familiar with the related skills and analyse more about the results deeply with discussion easily with classmates.

AR apps



Experiment 6:

Catalytic reaction of enzyme

Biotechnology Education Programme



保良局唐乃勤初中書院
Po Leung Kuk Tong Nai Kan Junior
Secondary College



優質教育基金
Quality Education Fund

Teaching Experience

2019-2020

S1 Biotech lab: Introduction to Microorganisms - Thumb culture, Spread plate & Streak plate (In group)

[4 Nov 2019 - 15 Nov 2019]

2020-2021

S1&2 Biotech lab: Introduction to DNA - DNA extraction from Strawberry (Individual)

[30 Oct 2020 - 19 Nov 2020]

S1-3 Biotech lab: Introduction to Enzyme - Catalytic reaction of enzyme in Fruit juice on gelatine (Individual)

S1-2 [19 April 2020 - 6 May 2020]

S3 [10 May 2020 - 25 May 2020]

2021-2022

S1 Biotech lab: Introduction to Microorganisms - Thumb culture & Spread plate (Individual)

[5 Nov 2021 - 23 Nov 2021]

S2 Biotech lab: Introduction to Microorganisms - Thumb culture, Spread plate & Streak plate (Individual)

[4 Nov 2021 - 3 Dec 2021]

S3 Introduction to GMO - GMO Investigation (In group)

[2 Dec 2021 - 21 Dec 2021]

Biotech Curriculum

S1 Biotech Lesson:

1st Term: Introduction to Microorganisms - Thumb culture & Spread plate

2nd Term: Introduction to Antibiotics - Effectiveness of Antibiotics

S2 Biotech Lesson:

1st Term: Introduction to DNA - DNA extraction from Strawberry

2nd Term: DNA Fingerprinting – Crime Scene Investigation

S3 Biotech Lesson:

1st Term: Introduction to GMO - GMO Investigation

2nd Term: Introduction to Enzyme - Catalytic reaction of enzyme in Fruit juice on gelatine

Upper primary school students

Provide educational service and workshops for other primary secondary schools

- 3-day Biotechnology Tasting Programme
 - to primary school students
- Benefit to both our students and the primary school students
 - Learn the presentation skill, cooperation skill and leadership



Training workshops for teachers

Provide educational service and workshops for other primary secondary schools

- Offered a bio-tech training programme to PLK Riverain Primary School
 - Thirteen teachers joined the first programme on 23rd September 2021.
 - Five student helpers participated in this activity





Subject Crossover

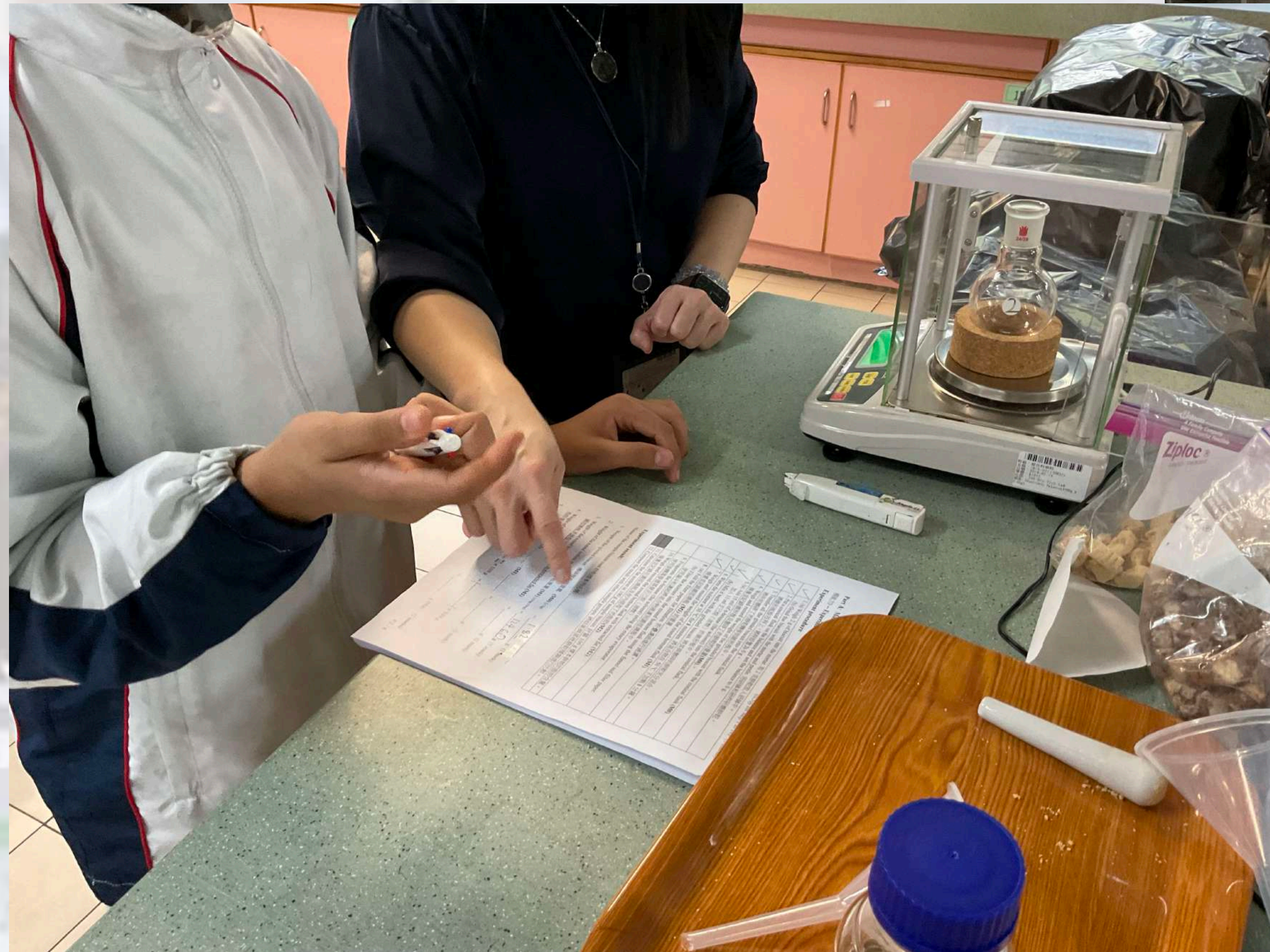
Living Technology, ITS and D&T

Living Technology



Living Technology

Eight STEM related experiments were designed



Living Technology

Sewing Lessons (4 cycles)		
Theory	Practical	Textbook
STEM + Food Science Lessons (8 cycles)		
1. Food Hygiene and Food Preparation, weigh and measuring equipment and technique	1. Kitchen cleaning Techniques	Unit 1
2. Cooking Appliances and Method I	2. Basic cutting skill	Unit 5 (1-9)
3. Cooking Appliances and Method II /Principle of heat transfer	3. Principal of heat transfer data recording using different cups demonstrate the heat lost (Alternative take away containers Plastic, Styrofoam, paper)	Unit 5 (10-14)
4. Fish & Meat	4. Marinate using enzyme	Unit 3 (1-5)
5. Milk, Egg & Soya Bean Products	5. Different egg experience	Unit 3 (6-10)
6. Cereals, Rice & Wheat	6. Principal of cheese making	Unit 3 (11-16)
7. Vegetables & Fruits/ How to store food properly	7. Vegetable, dietary fiber difference between fruit and vegetables (use press juicer)	Unit 3 (17-20)
8. Introduction of spherification	8. Making coffee caviar drink	

Living Technology

Sewing Lessons (4 cycles)		
Theory	Practical	Textbook
STEM + Food Science Lessons (8 cycles)		
1. Nutrients in food – Macro nutrients	1. Experiment on fat in food (potato chips)	Unit 4 (1-6)
2. Nutrients in food – Micronutrients	2. Experiment on simplified vitamin C determination	Unit 4 (6-12))
3. Using Nutrition Label	3. Activity on Nutrition Label	Unit 11
4. Meal planning	4. Activity on Meal Planning	Unit 10
5. Table Manner	1. Activity on Table setting	Unit 7
6. Science principle behind Meringue making	2. Making Meringue*	
3. Effect of heat on carbohydrate	7. Caramelization	
8. Raising agent	1. Machinal (beating egg), enzymatic (yeast) and chemical (baking soda)	Unit 6



Thank you

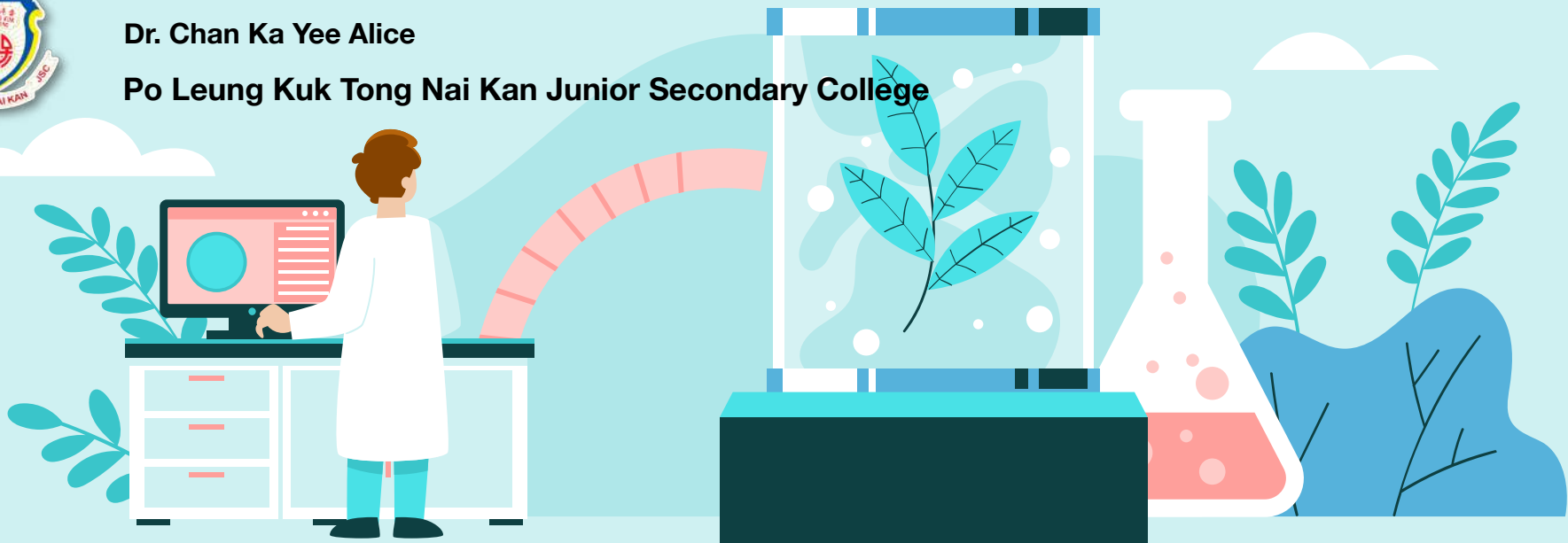
Pharmaceuticals

Project-based Consolidation and Redevelopment Work Production of Resource Packages of Biotechnology Education Programme 總結及再發展工作計劃「生物科技教育計劃」教學資源套



Dr. Chan Ka Yee Alice

Po Leung Kuk Tong Nai Kan Junior Secondary College



Production of Resource Packages of Biotechnology Education Programme



生物科技教育計劃



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延伸學習材料，並需要具有生物科技專業知識的教師教授。

BIOTECHNOLOGY EDUCATION PROGRAMME



This resource package is developed for extended learning for students with potential
and keen interest in science, and require teachers with expertise in biotechnology.

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Teaching support

3

INTRODUCTION OF BIOTECHNOLOGY

Biotechnology is a technology that involves the use of living organisms. Living organisms are used to make useful chemicals and products or to perform industrial tasks. It is mainly used in agriculture, food science, and medicine. It involves genes and genetic modification techniques.

Biotechnology is a combination of different science subjects and makes them useful to our daily lives. It is not pure biology, chemistry or physics. We make use of these knowledge to improve our quality of life. With the development of biotechnology, we are able to produce specific vaccine to fight against virus. Drug development also relies on biotechnology.

In this booklet, 6 activities are used to introduce the basics of biotechnology, from "bio" to "technology". These six experiments include microorganism, DNA extraction, application of DNA technology, genetic modified organism and one of the end products of DNA coding – Enzymes.

For the safety of Microbiology and Biotechnology Experiment in School Laboratories please refer to the EDB "Safety Guidelines on Microbiology and Biotechnology Experiments in School Laboratories" (2021).

https://cd1.edb.hkedcity.net/cd/science/biology/resources/pdf/eng/11_SG_E_v4_with%20cover.pdf

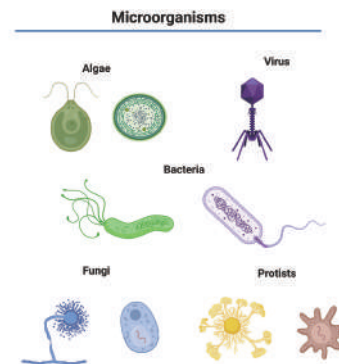


4

INTRODUCTION OF MICROORGANISMS

What is microorganisms?

A microorganism is a microscopic organism which is too small to be seen by the unaided human eyes. Microorganisms are everywhere on Earth including hot springs on the ocean floor and deep inside rocks within the Earth's crust. They even exist in your drinks, foods, bodies, furniture and other things around you. Microorganisms include bacteria, fungi, algae, protists and virus, and are among the earliest known life forms.



Some microorganisms are good for us while some are harmful to us. Microorganisms are one of the earliest use of living things in our daily life. We use them to make bread, alcohol, soy sauce and vinegar and this is the oldest biotechnology human used. The bad microorganisms are called pathogens. They include bacterium, virus, and other microorganism that can cause diseases. In modern biotechnology, we use a microorganism *Escherichia coli* (*E.coli*) and genetically modify it to manufacture useful chemicals (Valderrama-Rincon et al 2012).

Teaching Support

- Objective
- Lesson Plan
- Lesson arrangement

Experiment 3 DNA extraction from strawberry



Objectives of the activity

1. To learn what DNA is and the function of DNA in organisms
2. To learn how to extract DNA from strawberry

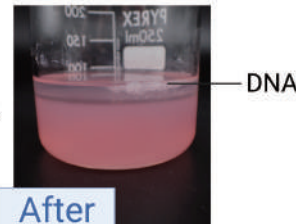


Lesson arrangement

1-2 classroom lesson, ~total 35 to 70 mins (including introduction of DNA, video to show how to perform the experiment)

2 practical lessons, ~total 70 mins (DNA extraction from strawberry)

DNA Extraction from Strawberry

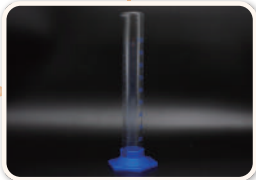


Materials and apparatus

Material and apparatus



250 ml Beaker x1



100 ml Measuring cylinder x1



Table salt x2 spoons



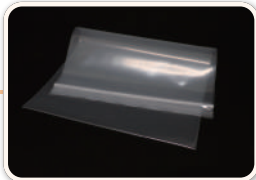
Dish soap x10 ml



Strawberry x1



Spoon x1



Ziplock bag x1



Sieve x1



Gauze x1



Cold absolute ethanol x25 ml



Forceps x1



Dropper x1

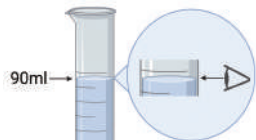


Microcentrifuge tube
with string x1

Procedure

Procedure

1. Measure 90 ml of water using a measuring cylinder.
2. Pour the 90 ml water into a 250 ml beaker.
3. Add 10 ml dish soap and 2 spoons of table salt into the 90 ml water. Mix it well with a spoon.



4. Put a strawberry in a ziplock bag and pour the extraction solution in. Zip the ziplock bag tight.



5. Use your fingers to mash the strawberry with the extraction solution until no large pieces can be found.
6. Filter the mixture with a layer of gauze on the sieve into the 250 ml beaker you used in step 4. Put the used gauze into the ziplock bag and zip it.
7. Take out the cold absolute ethanol from the ice bucket. Add 20 ml of cold ethanol into the 250 ml beaker along the inside wall. The ethanol will layer on the top of the filtrate. Put the remaining cold ethanol (5 ml) back to the ice bucket.

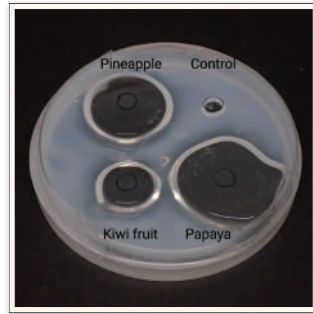


8. Observe the mixture.
9. Use a pair of forceps to gently take out the DNA and put them into a microcentrifuge tube containing ethanol.
10. Take out the cold ethanol from the ice bucket. Use a dropper to fill up the microcentrifuge tube with the cold ethanol and cover it.
11. Students can take home the tube with DNA from strawberry.

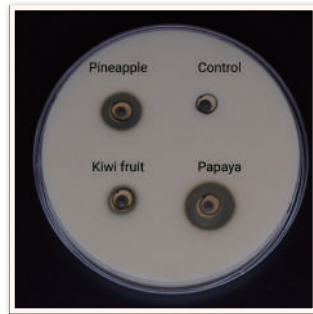
Results observation



Results observation



Milk gelatine plate

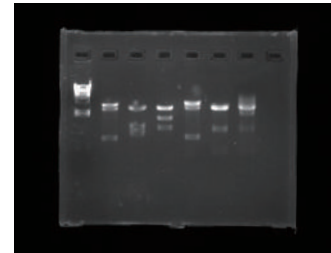


Skim milk agar plate

1. By comparing the clear/dissolved zone, students should be able to identify which fruit juice (pineapple/ papaya/ kiwi fruit) performs the best.
2. The control group is used again in this experiment. We can check if the students still remember the function of a control group.



Results observation



1. By comparing the gel electrophoresis results, students should be able to identify which suspect has committed the crime.
2. Understand the importance of changing tips between samples is to avoid cross contamination.

Teaching notes & Extended experiment



Teaching notes

Enzymes or catalysts are usually associated with biology and chemistry. In the form 3 syllabus, enzyme is introduced in the topic of “metabolism and enzymes”. We can combine the biology and biotech lessons together to enhance the teaching and learning effectiveness. In DNA fingerprint and GMO food determination experiment, enzyme (protein) polymerase plays a key role in the reaction. Replicate DNA needs enzyme and enzyme (protein) production is encoded in DNA. This relationship should be mentioned when we deliver this enzyme topic.



Extended experiment

We can extend the experiment to prove the physical parameters which can affect the performance of the enzyme, e.g. temperature effect by incubating the plate in different temperatures and pH effect by adjusting the pH of the food juice. We can also denature the enzyme by heat and demonstrate to the students the properties of enzyme.

To demonstrate the enzyme specificity, we can use carbohydrate gel instead of protein based agar plate to test the enzyme activities.

Cross-curricular learning: We can apply the enzyme from fruits in food preparation (Technology & Living / Home Economics), e.g. the use the fruit juice for meat tenderization.

Introduction of microorganisms

Part 1 (Day 1)

Question 1: What is microorganism?

"Micro" is extremely small.

"Organism" is a form of life.

Question 2: Are all microorganisms bad?

Yes ☐ No ☒

Question 3: What is the microorganism that will cause you sick?

Pathogen

Question 4: What is an example of good microorganism?

Yeast / Algae

Question 5: What microorganism have we cultured in the last lesson?

Yeast

Question 6: Why do you need to set an aseptic zone before starting the experiment?

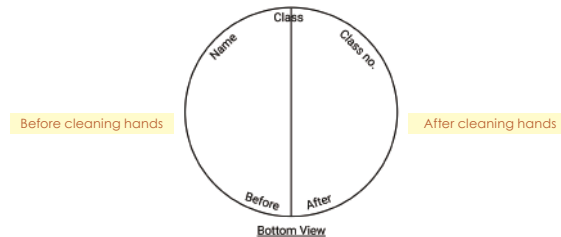
To prevent the agar plate from contamination by other non-specific microorganisms.

Question 7: Why are agar plates incubated at 30°C or higher temperature?

30°C or above is the optimum growing temperature for microorganisms.

Part 2 (Day 2)

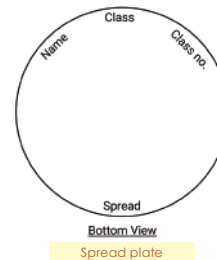
Question 1: Draw what you see on the plate in the space provided. **Caution! Don't open the agar plate!**



Question 2: According to your observation, what is the function of the alcohol wipe?

To kill the bacteria on the thumb/ To sterilize the thumb.

Question 3: Draw what you see on the plate in the space provided. Or count the number of colonies on the plate.



Introduction of Antibiotics

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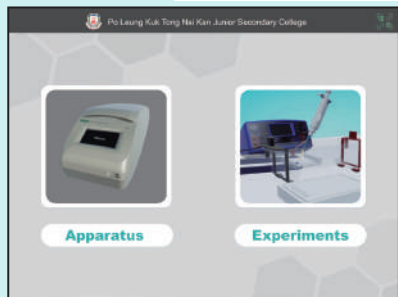
Teaching support

- Teaching resource

AR apps

Download on Apple App store

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TEACHING SUPPORT

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This application is mainly used to popularize the application method of scientific tools, and the specific operation method of some experiments.

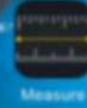
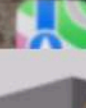
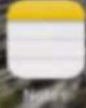
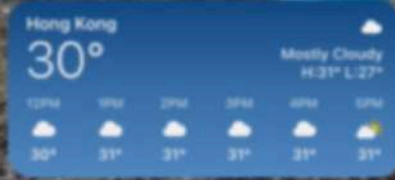
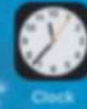
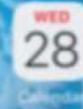
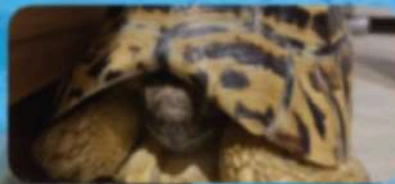
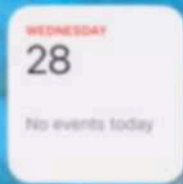
e.TNKJSC



Compatibility

e.TNKJSC is compatible with Apple devices. Below is a list of compatible devices.

- iPhone requires iOS 11.0 or later.
- iPad requires iPadOS 11.0 or later.
- iPod touch requires iOS 11.0 or later.
- Mac requires macOS 11.0 or later and a Mac with Apple M1 chip or later.



AR apps

- e.TNKJSC

Introduction of antibiotics

Experiment 2

How the concentration of antibiotics affects bacterial growth

(Used in S1-S3)



* Experiment 2

SUGGESTED BIOTECHNOLOGY CURRICULUM

2

Learning and teaching targets & teaching activities

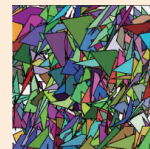
S1 Bacterial culture & Antibiotics

Introduction of microorganisms

Experiment 1

Growing microorganisms/
bacteria

(Used in ^ P4-P6 and S1-S3)



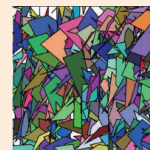
* Experiment 1

Introduction of antibiotics

Experiment 2

How the concentration of antibiotics affects bacterial growth

(Used in S1-S3)



* Experiment 2

^ Required appropriate training for upper primary school teachers
* Please scan the AR marker with the AR apps "e.TNKJSC"



INTRODUCTION OF ANTIBIOTICS

What is antibiotic?

Antibiotics are antibacterial substances. They are active in destroying or slowing down the growth of bacteria. Antibiotics include a range of powerful drugs to prevent or treat bacterial infections. There is no one type of antibiotic that cures every infection. Antibiotics specifically treat infections caused by bacteria but not viral infection such as SARS-CoV-2 virus infection.

