

Experience Sharing on Approach to Creating SBA Tasks and Guiding Questions

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TWO GOALS

- **Sharing what I learned from creating a new task from the ground up.**
- **Discussing concepts related to scientific inquiry terminology.”**



TASK SHARING

INVESTIGATING THE EFFECT OF NUTRIENT CONCENTRATION IN THE BACTERIAL CULTURE MEDIUM ON THE GROWTH OF *E. coli* AT DIFFERENT PH VALUES

Multiple IVs

1. Incubate *E. coli* cultures in LB broth under the following

conditions:

a. Nutrient concentrations: 50%, 100%, and 150% LB broth.

Practical skills

b. pH levels: acidic, neutral, and alkaline (9 combinations in total).

**Food preservation
as the context**

2. Incubate for 12 hours, 37°C.

3. Perform a 10-fold serial dilution of the cultures to find

4. Spread plate (with replicates).

5. Count the colonies.

**Quantitative
Data**

Scenario:

Escherichia coli, commonly known as *E. coli*, is a bacterium that can cause food poisoning. Although most *E. coli* strains are harmless, some pathogenic strains, such as *E. coli* O157:H7, can lead to foodborne illness in contaminated food. Symptoms in infected individuals include stomach pain, bloody diarrhoea, and vomiting.

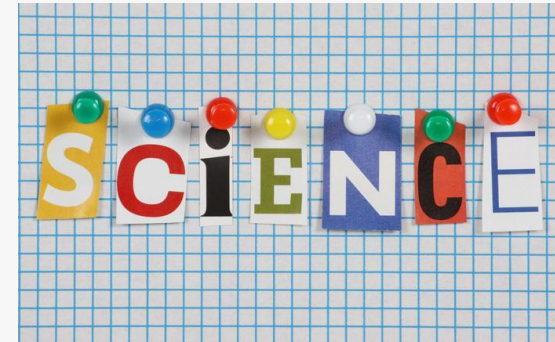
Pickling and marinating in lye water (鹼水) (alkaline in pH) are two common methods used to inhibit the growth of microorganisms. These methods work by altering the pH of the food. However, the growth of *E. coli* is also influenced by other factors, such as nutrient availability.

Steven would like to investigate the effect of nutrient concentration in the bacterial culture medium on the growth of *E. coli* at different pH values. Answer the following questions to help Steven design the investigation.

DESIGNING THE CONTEXT OF THE TASK



Focus on **solving a problem**/connecting with a problem.



Focus on **scientific inquiry skills** and experimental design, rather than just testing biology content.



Create scenarios that are relevant and **authentic** to students.



Provide students with opportunities to apply their scientific inquiry skills in **more complex experimental designs** and non-routine context.

CONTEXT SETTING WITH THE AID OF AI

I'm designing an investigatory task with students on studying how the nutrient concentration and pH of culture condition combine will affect the growth rate of *E. coli*. Give me 5 scenario examples that are related to daily life applications. Give me detail background.

GPT-4o Poe

Here are five detailed scenario examples, with background information, that relate to daily life applications for your investigatory task on how nutrient concentration and pH affect the growth rate of *E. coli*. These examples will help students connect their experimental work to real-world applications:

1. Food Spoilage and Preservation

Background: Food spoilage is a common problem in households and industries. The growth of bacteria like *E. coli* in food depends on factors such as nutrient availability and pH. Foods like milk, meat, and cooked vegetables provide ideal nutrient-rich conditions for bacterial growth, while acidic foods like vinegar, citrus fruits, or fermented products (e.g., pickles) inhibit bacterial proliferation due to low pH. Preserving food often involves limiting bacterial growth by reducing nutrient availability (e.g., drying or salting) or altering pH (e.g., acidification).

Scenario: Students investigate how nutrient concentrations (e.g., glucose or protein solutions mimicking food content) and pH levels (neutral vs. acidic) impact *E. coli* growth. This relates to understanding why acidic foods like pickles or yogurt resist spoilage and how nutrient-rich but neutral-pH foods like milk are more prone to contamination.

Application Question: Why do acidic foods like pickles or vinegar help preserve food, and how do nutrient-rich, neutral-pH foods become spoiled faster?