In 1928, Alexander Fleming discovered the first natural product antibiotic called penicillin (Tan et al 2015). He observed that *Penicillium* moulds produced a diffusible extract that had antibacterial activity against bacteria (staphylococci). In 1945, Fleming was awarded the Nobel Prize in Physiology or Medicine for his discovery of penicillin.



The recent overuse of antibiotics has led to bacteria that are resistant to antibiotics. Some bacteria have become resistant to almost all of the easily available antibiotics. These bacteria are able to cause serious disease, and this is a major public health problem. An important example is methicillin-resistant *Staphylococcus aureus* (MRSA).

In the following experiment, you will test the ability of different antibiotics in different concentration to inhibit the growth of *Escherichia coli* (*E.coli*).

Experiment 2 How the concentration of antibiotics affects bacterial growth

Objectives of the activity

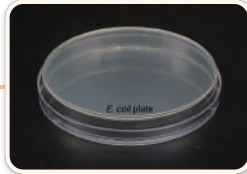
1. To understand what antibiotics are and the function of them
2. To understand the function of a control group
3. To understand the idea of concentration effect
4. To train students' logical thinking by comparing which antibiotic performs better

Lesson arrangement

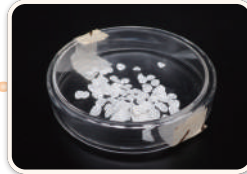
2 practical lessons, ~total 70 mins (including introduction and practical)

1 or 2 result observation lesson, ~total 35 to 70 mins (next day/week, at least 24 hours after the experiment)

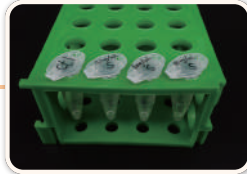
Material and apparatus



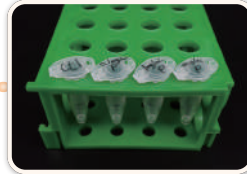
Nutrient agar plate with *E.coli* ×2



Sterile paper disks ×8



Streptomycin: Control (0), 0.1, 1, 10 mg/ml ×1



Penicillin: Control (0), 0.1, 1, 10 mg/ml ×1



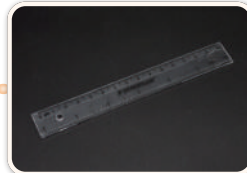
Dropper ×1



Forceps ×1



Marker ×1



Ruler ×1

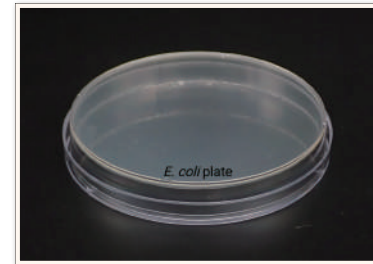


Parafilm strip ×2



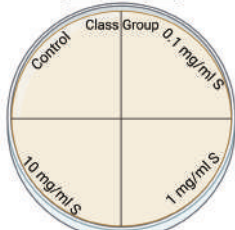
Procedure

1. Obtain two nutrient agar plates with *E.coli* on it. (for two antibiotics)



2. Divide the agar plate in 4 areas. Label the agar plate with different antibiotics and concentrations at the edge of the bottom of the agar plate. (Don't mark on the cover !)

Streptomycin



Bottom View

Plate 1: "Control", "0.1 mg/ml S",
"1 mg/ml S" and "10 mg/ml S"

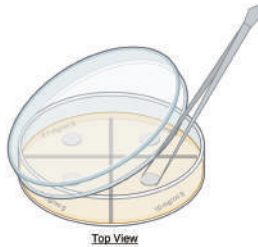
Penicillin



Bottom View

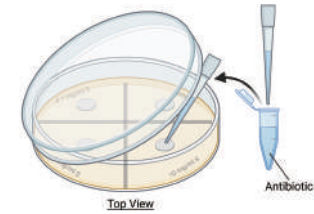
Plate 2: "Control", "0.1 mg/ml P",
"1 mg/ml P" and "10 mg/ml P"

3. Remove the cover of the nutrient agar plate.
4. Use forceps to transfer 1 paper disk to each of the divided areas.

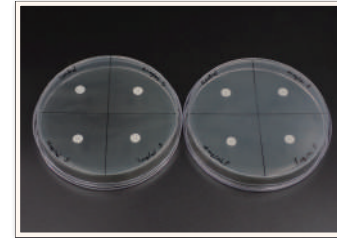


5. Add 1 drop of water to the "Control" paper disk.

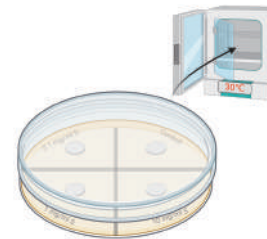
6. Add 1 drop of each of the antibiotic solutions to the corresponding paper disk.



7. Replace the cover and secure it with parafilm strips.



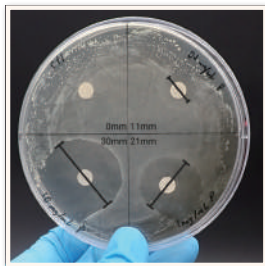
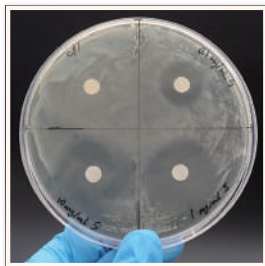
8. Leave the agar plate at room temperature to incubate for 24-48 hours, or overnight at 30 °C.





Results observation

Caution! Don't open the agar plate!



The results observation is conducted at least 24 hours after incubation. A picture of the agar plates can be taken like the one shown above. Students can easily read and compare the results.

Some students may spot out the 0 mm inhibition for control. The concept of control group was introduced in Form 1 science lessons.

1. What concentration is the best and why? Usually, students are able to tell which one is the best but not able to answer why. The more logical students are able to tell why (biggest area inhibition).
2. Which antibiotic performs better?



Teaching notes

This topic was originally designed to introduce the ethical topic about the “overuse of antibiotics”. In light of the pandemic in 2019, we added the contents about bacteria and virus. Antibiotics are not able to treat viral infection and this is the reason why we need vaccination to tackle SARS-CoV-2 virus infection.

In this experiment bacteria culture (*E.coli*) need to be used to demonstrate the properties of antibiotics. *E.coli* can be purchased from sciences Equipment Company. (To prepare *E. coli* solution, please refer to Supplementary Information on page 88)

The concept of control experiment can be easily introduced from this experiment. The water sample (control) won't show any inhibition. Most of the students can note that and understand the function of control here is to provide comparison with the antibiotics.



Extended experiment

This experiment can be applied on investigating the efficiency of different sanitization products or the concentration effect of alcohol/bleach. Different concentrations of alcohol/bleach can be prepared and used to substitute the antibiotics.

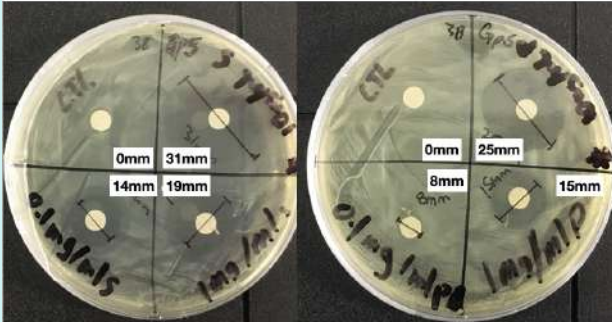
Introduction of Antibiotics

Antibiotics

Group 5

Streptomycin

Penicillin

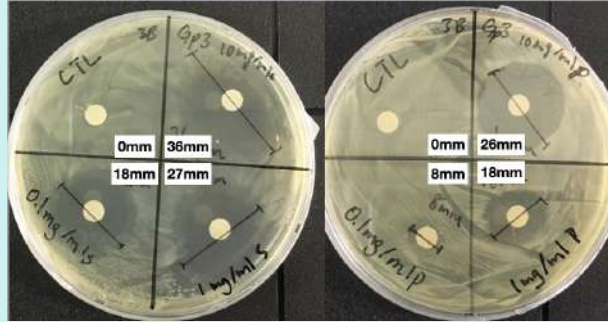


Antibiotics

Group 3

Streptomycin

Penicillin

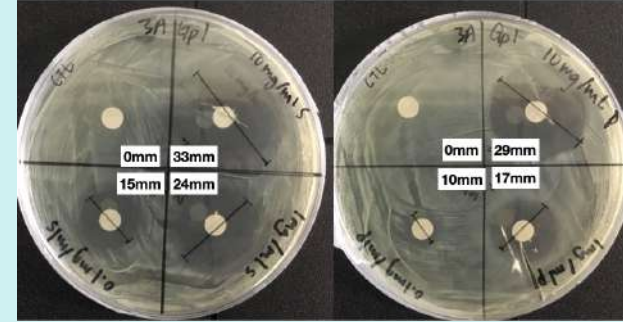


Antibiotics

Group 1

Streptomycin

Penicillin

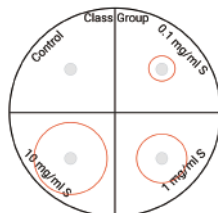


Introduction to Antibiotics

Observe your plate. Answer the following questions.

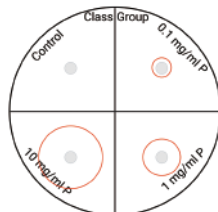
Caution! Don't open the agar plate!

Question 1: Draw/circle the observed clear zone in the following diagram.



Bottom View

Streptomycin plate



Bottom View

Penicillin plate

Question 2: Why should the agar plates be incubated at 30°C or higher temperature?

30°C or above is the optimum growing temperature for bacteria.

Question 3: Is there any bacteria grown on your agar plate? Is any bacteria presents in a blur/clear zone?

Yes/ No (Refer to the agar plate)

Question 4: Do you see a clear zone around any of the disks without bacterial growth? If so, measure (with a ruler) the diameter of the clear zone and compare with the control.

Yes/ No (Refer to the agar plate)

	Diameter of clear zone	
	Streptomycin (mm)	Penicillin (mm)
Control (0 mg/ml)		
0.1 mg/ml		
1 mg/ml		
10 mg/ml		

Question 5: What is the control used in this experiment? Why do you need a control in your experiment?

Water. To show the antibiotics are the only factor which inhibit the bacterial growth.

Question 6: Do some of your bacteria grow better on different antibiotics? If so which ones? Compare your data with the rest of the class. Research and discuss the possibilities as to why you might see these differences.

Yes/ No (Refer to the agar plate)

Integrated STEM - Science
Biotechnology

Name: _____ Class: _____ () Date: _____

Introduction of Biotechnology

Biotechnology is a technology that involves the use of living organisms. Living organisms are used to make useful chemicals and products or to perform an industrial task.
Biotechnology is mainly used in agriculture, food science, and medicine. It involves genes and genetic modification techniques.

Introduction of microorganism

A microorganism is a microscopic organism too small to be seen by the unaided human eye. Microorganisms include bacteria, fungi, algae, protists and virus, and are among the earliest known life forms.



Microorganisms are everywhere on Earth where there is liquid water, including hot springs on the ocean floor and deep inside rocks within the Earth's crust. They even exist in your drinks, foods, bodies, furniture or other things around you. Some microorganisms are good for us while some are harmful to us.

Part 2 (day 2)

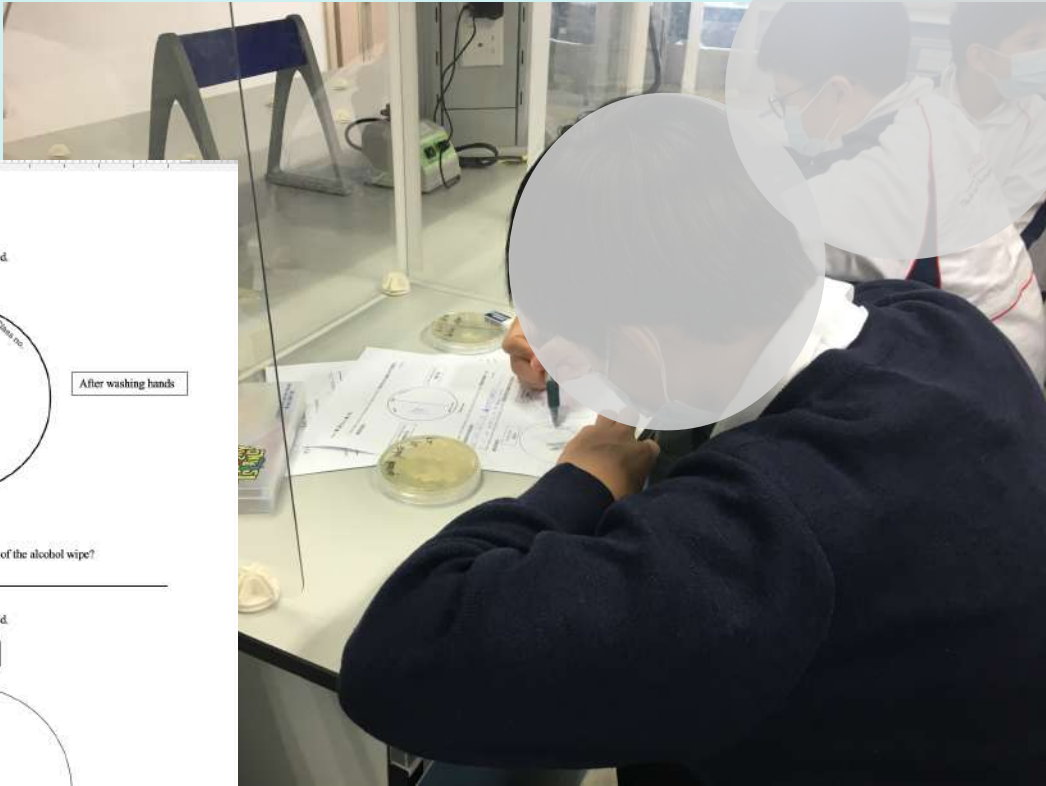
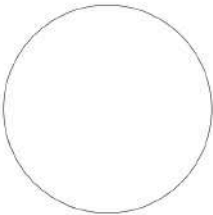
1. Draw what you see on the plate in the space provided.



2. According to your observation, what is the function of the alcohol wipe?

3. Draw what you see on the plate in the space provided.

Spread plate



INTRODUCTION TO BIOTECHNOLOGY INTRODUCTION OF ANTIBIOTICS

Dr. CHAN Ka Yee, Ms. NG Tsz Ying



保良局唐乃勤初中書院
Po Leung Kuk Tong Nai Kan Junior
Secondary College



優質教育基金
Quality Education Fund



Experiment 2:

How the concentration of antibiotic affects bacterial growth

Biotechnology Education Programme



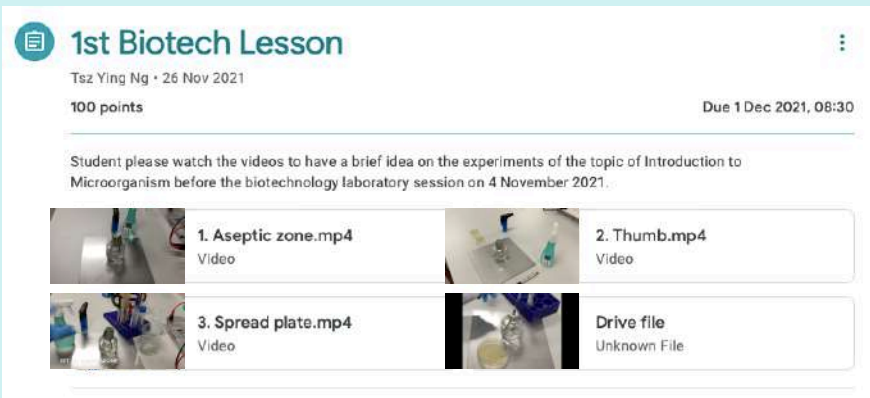
保良局唐乃勤初中書院
Po Leung Kuk Tong Nai Kan Junior
Secondary College



優質教育基金
Quality Education Fund

Flipped classroom

- A video of how to perform the experiment was posted in their Google Classroom



The screenshot shows a Google Classroom interface. At the top, the title '1st Biotech Lesson' is displayed next to a document icon. Below the title, the teacher's name 'Tsz Ying Ng' and the date '26 Nov 2021' are shown. The post is worth '100 points' and has a due date of '1 Dec 2021, 08:30'. The main text of the post reads: 'Student please watch the videos to have a brief idea on the experiments of the topic of Introduction to Microorganism before the biotechnology laboratory session on 4 November 2021.' Below the text, there are four video thumbnails arranged in a 2x2 grid. The first three are labeled '1. Aseptic zone.mp4', '2. Thumb.mp4', and '3. Spread plate.mp4', all with 'Video' as the file type. The fourth thumbnail is labeled 'Drive file' and 'Unknown File'.

1st Biotech Lesson

Tsz Ying Ng • 26 Nov 2021

100 points Due 1 Dec 2021, 08:30

Student please watch the videos to have a brief idea on the experiments of the topic of Introduction to Microorganism before the biotechnology laboratory session on 4 November 2021.

 1. Aseptic zone.mp4 Video	 2. Thumb.mp4 Video
 3. Spread plate.mp4 Video	 Drive file Unknown File

Technique demonstration videos (USB)

Supplementary Information

Preparation of agar plate	83
Preparation of <i>Escherichia coli</i> (<i>E.coli</i>)	88
Preparation of 1% agarose gel	91
Preparation of gel staining	94

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	Preparation of 1% agarose gel	91
	Preparation of gel staining	94

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Supplementary Information 1:

Preparation of agar plate

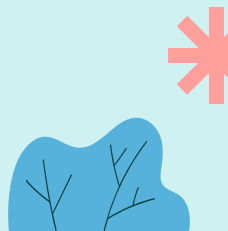
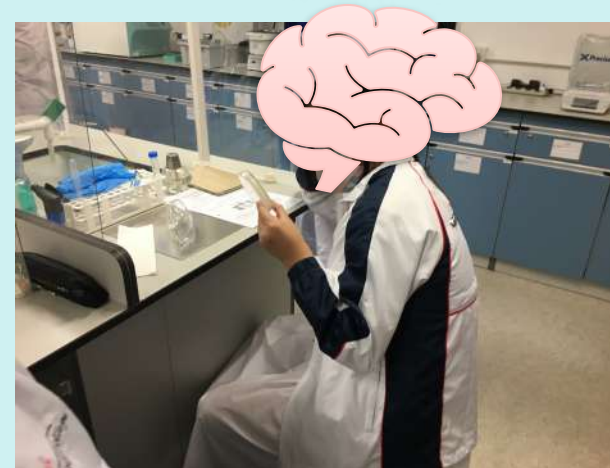
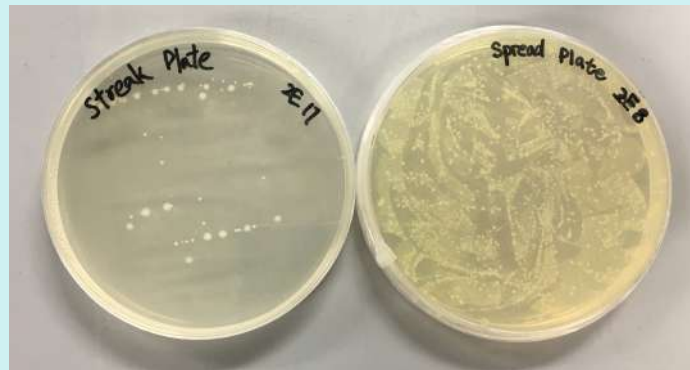
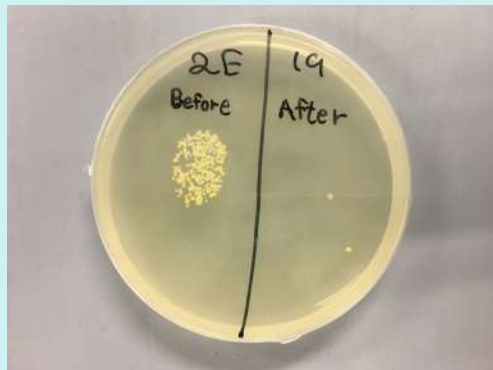
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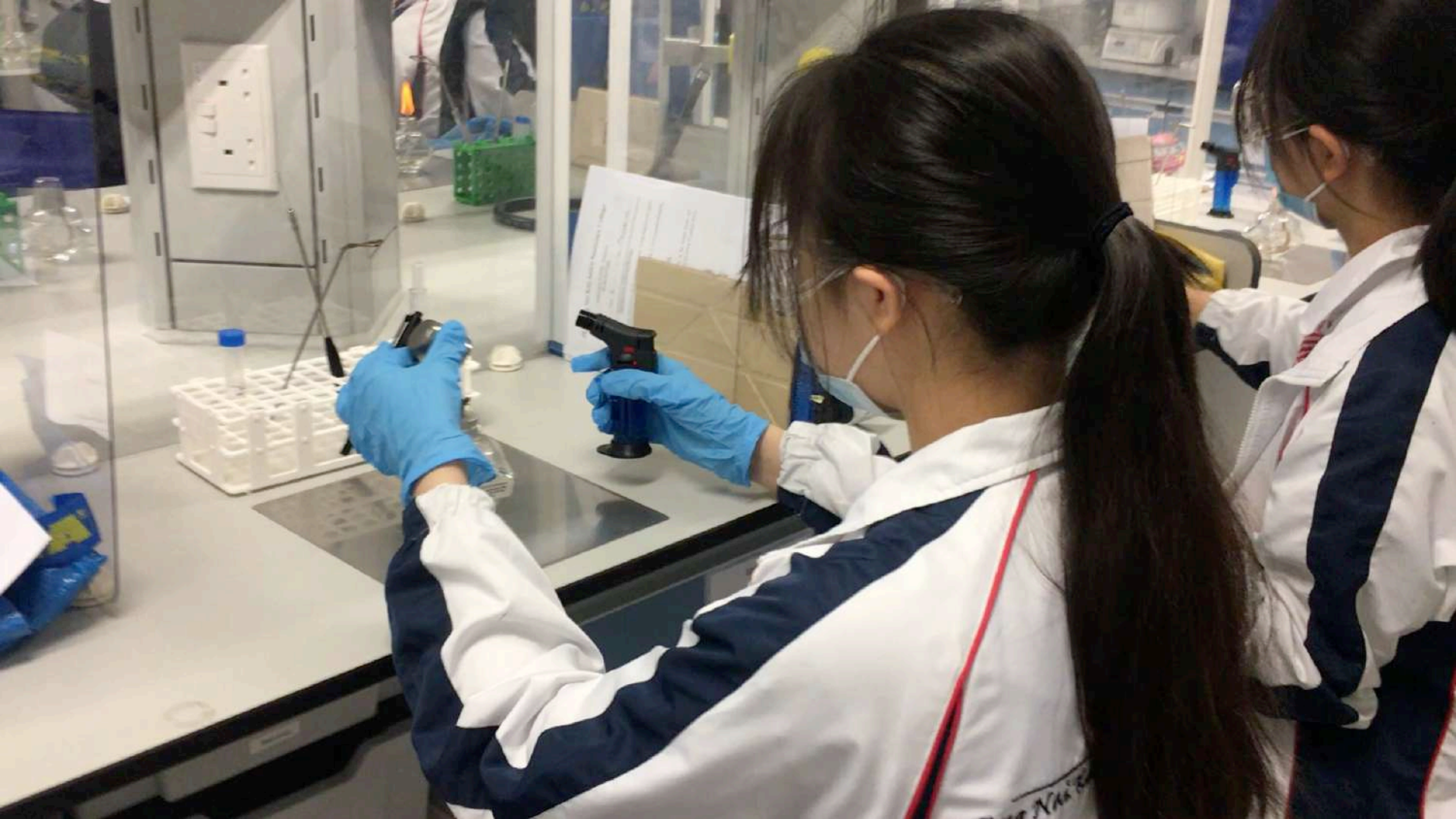
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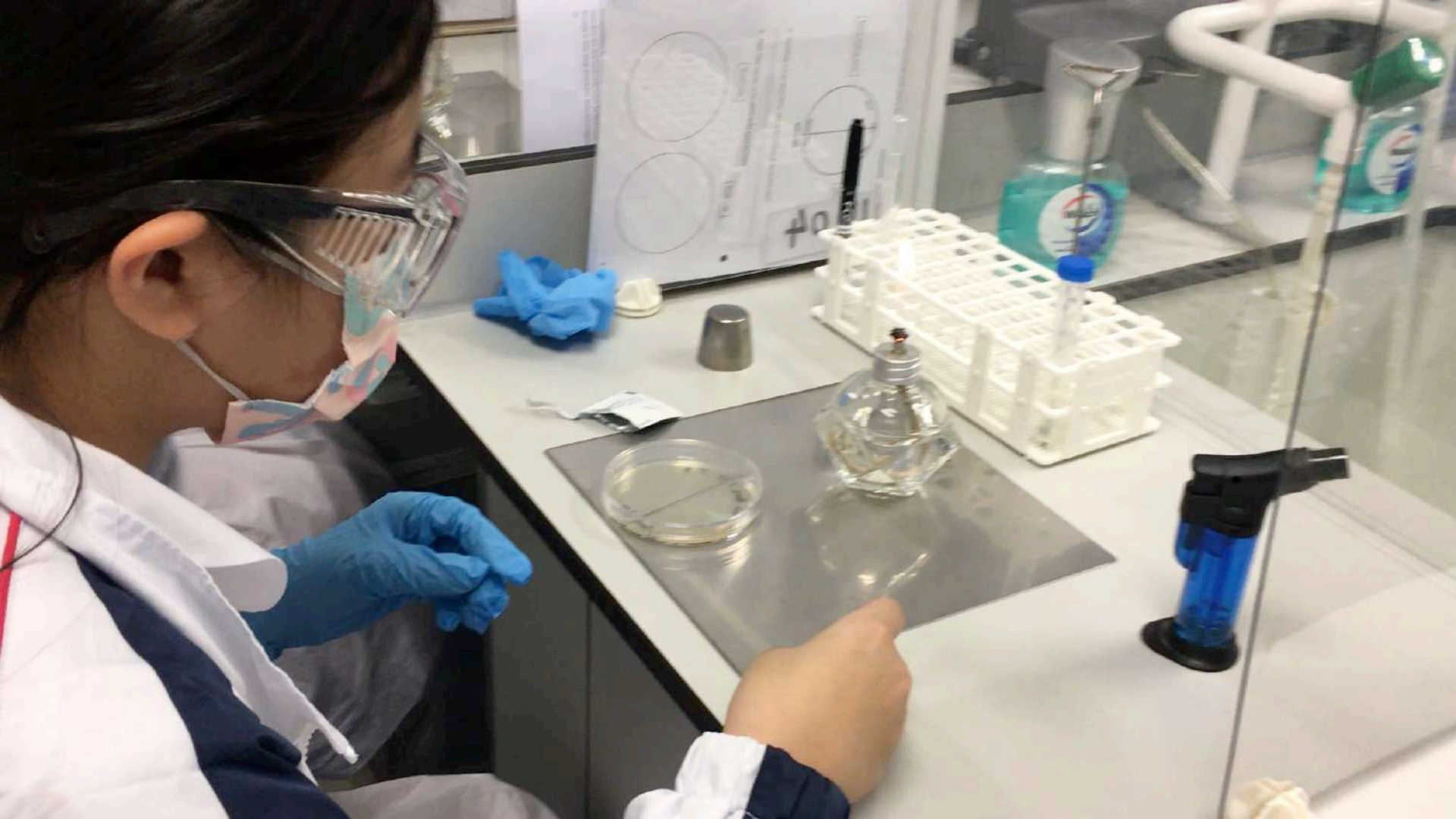
Flipped classroom



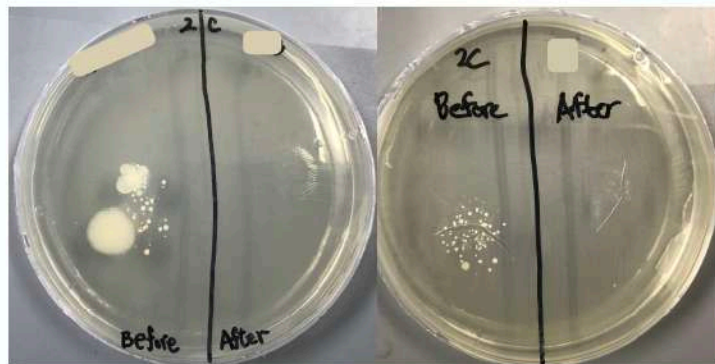








RESULT OBSERVATION



Result

RESULT OBSERVATION



Result

RESULT OBSERVATION



Result

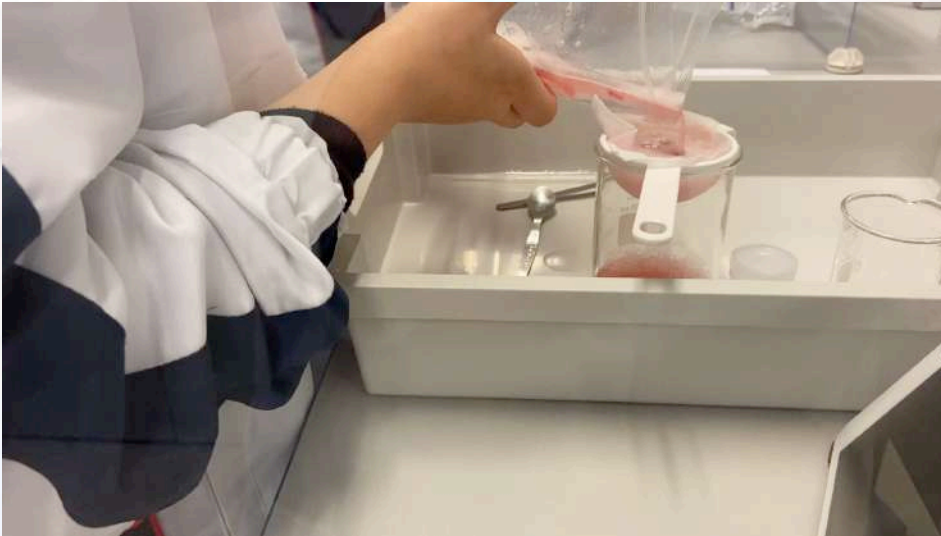
RESULT OBSERVATION



Result

Item	Material No.	Description	Qty	Unit Price	Total Value	lue
10	PP2036	Nutrient agar pk/10 Packing Size : 1X10 PLATES Batch No: 4342463 : 07.03.2022 - 6 EA	6 EA	75.00	450.00	HKD
20	PP2133	Sheep blood agar (columbia) pk/10 Packing Size : 1X10 PLATES Batch No: 4345900 : 16.02.2022 - 15 EA	15 EA	66.00	990.00	HKD
30	PP2002	Chocolate pk/10 Packing Size : 1X10 PLATES Batch No: 4345112 : 16.03.2022 - 15 EA	15 EA	75.00	1,125.00	HKD
40	PP2085	Anaerobic + nali + vanc pk/10 Packing Size : 1X10 PLATES Batch No: 4347070 : 09.03.2022 - 5 EA	5 EA	85.00	425.00	HKD
50	PP2019	Macconkey + salt pk/10 Packing Size : 1X10 PLATES Batch No: 4345875 : 29.03.2022 - 12 EA	12 EA	66.00	792.00	HKD
Total net value					3,782.00	HKD
VAT 0 %					0.00	HKD
Total incl. tax					3,782.00	HKD

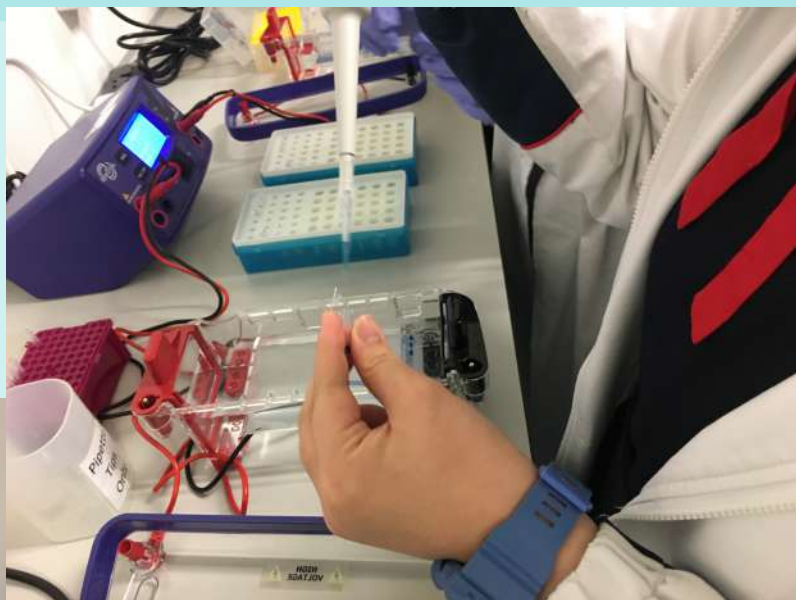




DNA extraction experiment

- This experiment was highly recommended.
- No expensive equipment needed
- Most expensive is the strawberry
- Some very interesting questions were suggested from students e.g. why add ethanol?, what is the colour of DNA? Can use other fruit to perform this experiment?



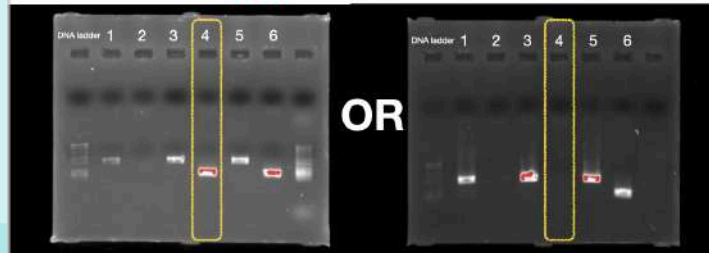


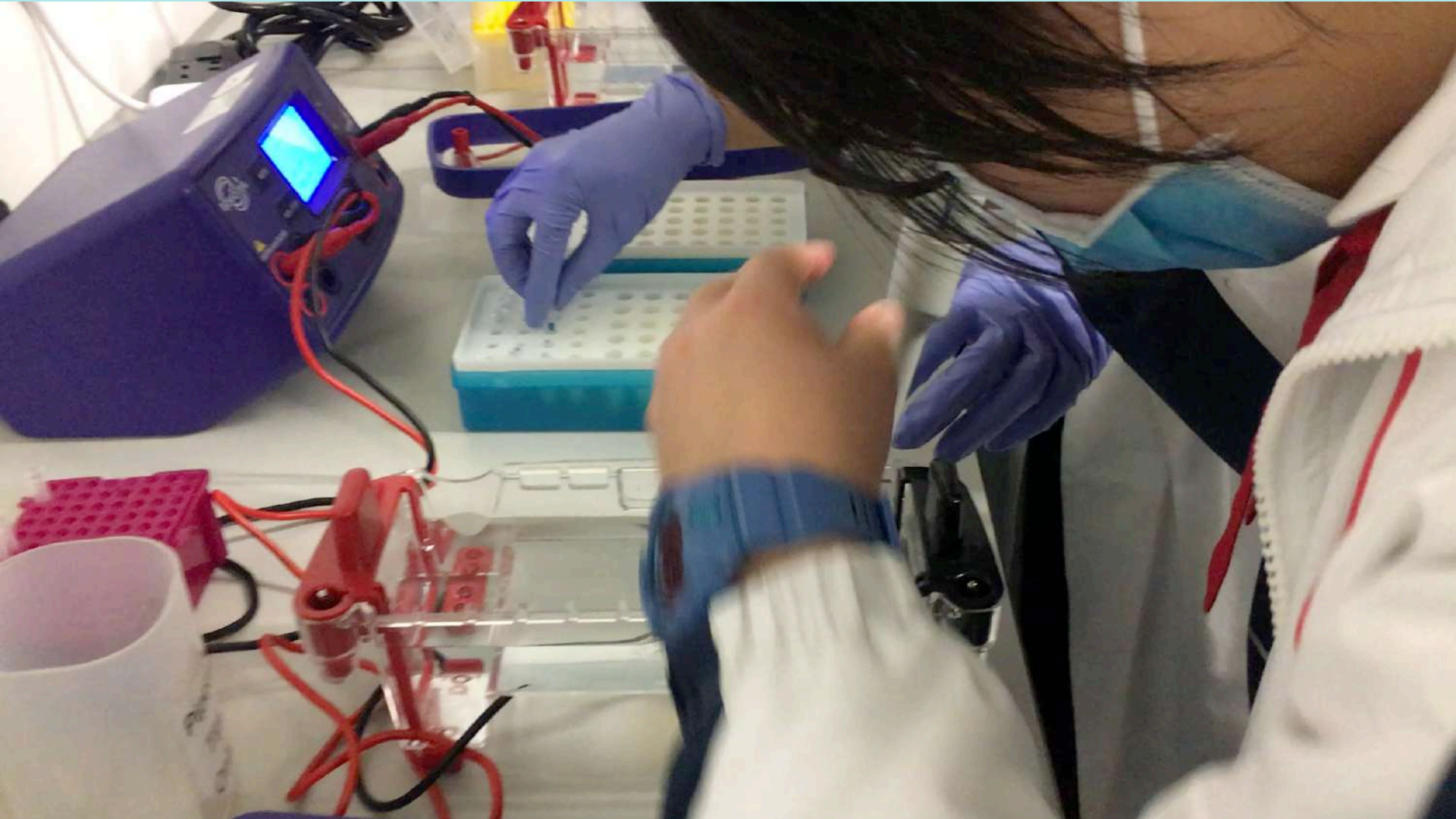
Question 2

Did your test food generate a band with GMO primer (lane 4)?

Answer: **YES**

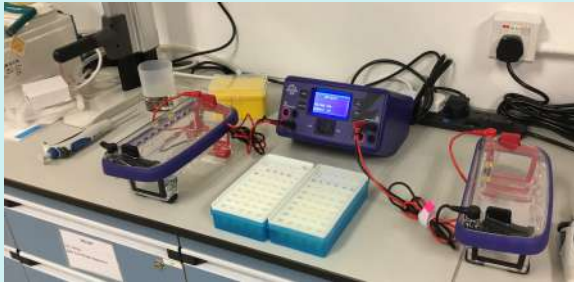
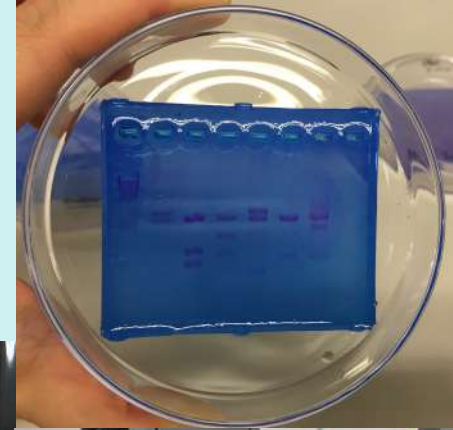
OR





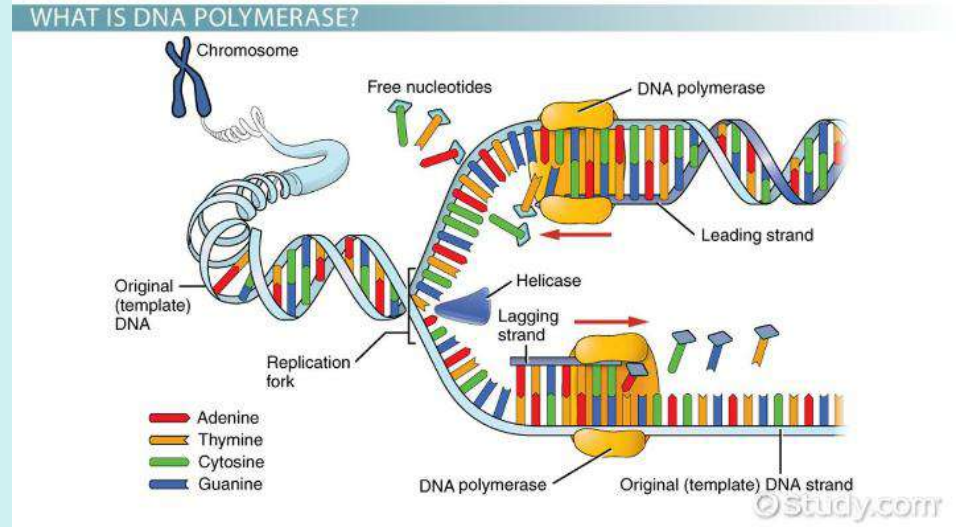
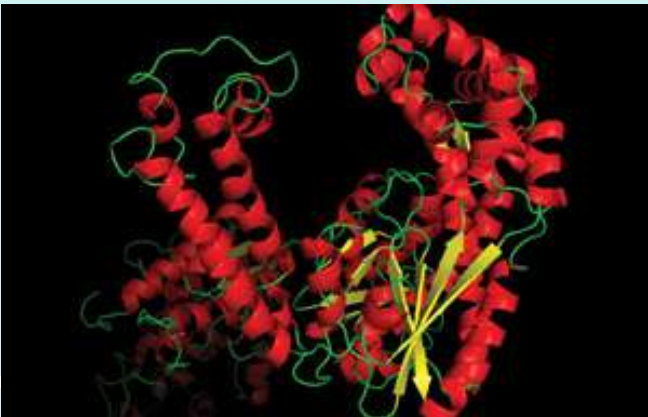
Equipment

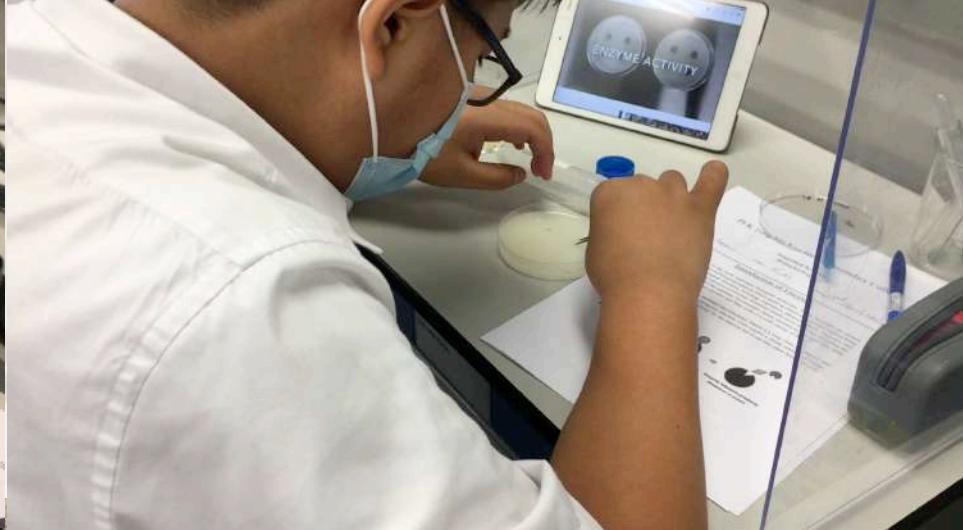
- Autopipette
- Thermal cycler
- Gel electrophoresis
- Gel Documentary/ UV box/ gel stain



Introduction of enzyme

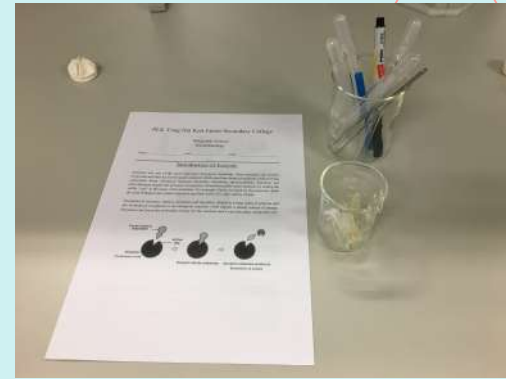
- Class arrangement
 - 2+1 practical lesson
- DNA and enzyme relationship
- Enzyme is in the Form 3 regular curriculum



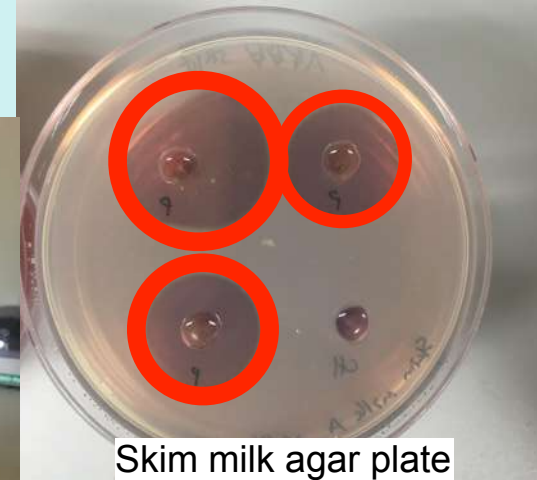


Equipment

- Autopipette / Dropper
- Milk gelatine plate/ Skim milk agar plate
- Recommended experiment



Milk gelatine plate



Skim milk agar plate

Extended learning activities (Gifted students research team)

Apply the knowledge and apply in real-life problems



Key project information

3. Provide educational service and workshops for other primary secondary schools

- 3-day Biotechnology Tasting Programme
 - to primary school students
- Benefit to both our students and the primary school students
 - Learn the presentation skill, cooperation skill and leadership



Key project information

3. Provide educational service and workshops for other primary secondary schools

- Offered a bio-tech training programme to PLK Riverain Primary School
 - Thirteen teachers joined the first programme in 23rd September 2021.
 - Five student helpers participated in this activity



Laboratory tour

- **Biotechnology lab**

- **Living technology lab**

1. Principal of heat transfer data recording using different cups demonstrate the heat lost (Alternative take away containers, Plastic, Styrofoam, paper)
2. Marinate using enzyme
3. Vegetable, dietary fibre difference between fruit and vegetables (use press juicer)
4. Making coffee caviar drink with liquid with different density*
5. Experiment on fat in food (potato chips)
6. Experiment on simplified vitamin C determination



THANKS!