2. Water Contamination and Public Health

Background: *E. coli* contamination in water is a major public health concern, especially in developing areas or during flooding and natural disasters. Nutrient pollution from agricultural runoff (e.g., fertilizers or livestock waste) and industrial effluents can create conditions that promote bacterial growth. Additionally, pH changes in water due to pollutants can further influence bacterial survival and reproduction. Monitoring and controlling these factors is critical for ensuring safe drinking water.

Scenario: Students simulate water contamination by adjusting nutrient levels and pH in water samples to study *E. coli* growth. For example, they might mimic agricultural runoff by adding nutrients (e.g., nitrogen or phosphorus) and observing how pH variations (acidic or alkaline conditions) affect bacterial growth rates.

DESIGNING AREA A

ASSESSMENT RUBRICS

WITH THE AID OF AI

For this investigation, I'll ask students to use micropipette, carry out serial dilution 10X to 100-fold, aseptique technique, spread LB plates and colony counting. Can you make a rubrics, with basic, good, excellent level for me to assess student's practical skills? I want a total of 10 items to assess them.

ChatGPT-4o-Latest [Poe](#)

Here's a 10-item rubric designed to assess students' practical skills in your *E. coli* growth rate investigation. The rubric evaluates key aspects of the experiment, with criteria for **Basic**, **Good**, and **Excellent** levels of performance for each skill.

Rubric for Assessing Practical Skills

Skill	Basic (1 Point)	Good (2 Points)	Excellent (3 Points)
1. Micropipette Setup	Struggles with setting the correct volume or uses the wrong pipette for the task.	Sets the correct volume on the micropipette with minor assistance.	Accurately sets the correct volume on the micropipette with no assistance, demonstrating confidence and precision.
2. Pipetting Technique	Inconsistent pipetting (e.g., bubbles, incorrect angle, or incomplete volume).	Pipettes accurately most of the time but may make minor errors like inconsistent speed.	Consistently uses proper technique, including correct angle, smooth operation, and precise dispensing.
3. Serial Dilution	Incorrectly prepares dilutions or skips steps, leading to errors in concentrations.	Prepares serial dilutions with minor errors but achieves mostly correct concentrations.	Prepares serial dilutions accurately, following the 10x/100-fold dilution steps with clear labeling and precision.
4. Aseptic	Frequently contaminates tools	Demonstrates aseptic technique	Maintains perfect aseptic technique, including proper

MY APPROACH TO DESIGNING TASK SHEETS



- Refer to the **Assessment Guidelines** and review each guiding question individually to ensure the investigation aligns with the required criteria.
- Aim to cover as many categories [e.g., variables, measurements] as **possible, marking the criterion** numbers to help keep track.
- Include **sufficient and balanced number** of G/E questions
- Focus questions on **experimental design** rather than general biological principles only.
- Ensure questions are directly related to the investigation, **avoiding general or “canned” questions.**



THINGS I LEARNED...

Assessing the **same** concept while providing sufficient structure to help students express their understanding related to **Gs** and **Es**.

Complete the following table to help Steven identify the independent variable(s) and important control variables in this investigation. (Put a '✓' into the appropriate box(es))