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INTRODUCTION TO BIOTECHNOLOGY

INTRODUCTION OF ANTIBIOTICS

Dr. CHAN Ka Yee, Ms. NG Tsz Ying

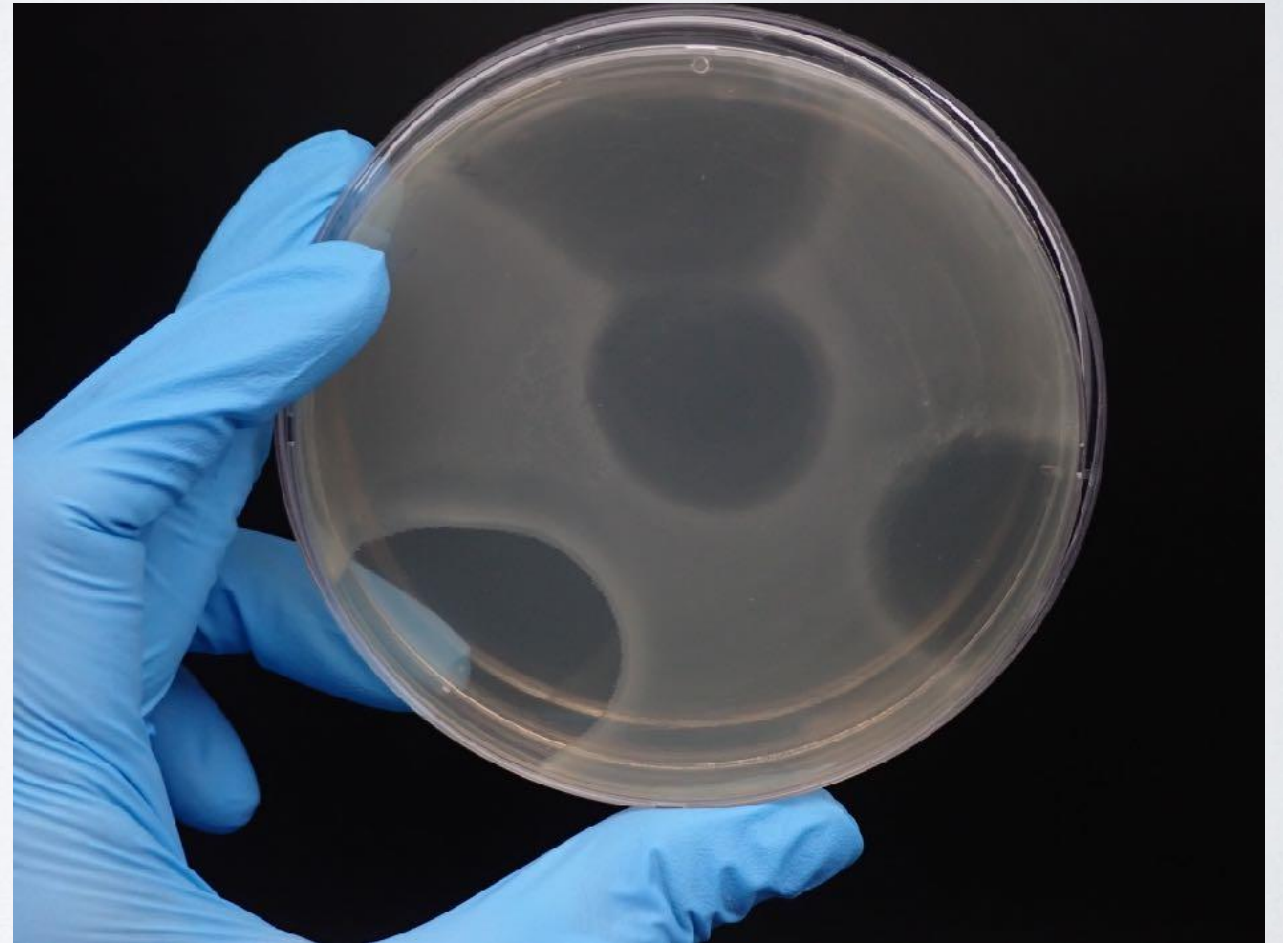


保良局唐乃勤初中書院
Po Leung Kuk Tong Nai Kan Junior
Secondary College



優質教育基金
Quality Education Fund

WHAT IS ANTIBIOTICS?

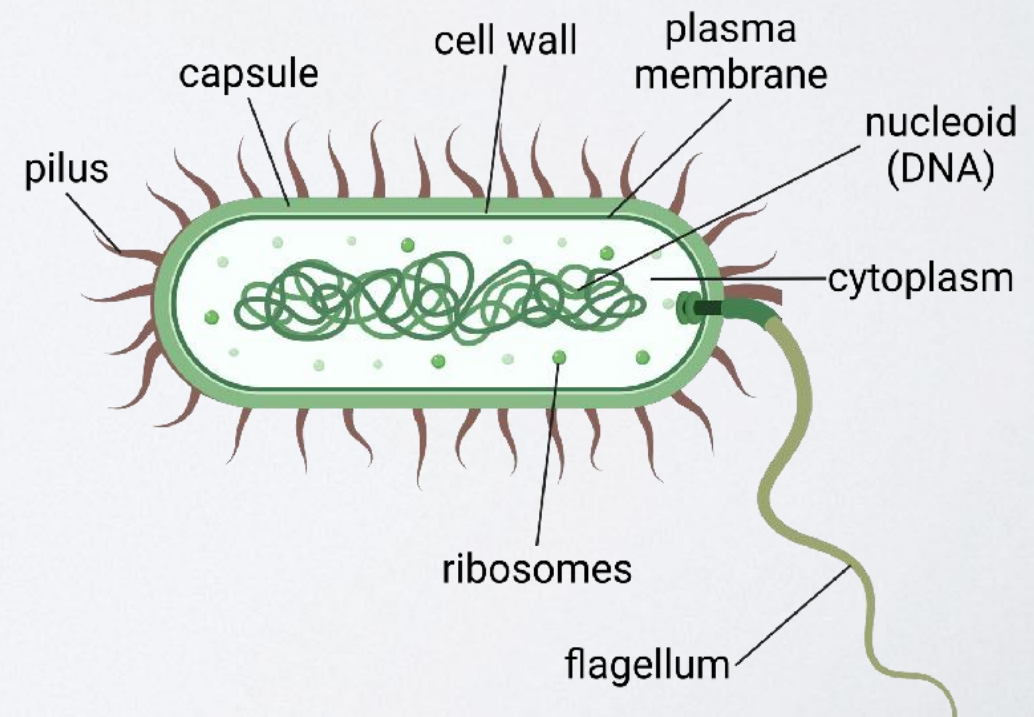
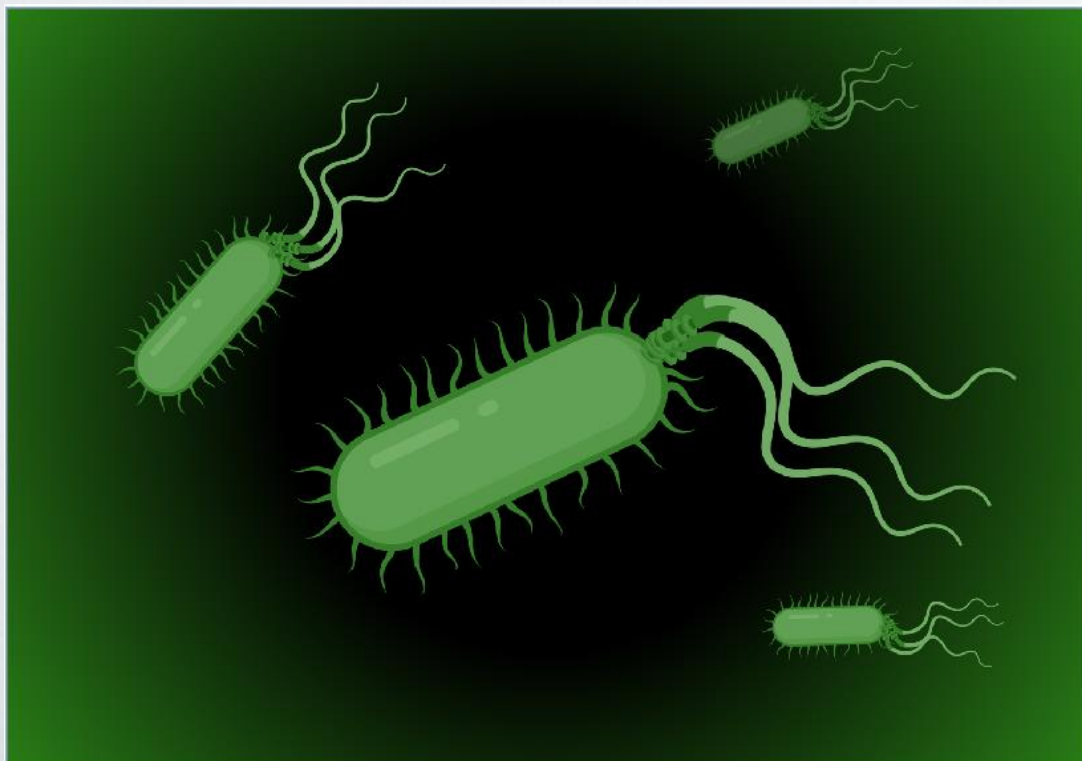


INTRODUCTION

- Bacteria vs virus
- Both can cause mild to serious infections
- But they are different from each other

BACTERIA

- A bacteria is a single, but complex cell.
- It can survive on its own, inside or outside the



BACTERIA

- Bacteria are everywhere, including your entire body.
- The bacteria in our body weighs as much as our brain.



3lbs

BACTERIA

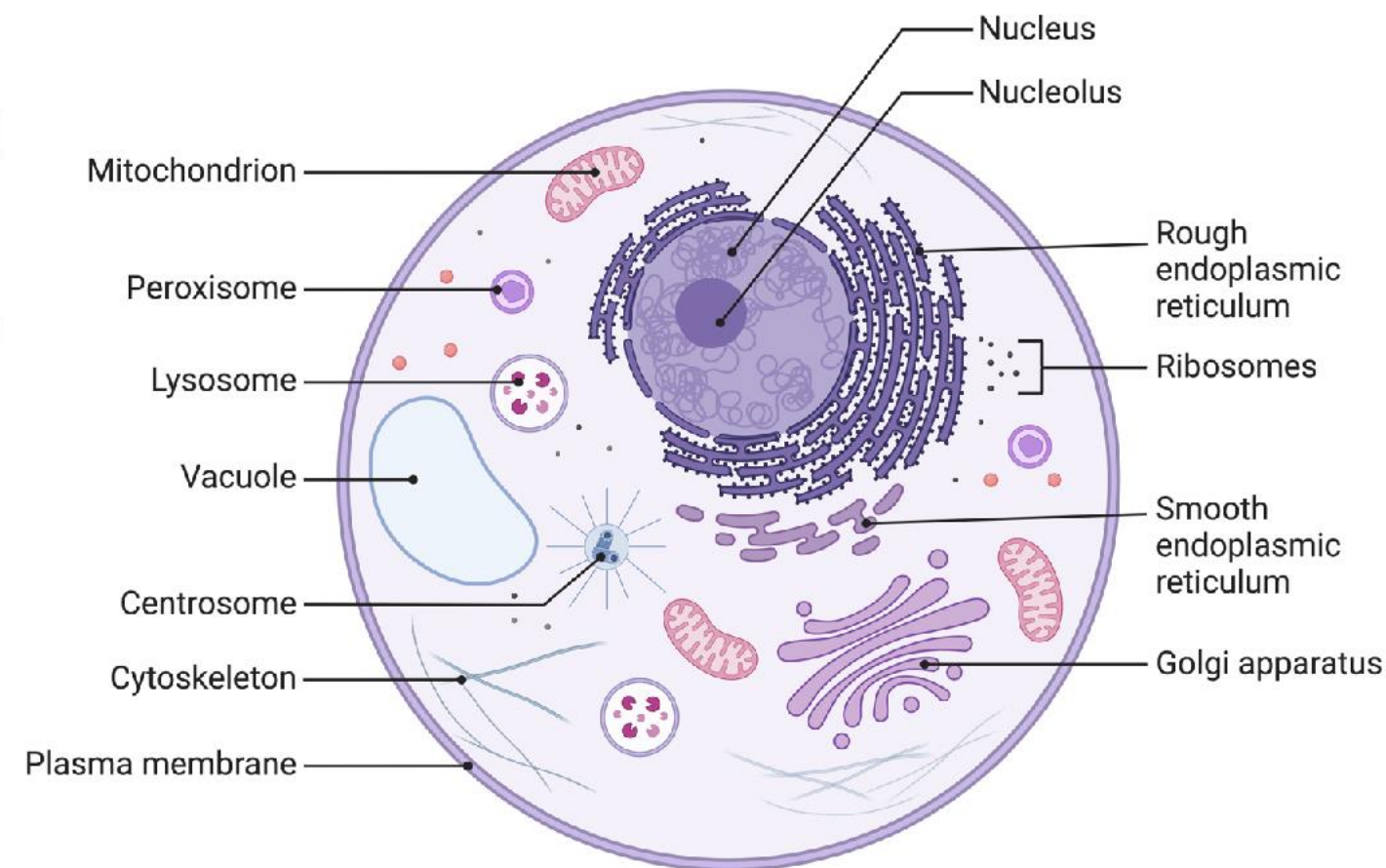
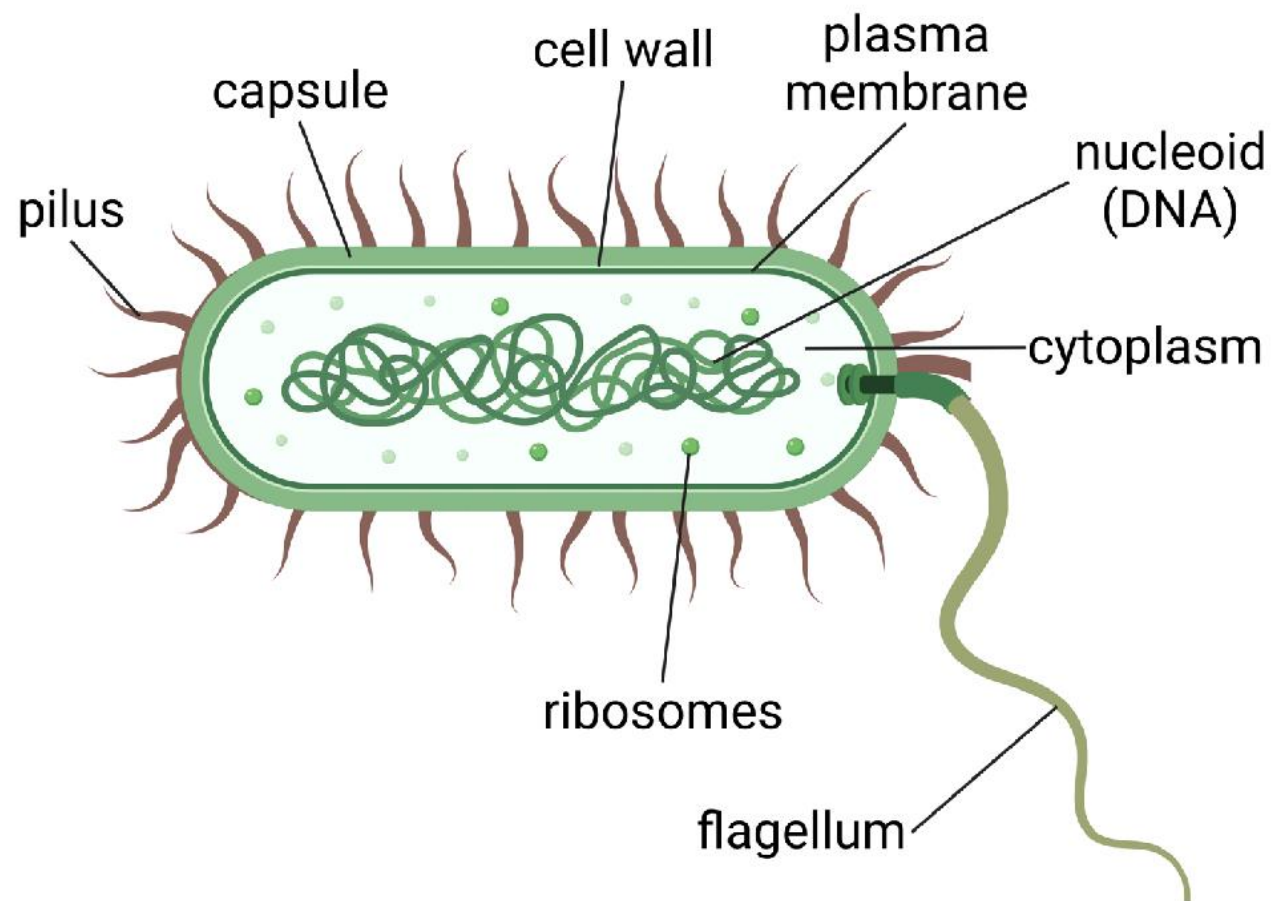
- Single cell
- Prokaryotic microorganisms
 - prokaryotic cells are simple, unicellular, and small that does not have a well-defined nucleus
 - eukaryotic cells are multi cellular, larger, and have a well-defined nucleus

PROKARYOTIC CELL

VS

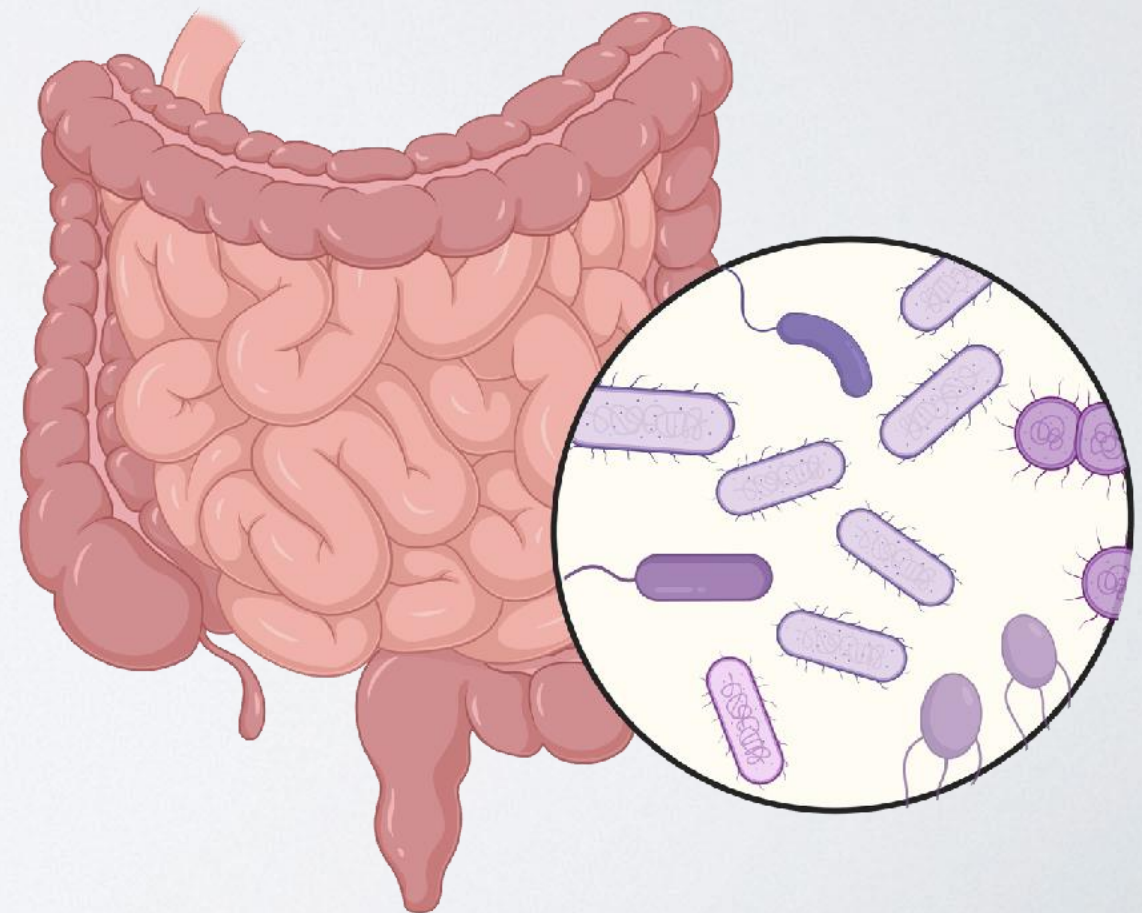
Prokaryotic Cell

Eukaryotic Cell



BACTERIA

- Most bacteria aren't harmful.
- “Good” bacteria is called beneficial bacteria
- Most well known good bacteria is called probiotics.
- Probiotics
 - Live in our gut
 - Live bacteria that are good for your digestive system (digest food))



BAD BACTERIA

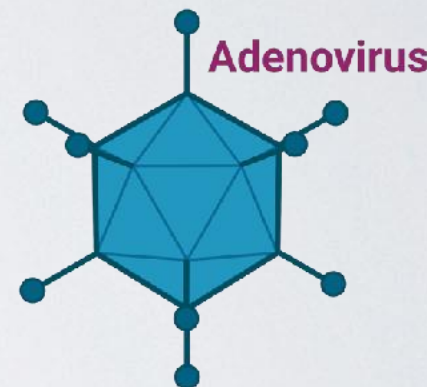
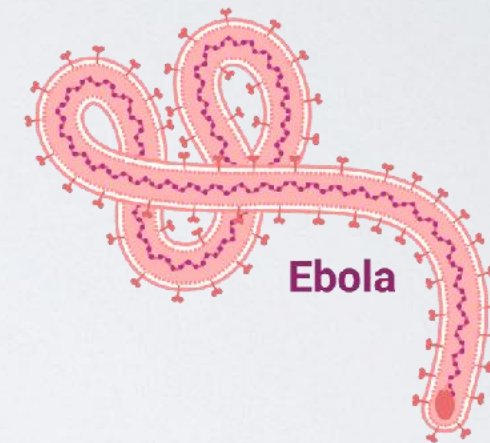
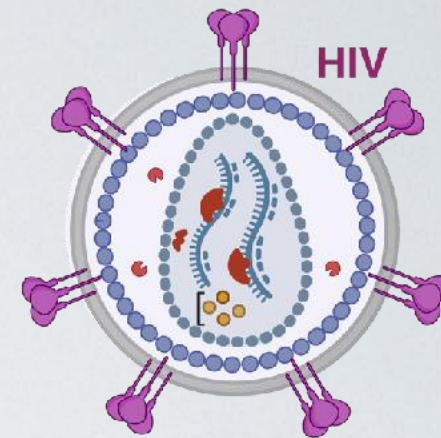
- “Bad” bacteria - pathogen
 - Pathogen cause infection, make us sick or in some cases can kill us.
 - Bad bacteria can come from external environment such as food.
 - Food poison

BAD BACTERIA

- Can result in diseases
 - Cancer
 - Diabetes
 - Cardiovascular disease
 - Obesity

VIRUSES

- Viruses are smaller and are not cells.
- Unlike bacteria, they need a host such as a human or animal to multiply/reproduce.
- Viruses cause infections by entering and multiplying/reproduce inside the host's healthy cells.

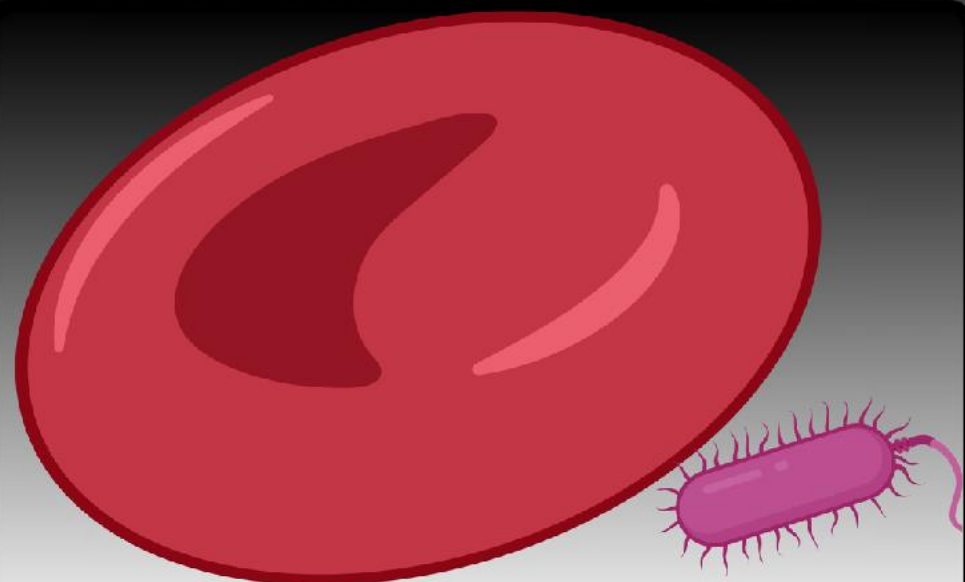


VIRUSES

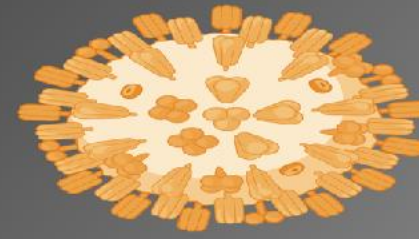
- They are made of proteins and genes
- Cause of history-altering outbreaks and pandemics
 - Smallpox and polio to HIV and Ebola

VIRUSES

- Ultra-tiny packages of genetic material.
- 100 times smaller than common bacteria.
- The outer layer is a protective shell called a capsid.



Red blood cell (10,000 nm)



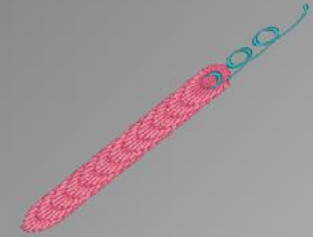
Smallpox Virus
(200 nm x 300 nm)



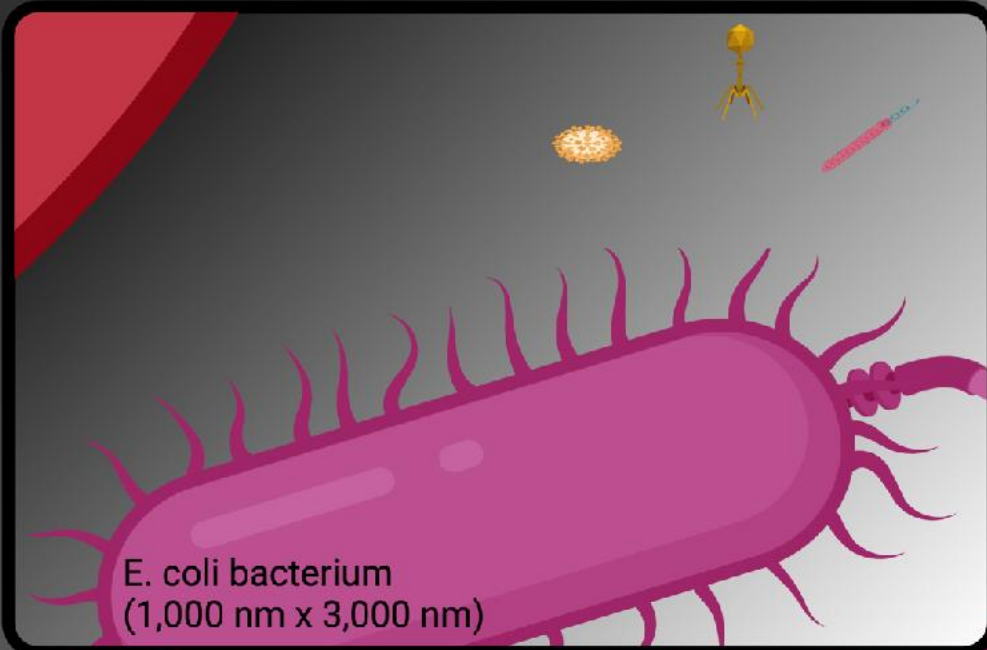
Bacteriophage T4
(50 nm x 225 nm)



Poliovirus
(30 nm)



Tobacco mosaic virus
(15 nm x 300 nm)



E. coli bacterium
(1,000 nm x 3,000 nm)

Bacteriophage MS2
(24 nm)

Bacterial ribosomes
(25 nm)

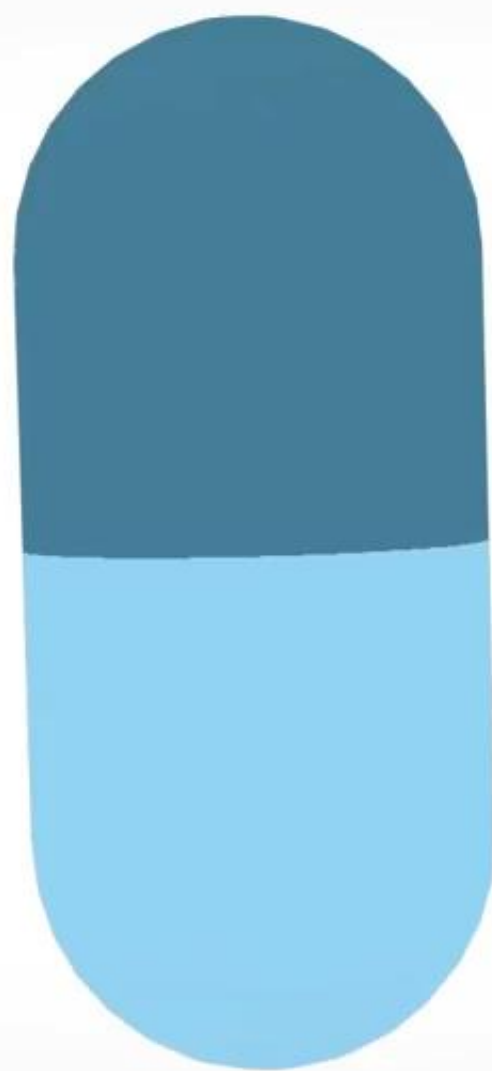
300nm

BACTERIA VS VIRUS

- Both cause mild to serious infections
- Bacterial infections are caused by bacteria
- Viral infections are caused by viruses

BACTERIA VS VIRUS

- Antibiotic drugs kill bacteria
- But they aren't effective against viruses



ANTIBIOTICS RESISTANCE

- <https://www.who.int/news-room/fact-sheets/detail/antibiotic-resistance>

BACTERIAL INFECTION

- Food poisoning *E.coli*
- Skin infection
 - *Streptococcus*
- Tuberculosis

VIRAL INFECTION

- Common cold
- Flu
- HIV/AIDS

ANTIBIOTICS

- Medications that fight bacterial infections
- They work by disrupting the processes necessary for bacterial cell growth
- Antibiotics don't treat viruses

VACCINES

- Vaccines contain the same antigens (or parts of antigens) that cause disease
- The antigens in vaccines are either killed, or weakened
- The antigens in vaccines don't causes disease
- However, they are strong enough to make the immune system produce antibodies that lead to immunity
- Provide immunity against one or several diseases
- Prepared from the causative agent of a disease

IMMUNE SYSTEM

- Immune system enables the body to recognise its own cells and to defend against infections, cancer, and foreign substance
- White blood cells play major roles in the immune system

WHITE BLOOD CELL

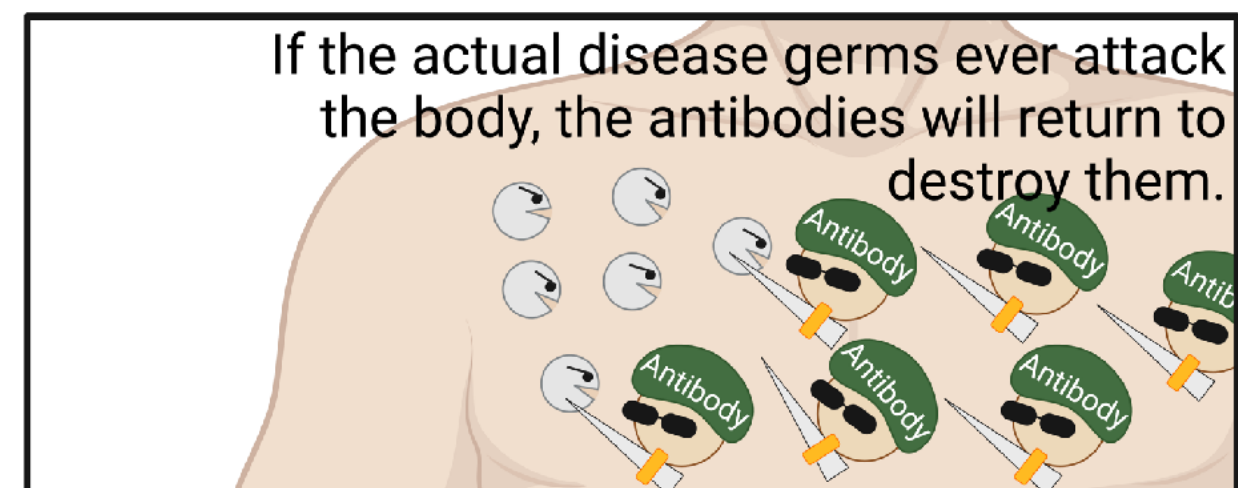
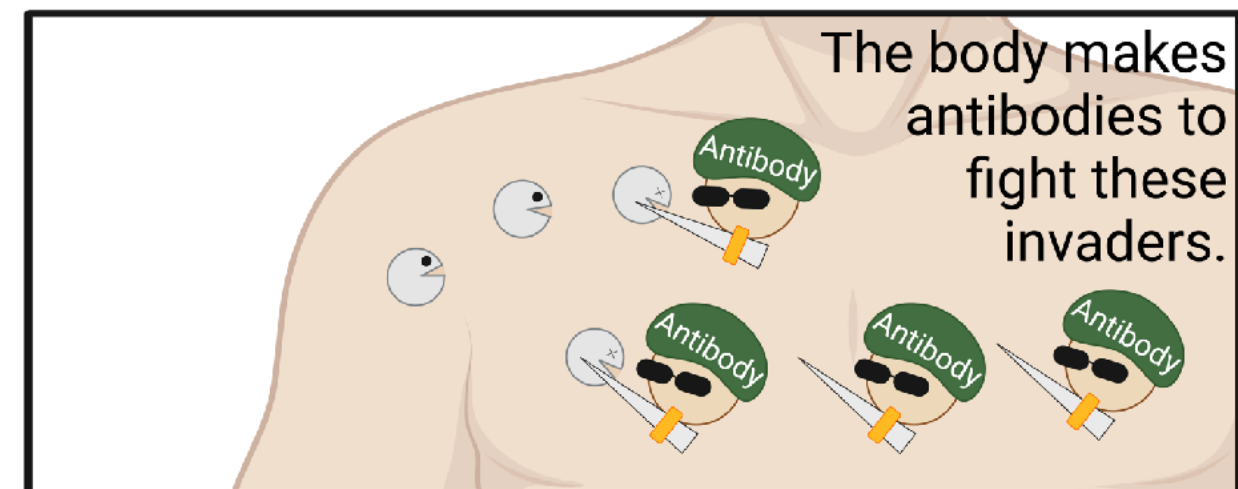
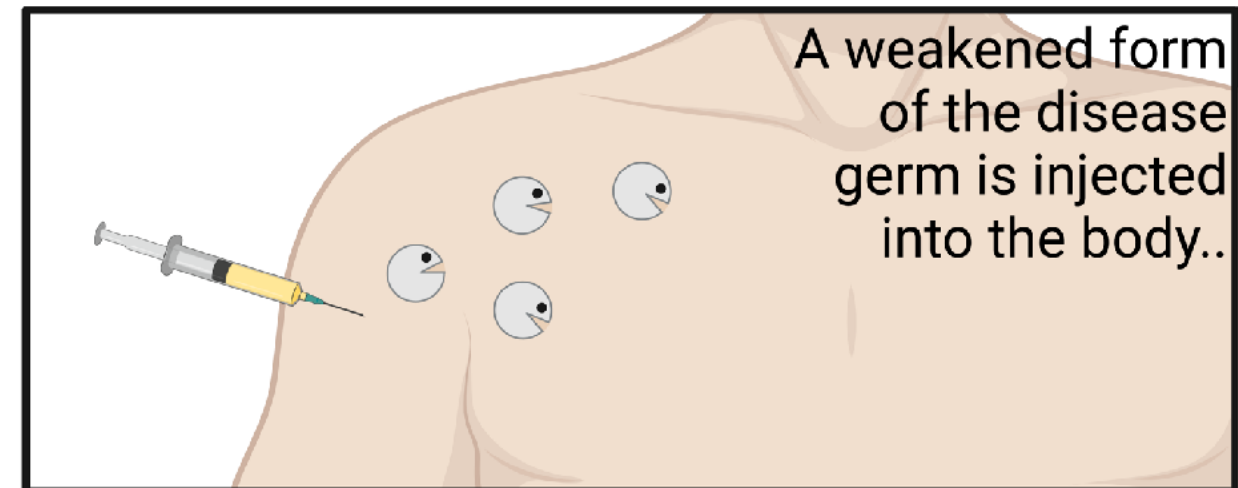
- Suspended in blood plasma and occupy the interstitial fluid between cells
- White blood cell produced in red bone marrow
 - Phagocytes
 - Eosinophil
 - Basophil
 - Lymphocyte

LYMPHOCYTE

- B cell
- Responses to specific pathogens
- Response is strongest and fastest for previously encountered pathogens

HOW VACCINE WORK?

- Prevent a disease
- Immunity is the body's way of preventing disease



- <https://www.youtube.com/watch?v=IXMc15dA-vw>

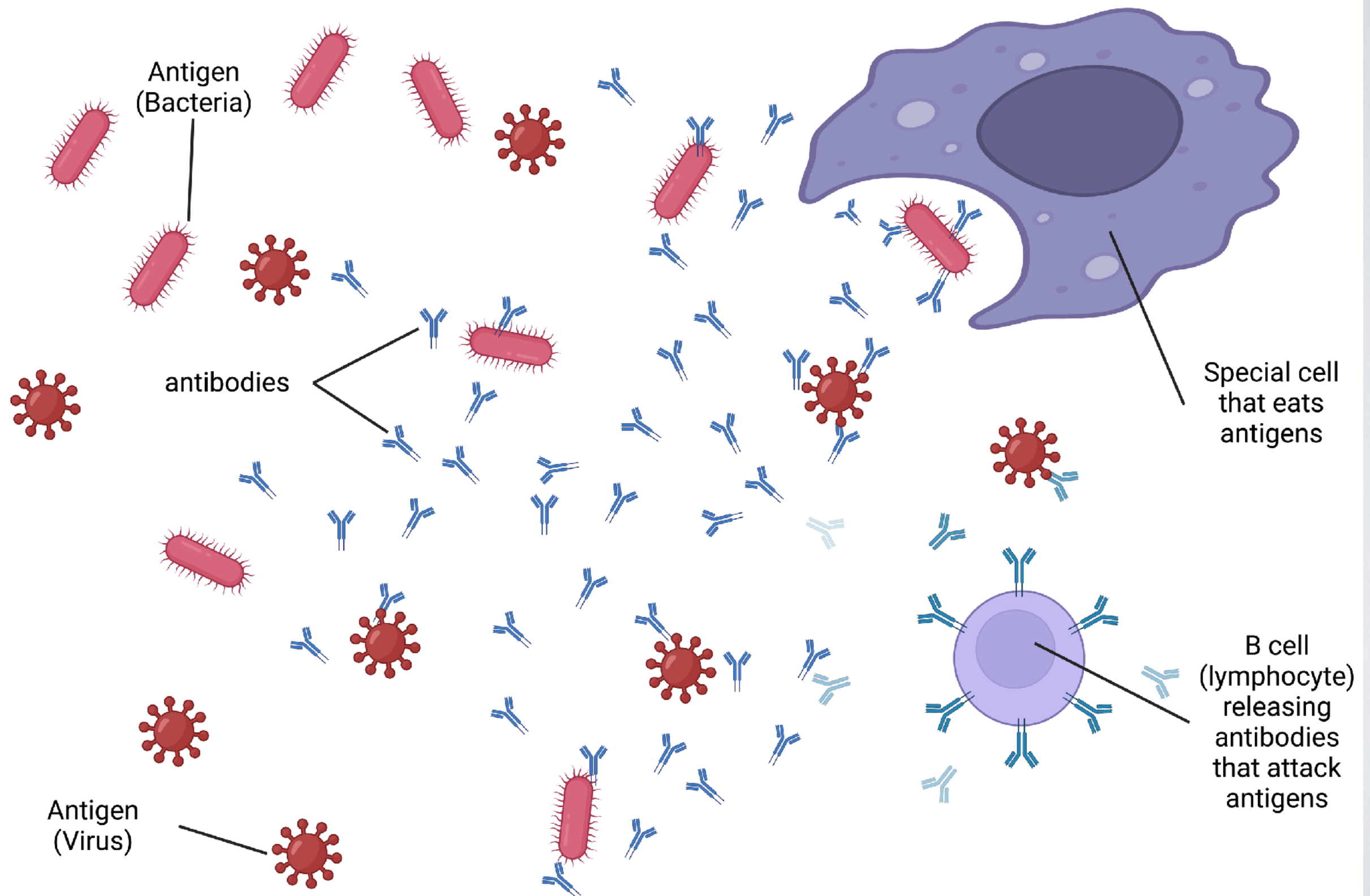
ANTIBODIES

- A protective protein produced by the immune system in response to the presence of a foreign substance, called antigen
- Antibodies recognise and latch onto antigens in order to remove them from the body
- A wide range of substances are regarded by the body as antigens, including disease-causing organism and toxic materials such as insect venom

ANTIBODIES

- Antibodies are produced by specialised white blood cells called B lymphocytes (or B cells)
- When an antigen binds to the B-cell surface, it stimulates the B cell to divide and mature into a group of identical cells called a clone
- The mature B cells, called plasma cells, secrete millions of antibodies into the bloodstream and lymphatic system

IMMUNE SYSTEM



B CELL

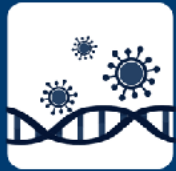
- Collectively B cells recognise an almost limitless number of antigens
- However, individually each B cell can bind to only one type of antigen
- B cells distinguish antigens through proteins, called antigen receptors
- An antigen receptor is basically an antibody protein when located on the B-cell membrane.

'Virus' vs 'Bacteria'

The key differences between two common pathogens.



Viruses are NOT living organisms.



Viruses only grow and reproduce inside of the host cells they infect. When found outside of these living cells, viruses are dormant. Their "life" therefore requires the hijacking of the biochemical activities of a living cell.



Viruses are submicroscopic.



A viral infection is systemic. Viruses infect a host cell and then multiply by the thousands, leaving the host cell and infecting other cells of the body.



Systemic diseases caused by viral infection include influenza, measles, polio, AIDS, and COVID-19.

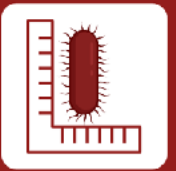
Bacteria are living organisms.



Bacteria are living organisms that consist of single cell that can generate energy, make its own food, move, and reproduce (typically by binary fission). This allows bacteria to live in many places - soil, water, plants, and the human body - and serve many purposes.



Bacteria are giant compared to viruses.



Bacterial infection is usually confined to a part of the body, described as a localized infection. Infections may be caused by the bacteria or by toxins (endotoxins) produced.

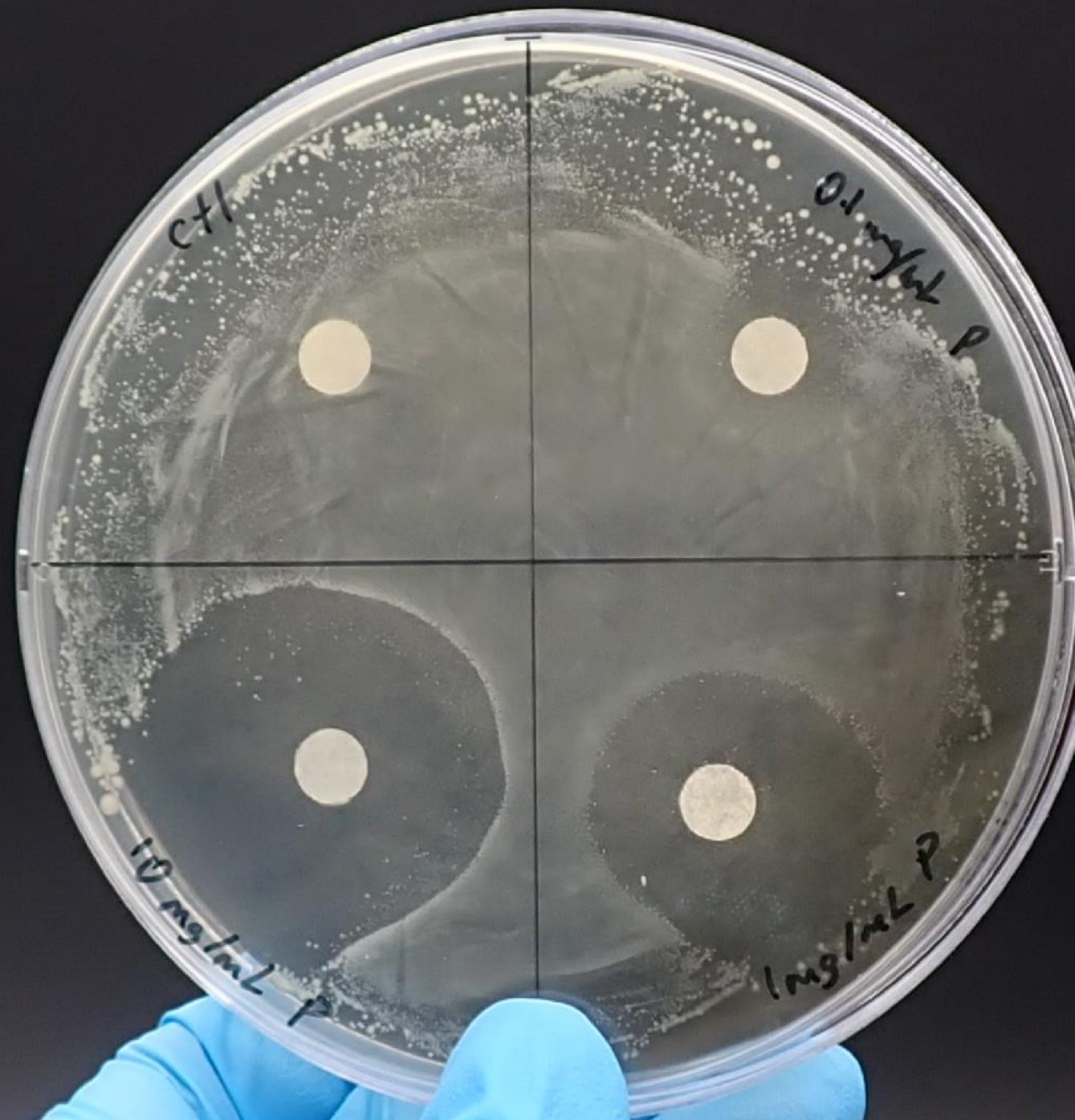
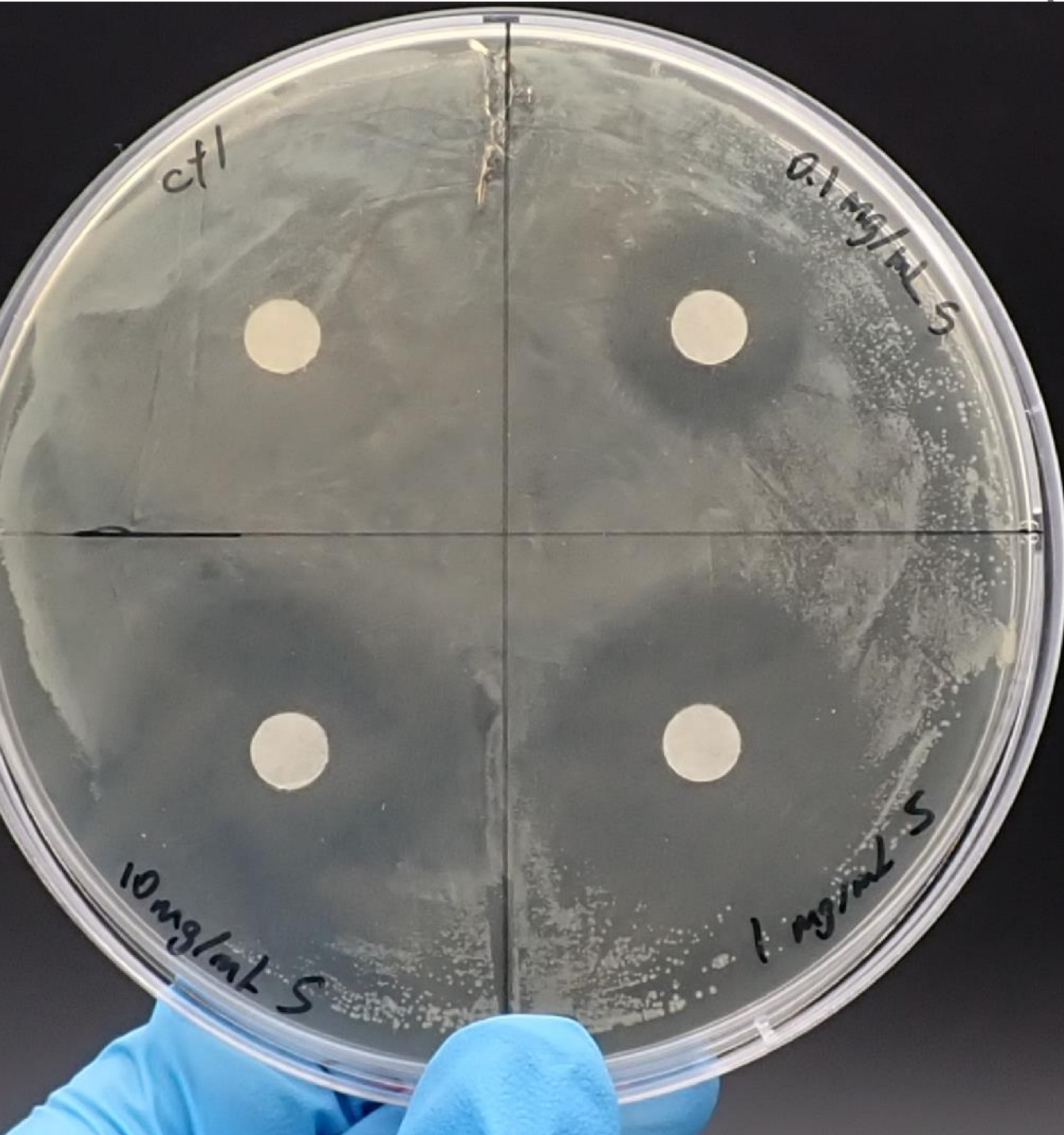


Bacteria diseases include pneumonia, tuberculosis, tetanus, and food poisoning.