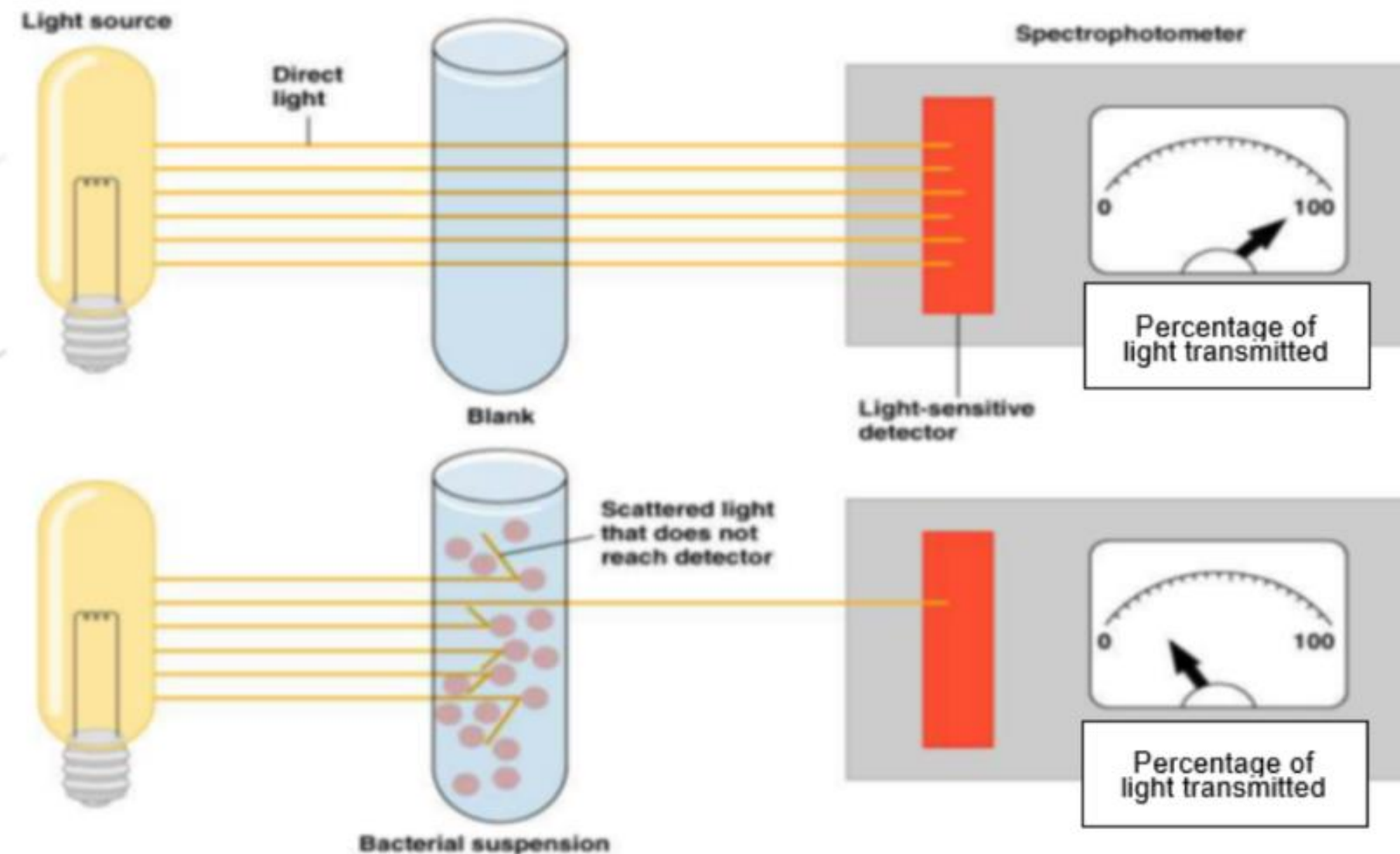
G5: U ☐ B ☐ G ☐ G7: U ☐ B ☐ G ☐

<i>Variable</i>	Independent variable	Control variable
• pH of the bacterial culture medium		
• Brand of the bacterial culture tube		
• Temperature for incubating the bacterial culture		
• Concentration of nutrients in the bacterial culture medium		
• Strains of the bacteria		
• Time to incubate the bacterial culture		

G5. Identify multiple IV/DVs

G7. Identify important CVs/describe how these CVs can be controlled.

Steven wanted to use a spectrophotometer to measure the turbidity of the bacterial culture as the dependent variable. The following shows how the spectrophotometer works:



(1) How can the above measurement method be used to measure the dependent variable?

G6: U ☐ B ☐ G ☐

(2) What is the limitation of using this method to measure the dependent variable?