EXPERIMENT 2: HOW THE CONCENTRATION OF ANTIBIOTIC AFFECTS THE BACTERIAL GROWTH

In the following experiment, you will test the ability of different antibiotics in different concentration to inhibit the growth of *E.coli*.



EFFECTIVENESS OF ANTIBIOTICS

Materials and apparatus

Agar plate with <i>E.coli</i>	2 nos	10mg/ml streptomycin	0.5ml
Marker	1 nos	1mg/ml streptomycin	0.5ml
Dropper	1 nos	0.1mg/ml streptomycin	0.5ml
Alcohol lamp	1 nos	10mg/ml penicillin	0.5ml
Sterile paper disks	8 nos	1mg/ml penicillin	0.5ml
Forceps	1 nos	0.1mg/ml penicillin	0.5ml
Ruler	1 nos	Sterile water	0.5ml

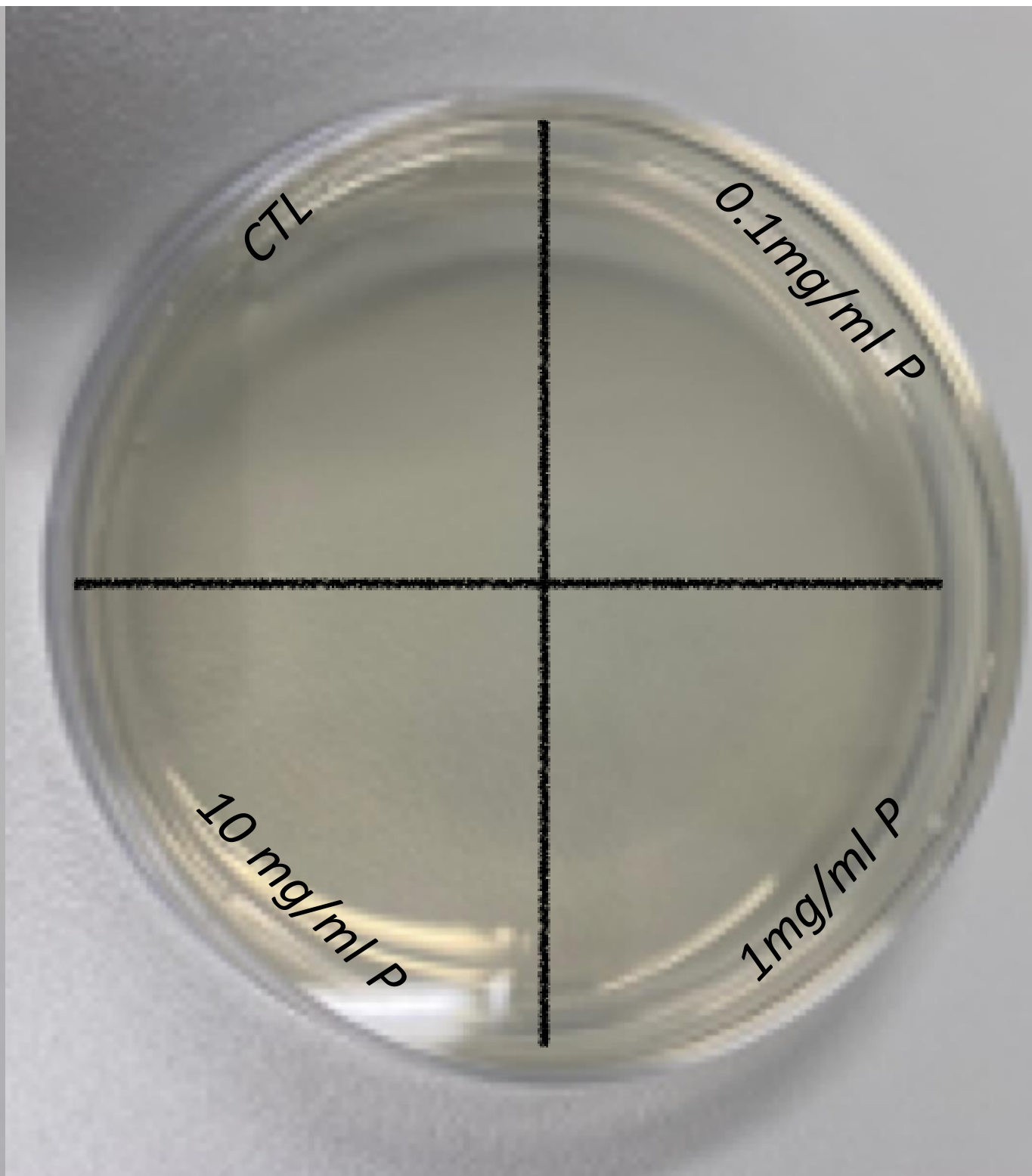
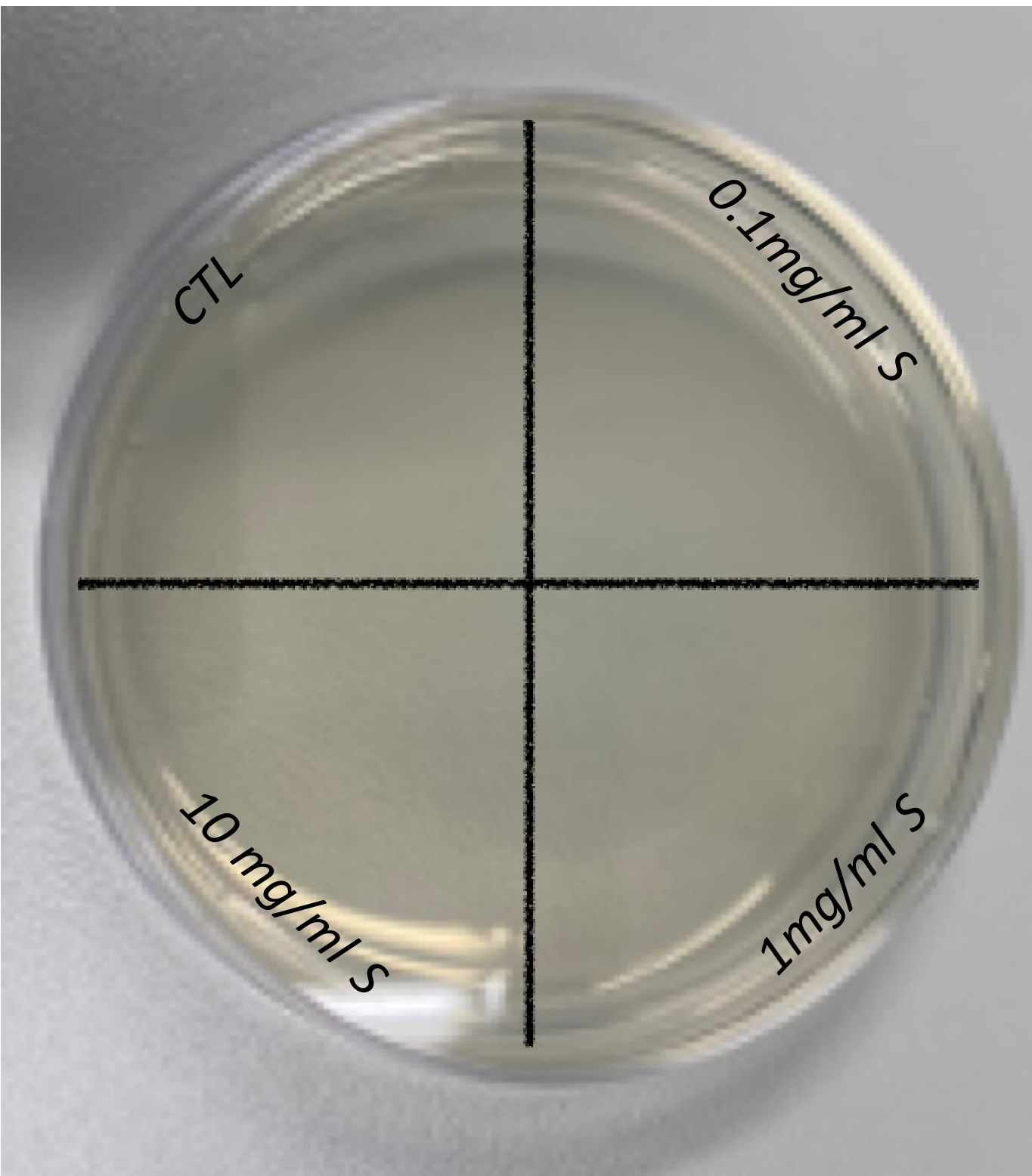
EFFECTIVENESS OF ANTIBIOTICS

For reference: Spreading *E. coli*

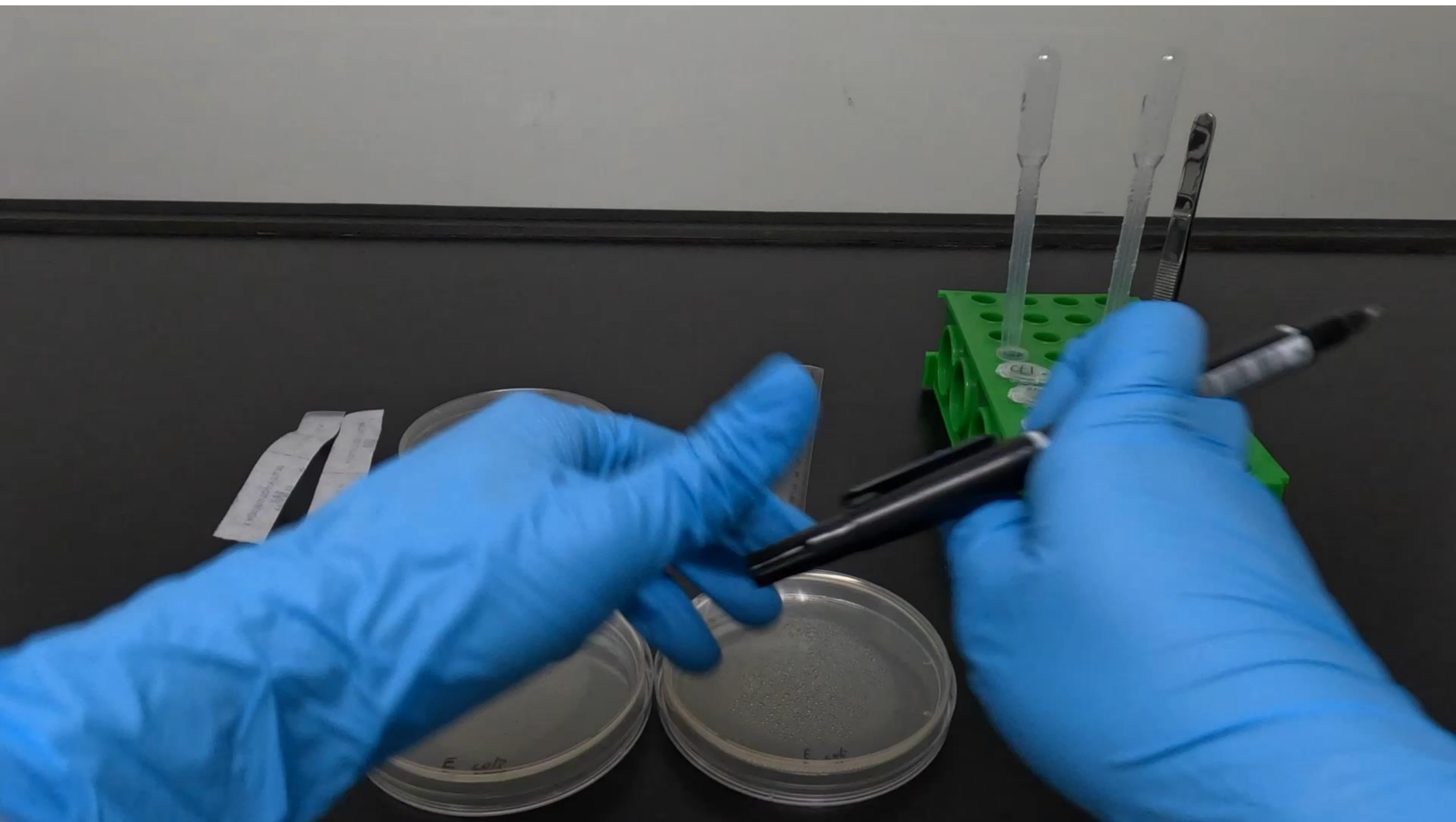


EFFECTIVENESS OF ANTIBIOTICS

Step 1: Label the agar plates

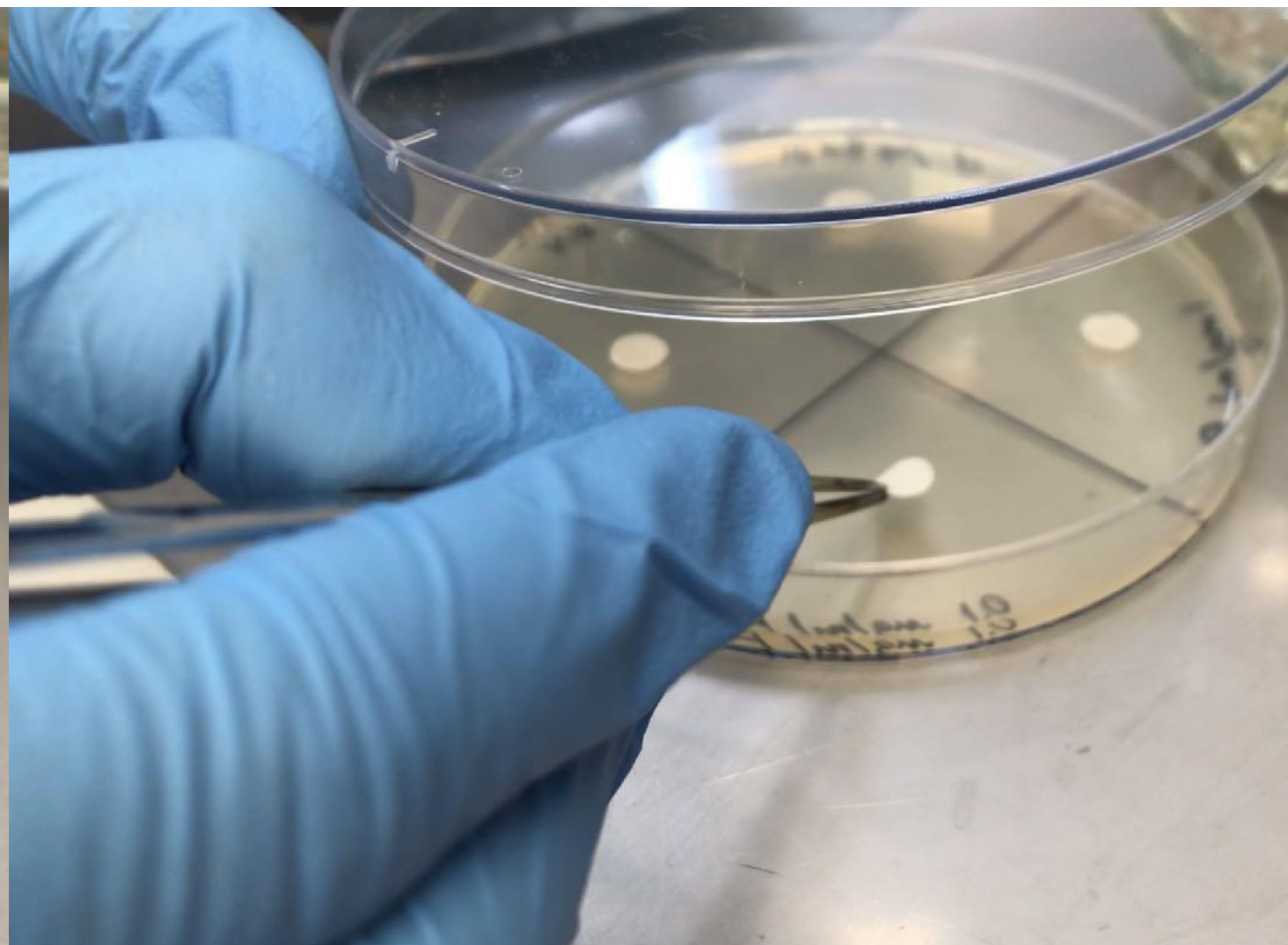
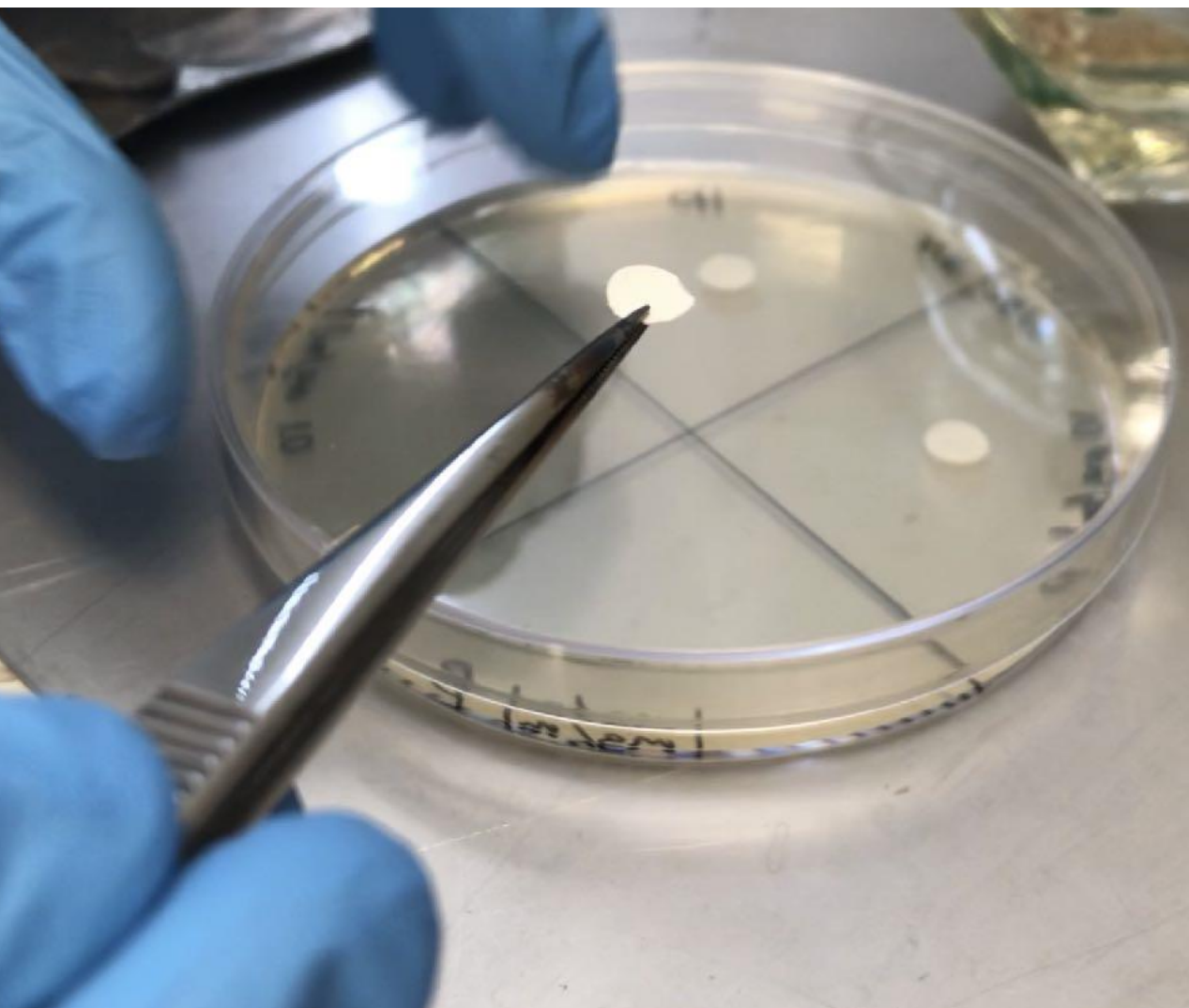


EFFECTIVENESS OF ANTIBIOTICS



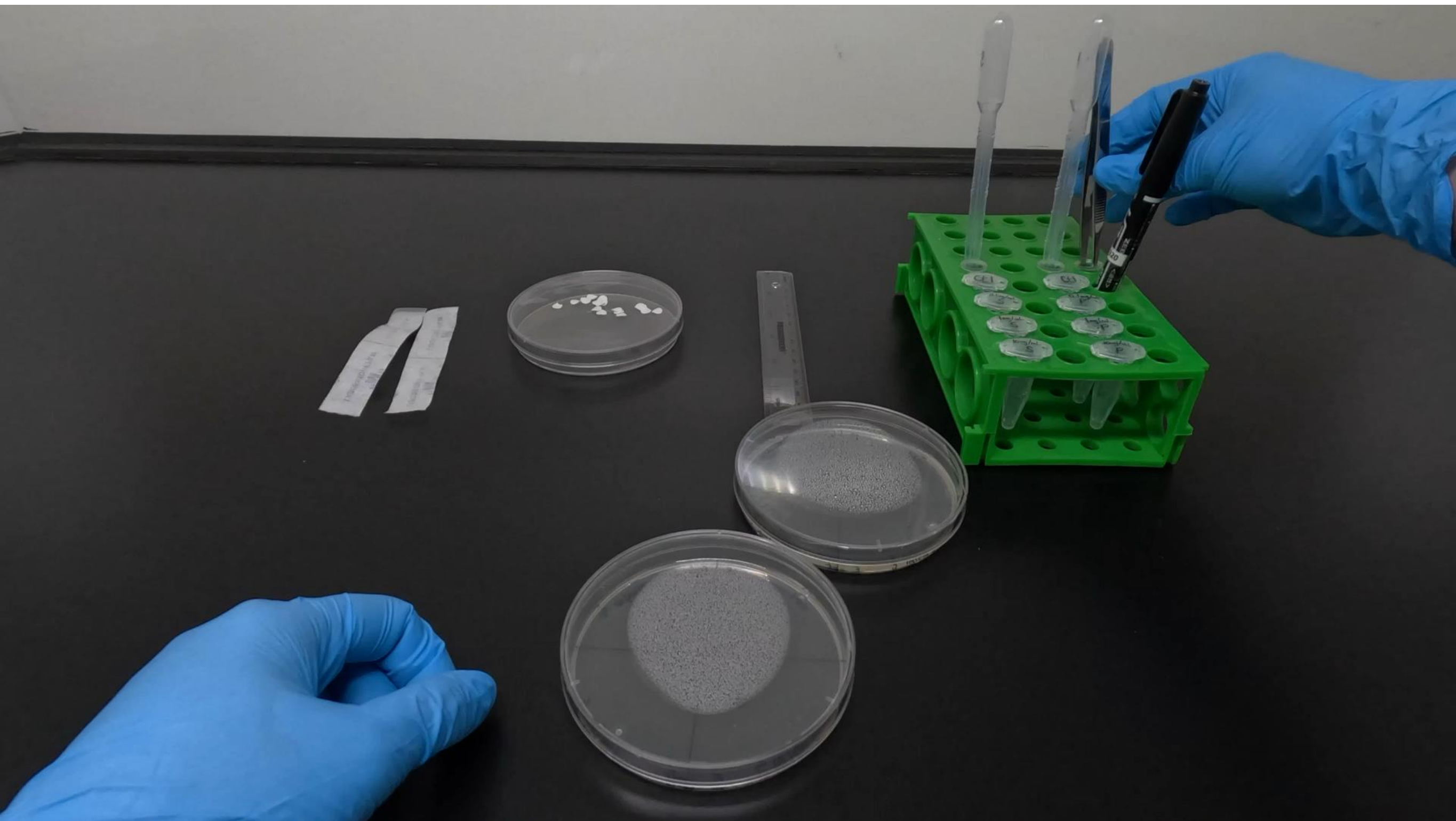
EFFECTIVENESS OF ANTIBIOTICS

*Step 2: Use a pair of forceps to transfer **1 paper disk** to each of the areas of the agar plate.*



EFFECTIVENESS OF ANTIBIOTICS

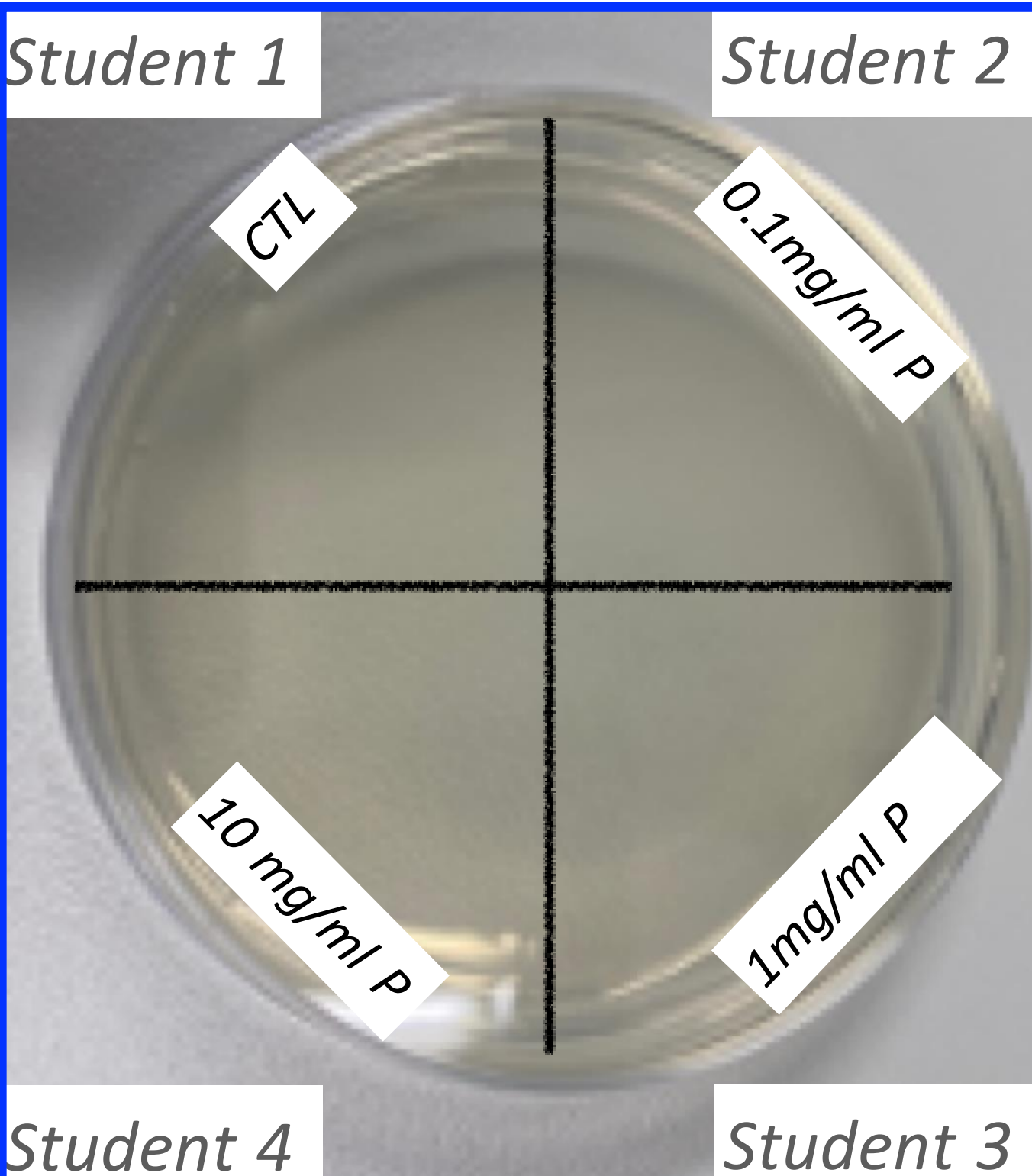
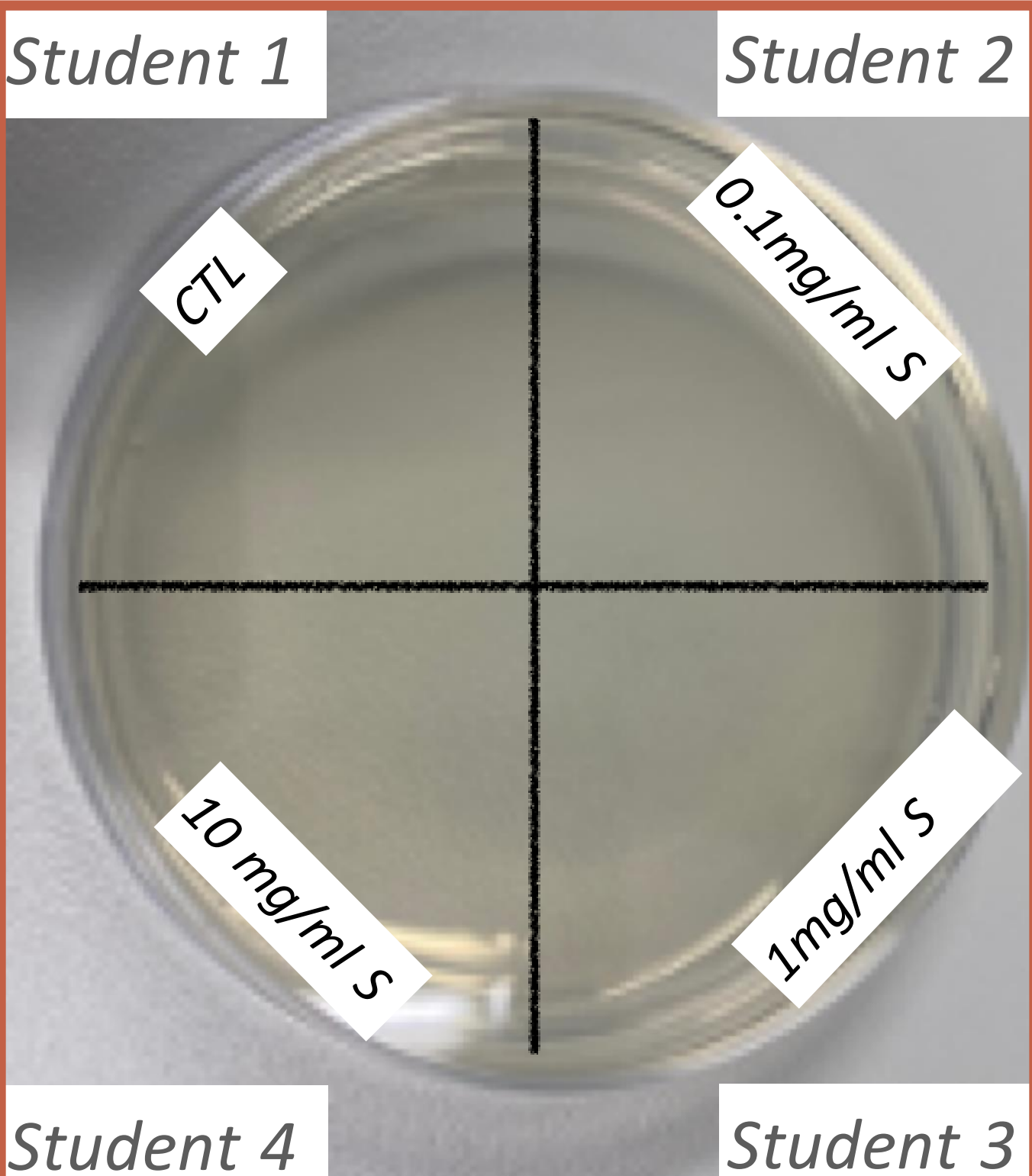
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EFFECTIVENESS OF ANTIBIOTICS

streptomycin

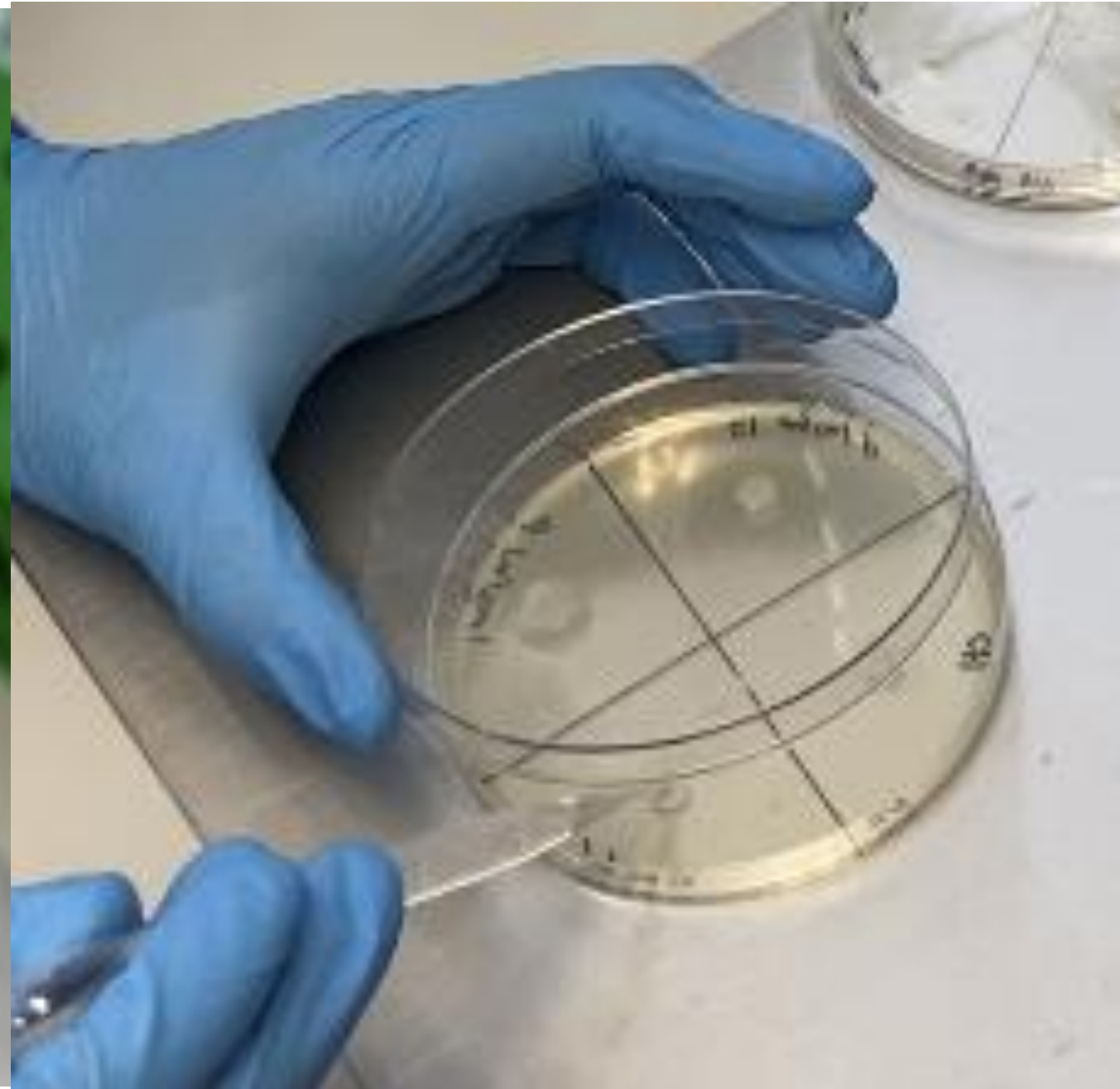
penicillin



EFFECTIVENESS OF ANTIBIOTICS

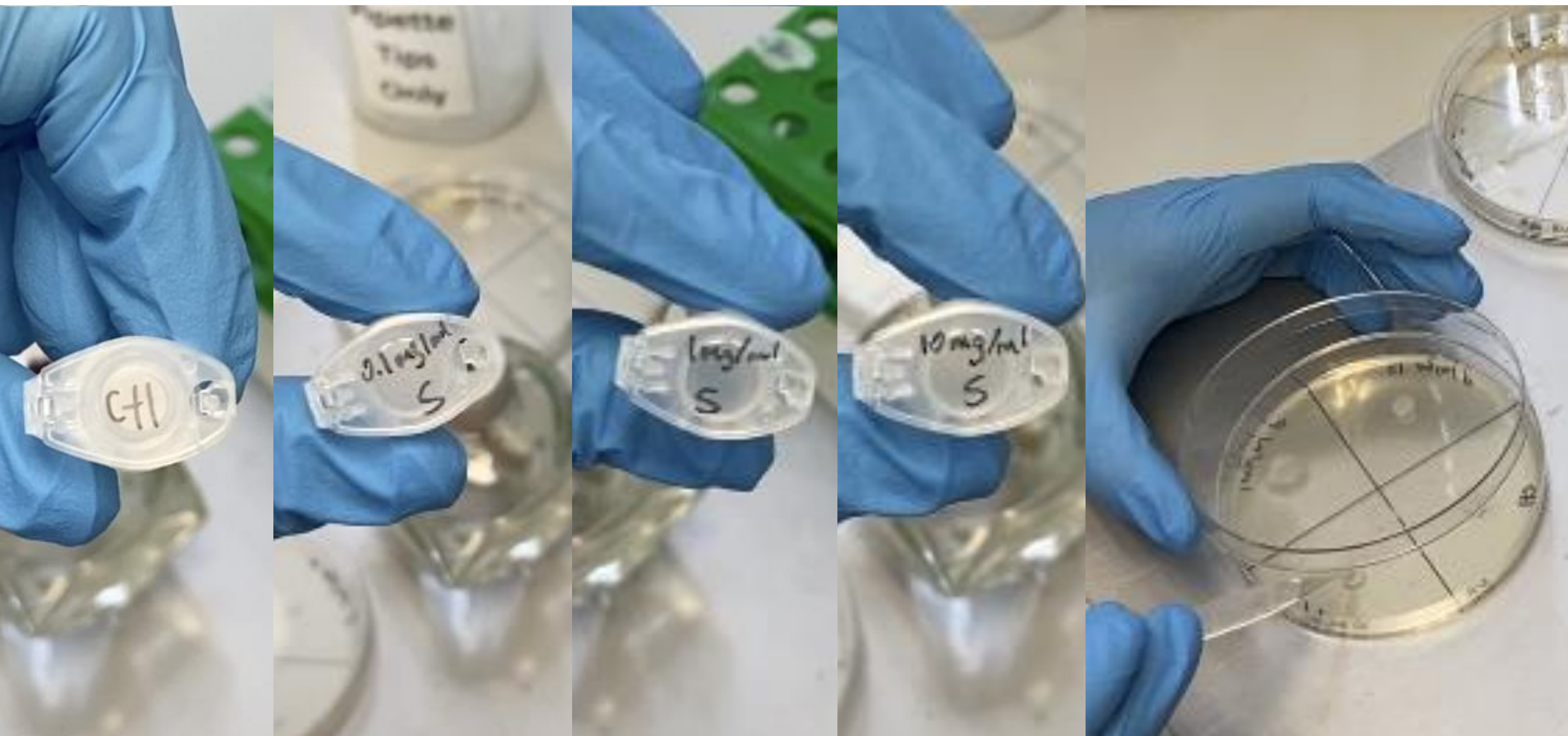
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Step 3:

Add a drop of water (Ctl) to the control disk with a dropper



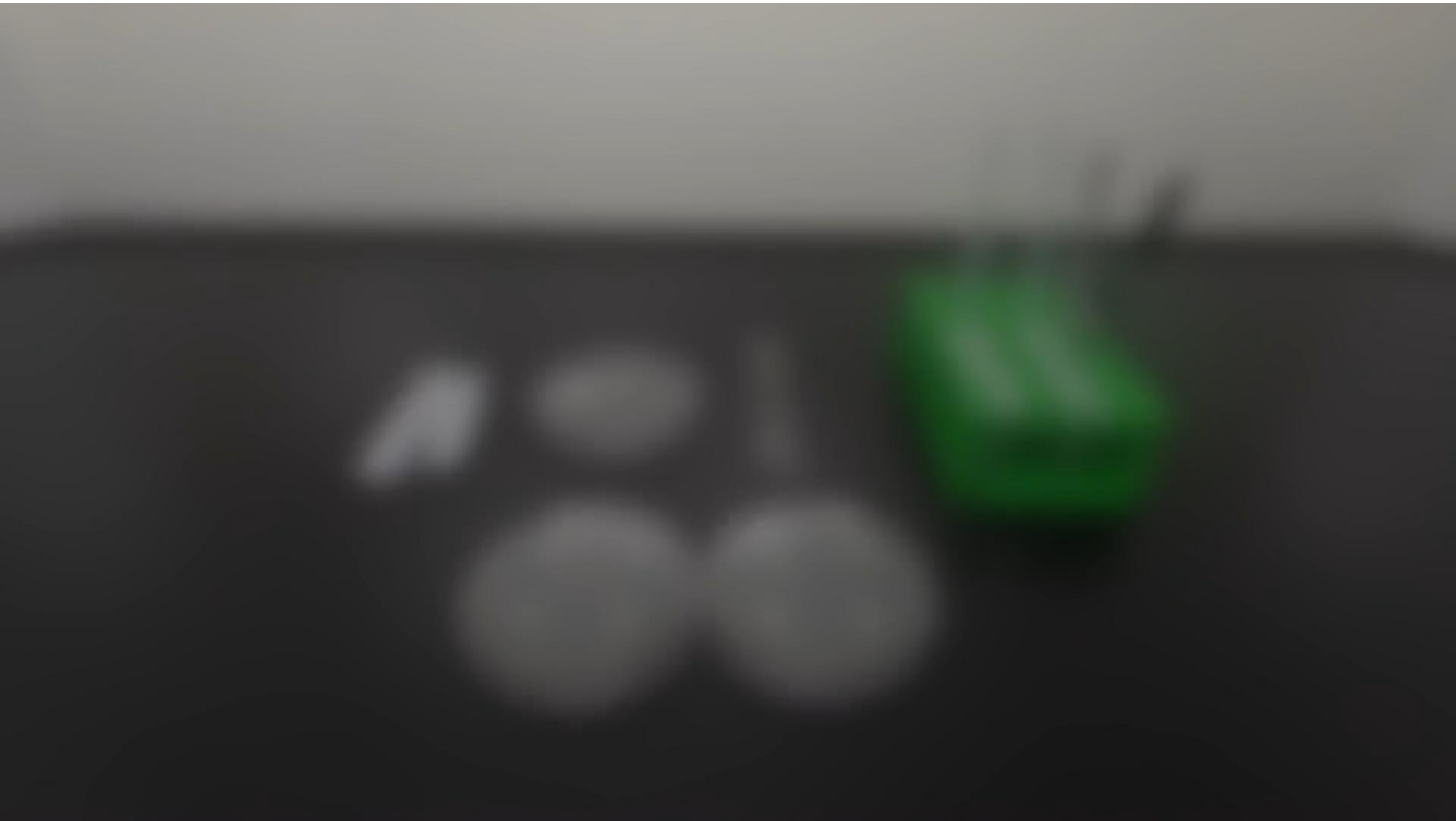
EFFECTIVENESS OF ANTIBIOTICS

*Step 4: Add 1 drop of **streptomycin** solution with different concentrations to the corresponding disk with a dropper*



EFFECTIVENESS OF ANTIBIOTICS

streptomycin



EFFECTIVENESS OF ANTIBIOTICS

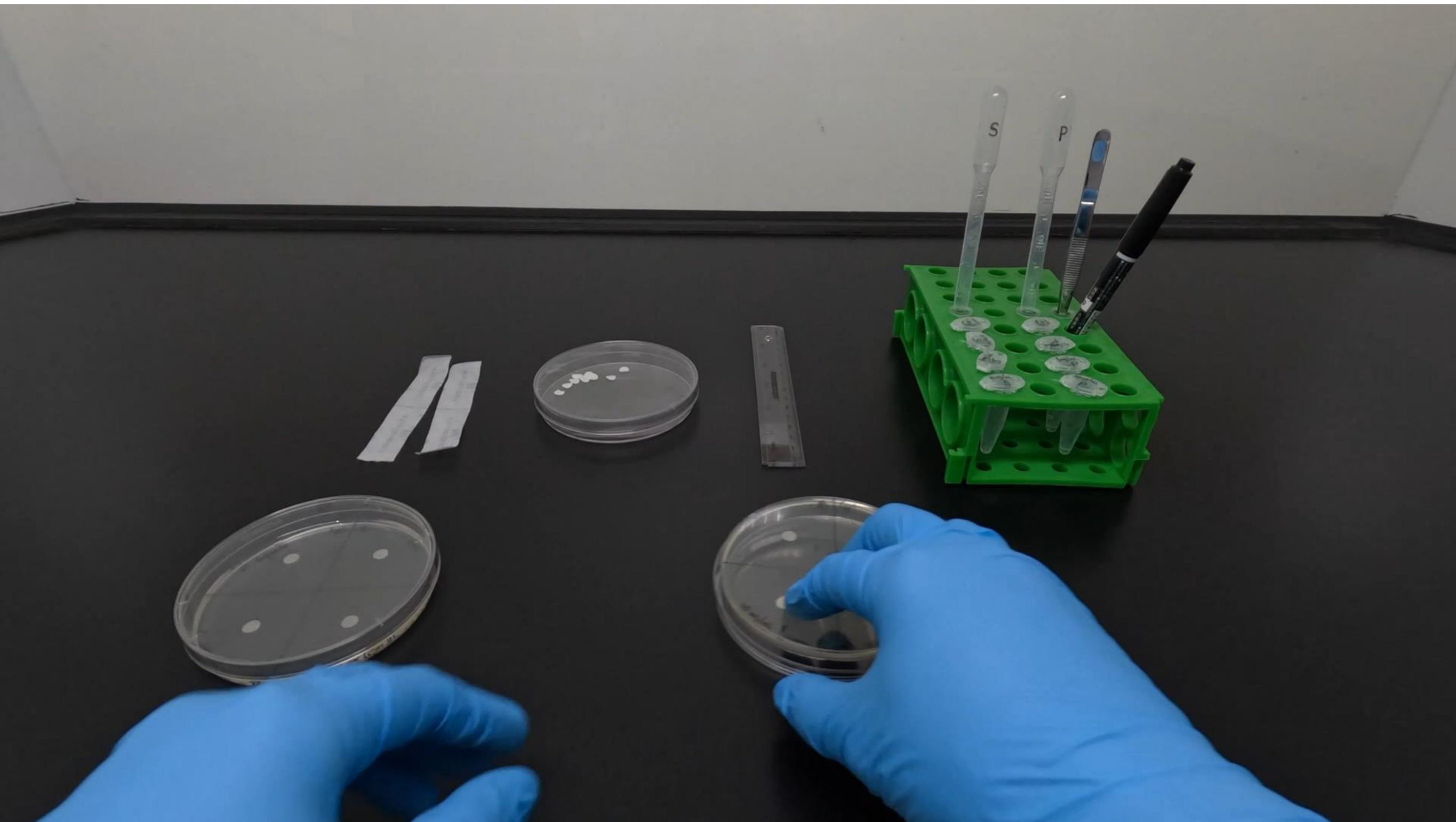
Step 5: Repeat with penicillin

*Add **1 drop** of **penicillin** solution with different concentrations to the corresponding disk with a dropper*



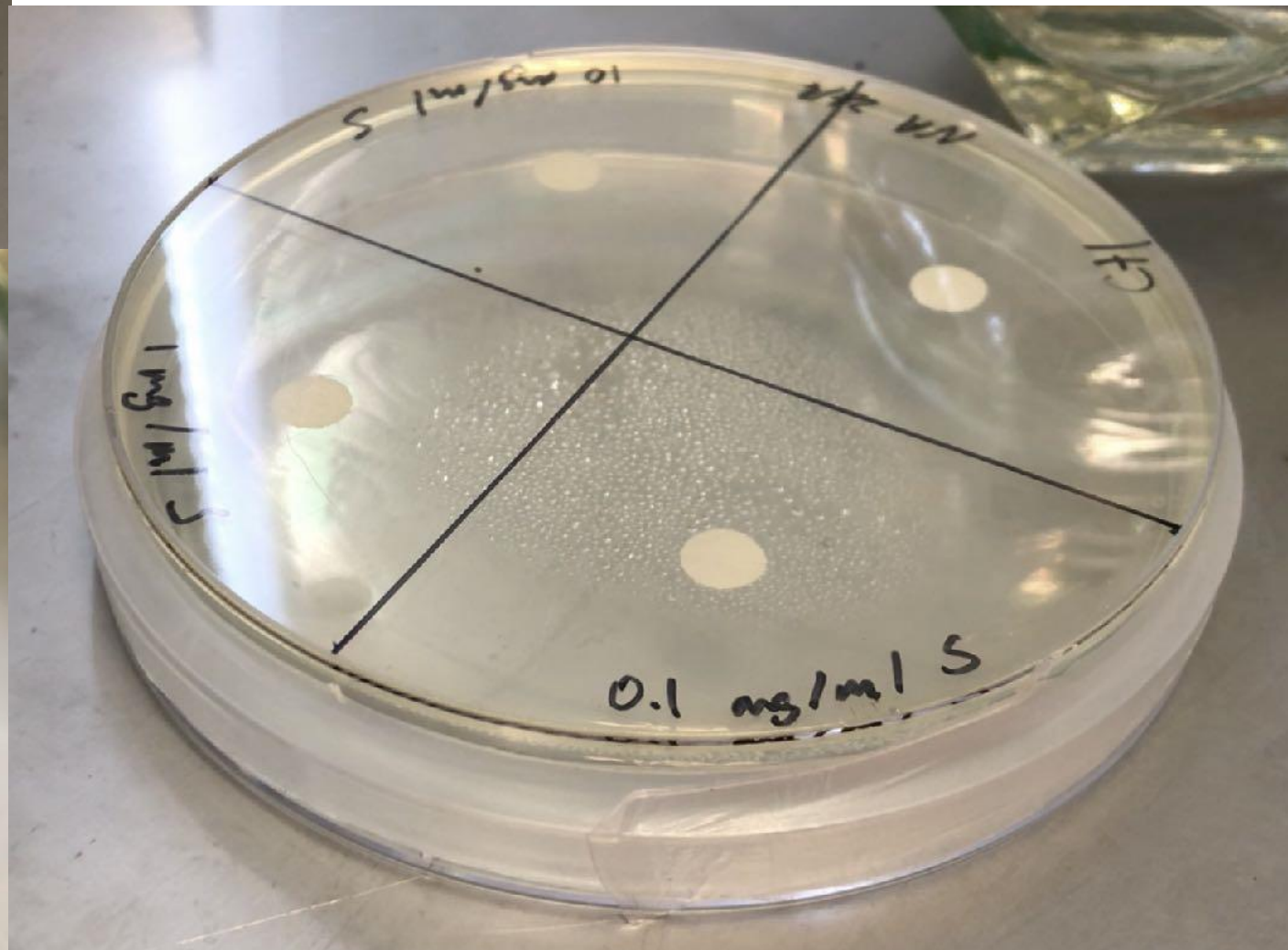
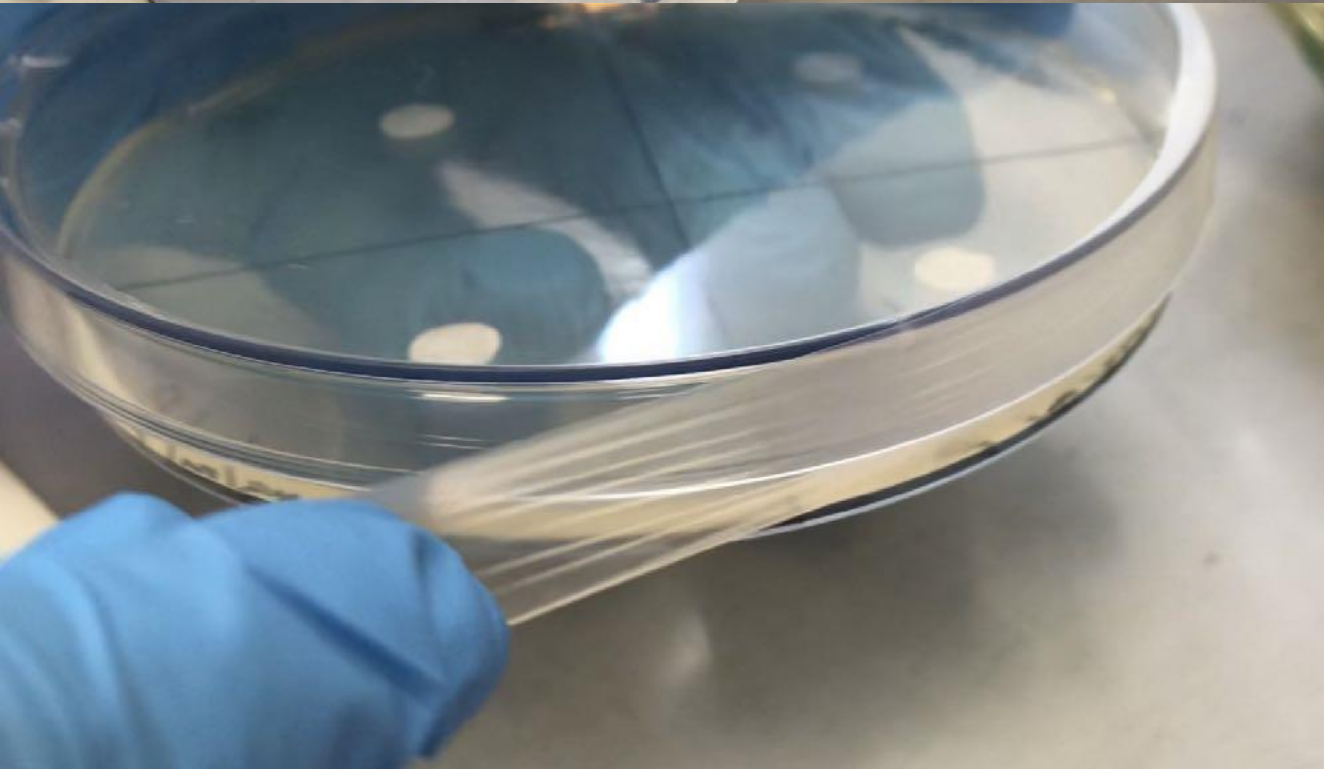
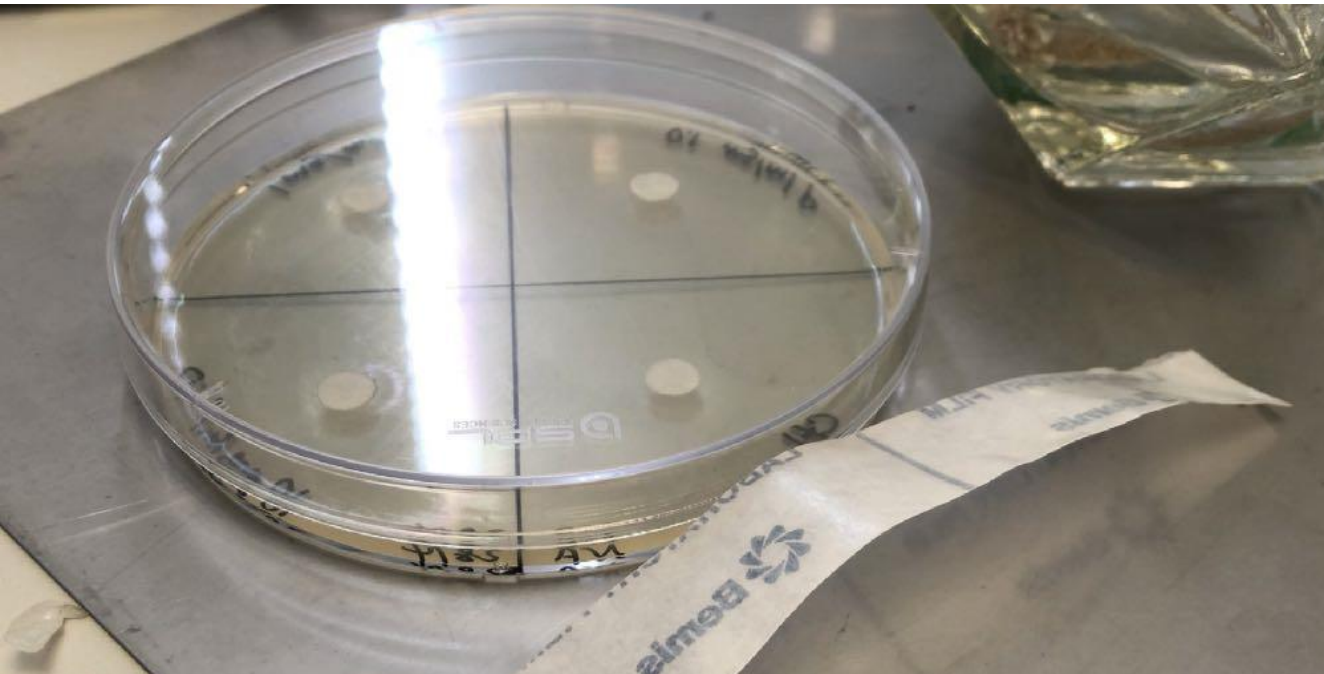
EFFECTIVENESS OF ANTIBIOTICS

Repeat with *penicillin*

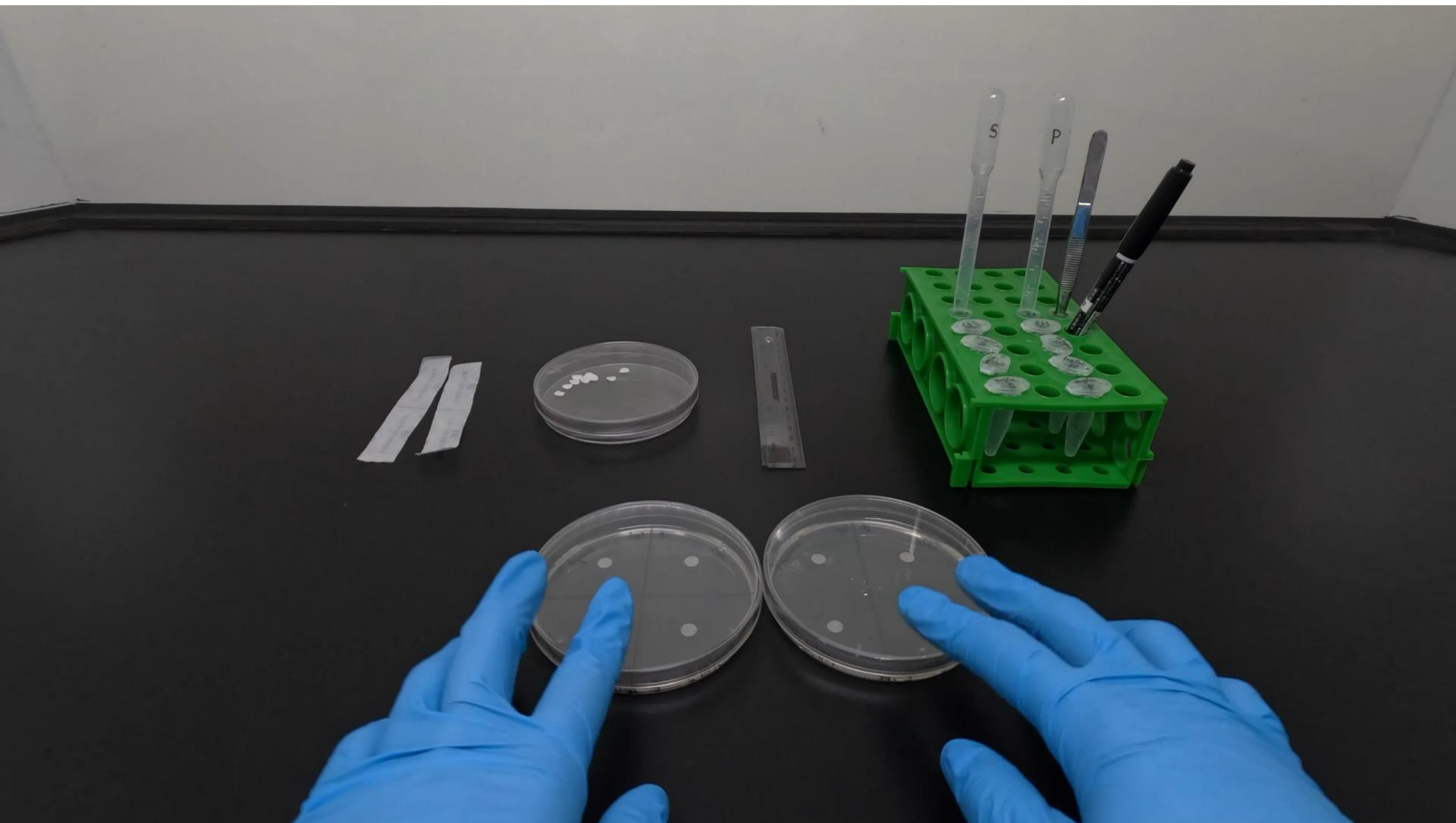


EFFECTIVENESS OF ANTIBIOTICS

Step 6: Wrap the plates with parafilm strips

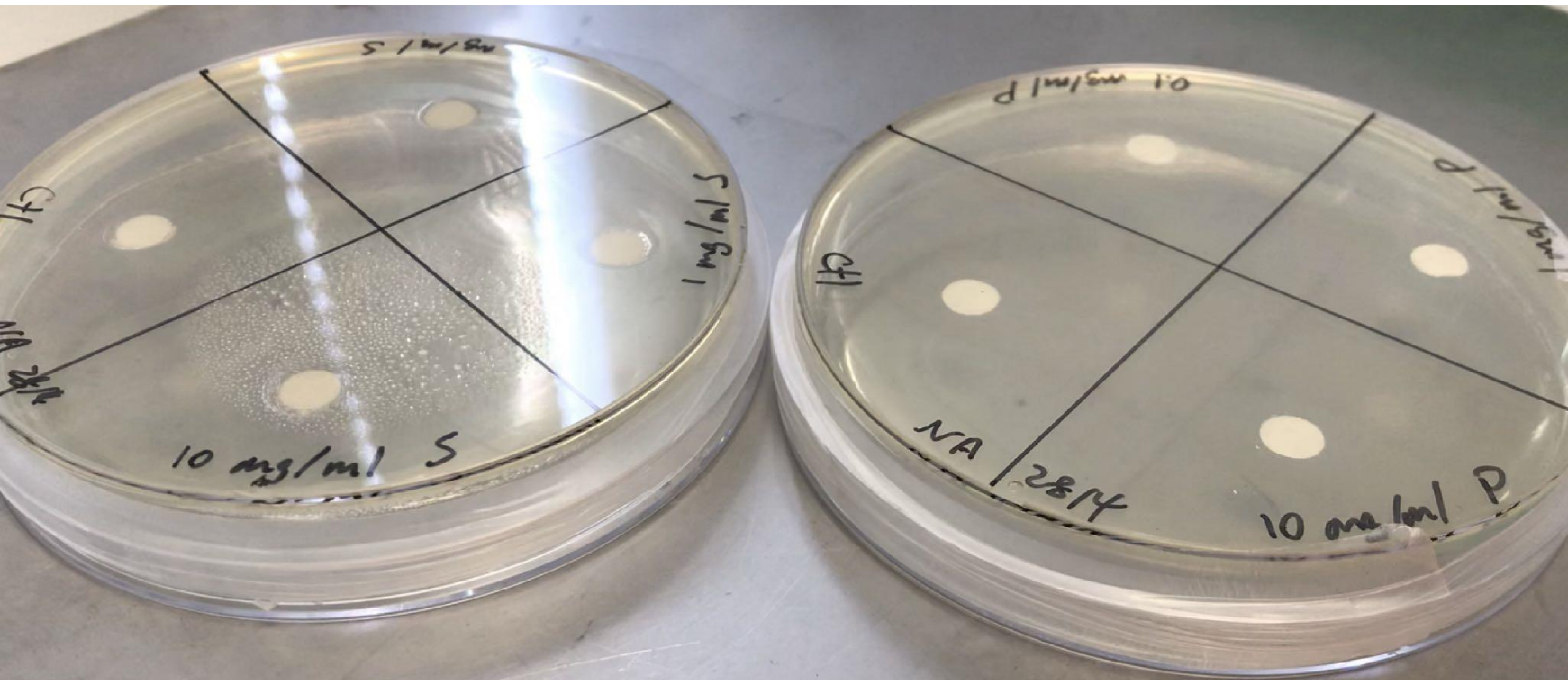


EFFECTIVENESS OF ANTIBIOTICS



EFFECTIVENESS OF ANTIBIOTICS

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EFFECTIVENESS OF ANTIBIOTICS

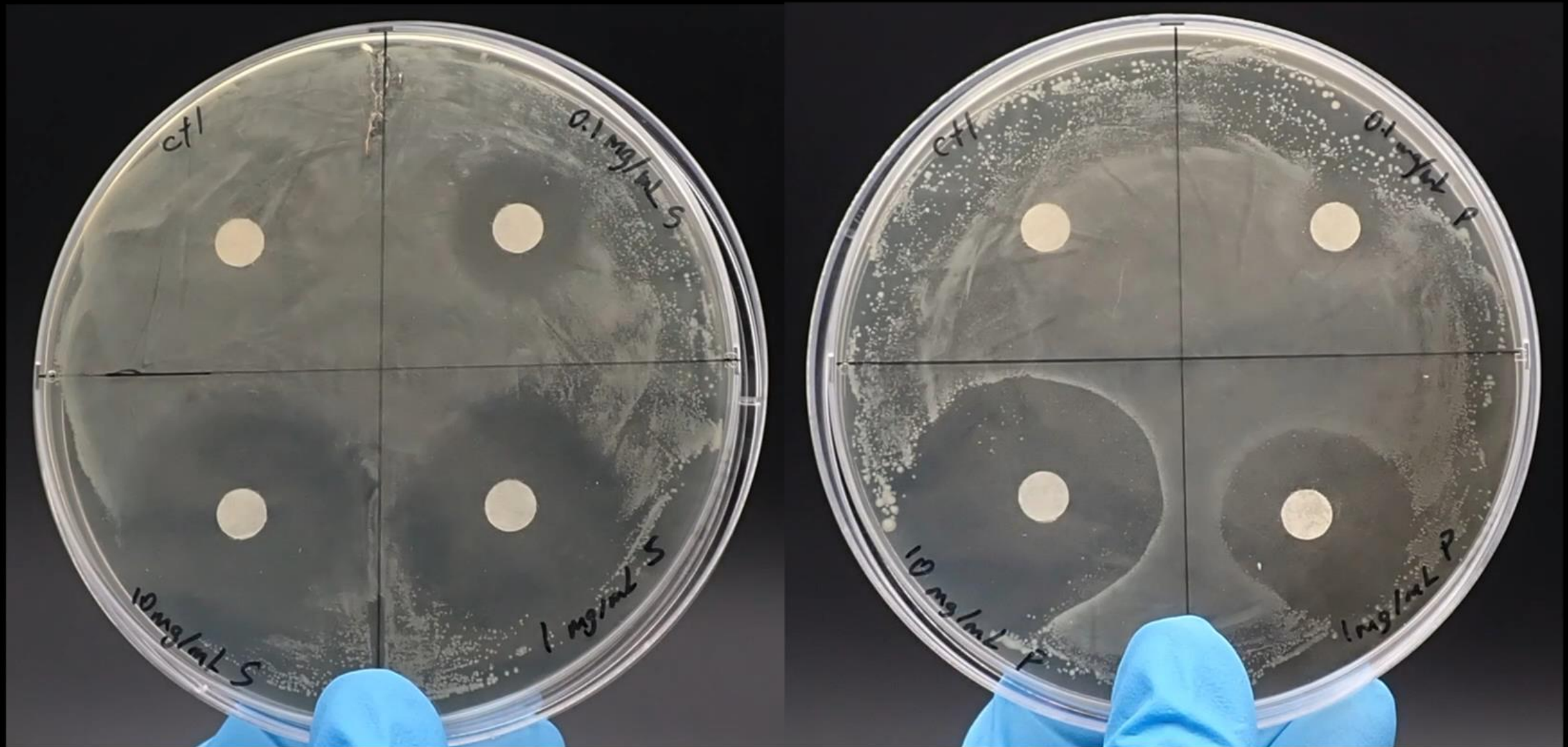
Step 7: Incubate at 30°C for 24 hours



OBSERVATION OF THE
RESULT WILL BE DONE
AT THE BEGINNING OF
THE NEXT LESSON

EFFECTIVENESS OF ANTIBIOTICS

Result



Experiment 2:
How the concentration of antibiotic
affects bacterial growth

Biotechnology Education Programme Learning and Teaching Resources
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