E3: U ☐ B ☐ G ☐ E ☐

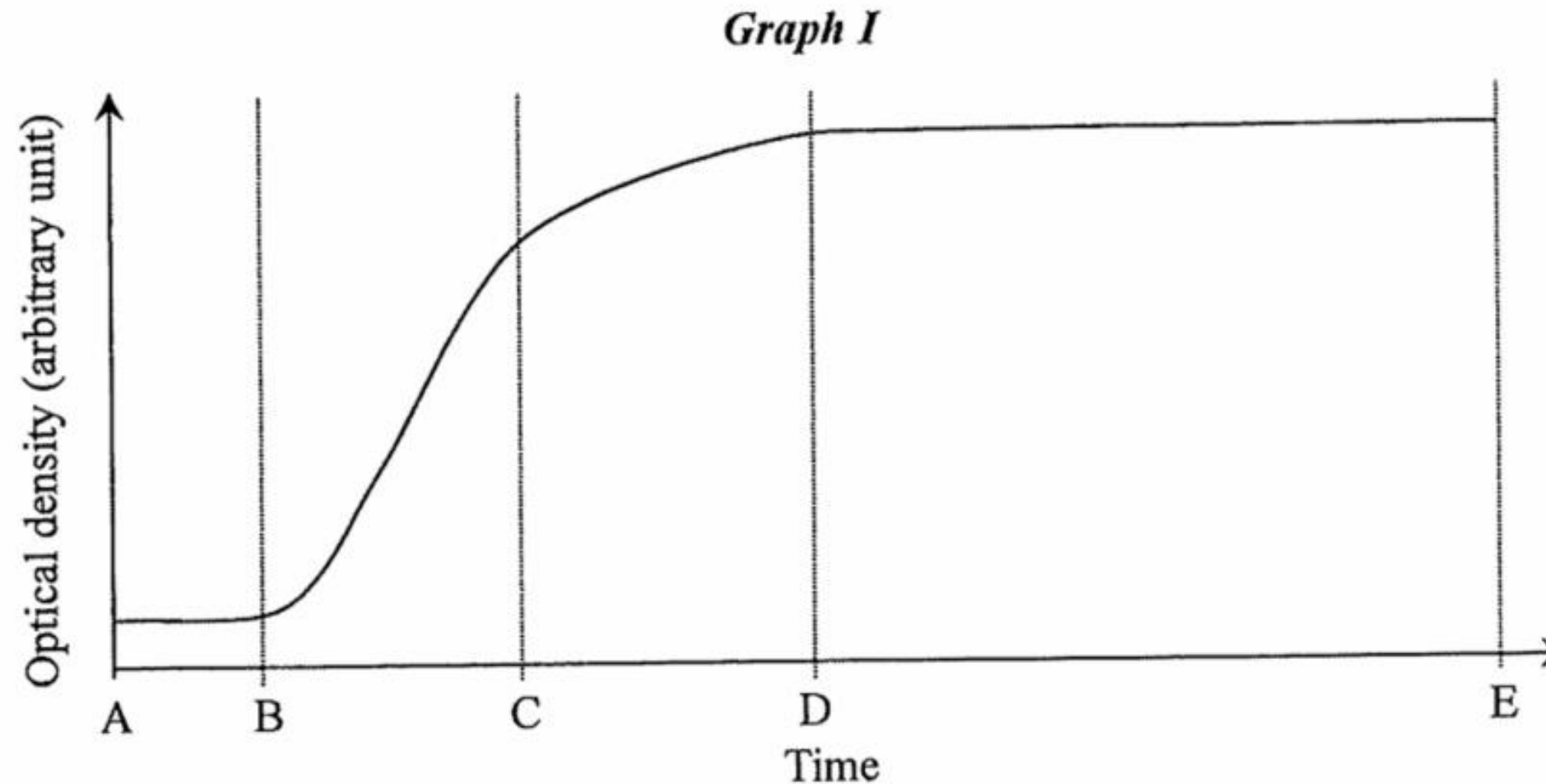
Using visual aids to help students understand unfamiliar scenarios.

G6. Explain how variables are connected with the manipulation(s) and measurement(s)

E3. Explain the limitations related to the manipulation/measurement method(s)/ instrument(s) for the variable(s)

HKDSE 2023 Paper 2 Section C 3(b)

- 3(b) The growth of a bacterial culture was monitored by measuring the turbidity of the culture in terms of optical density. The results are shown in the Graph I below:



- (i) What are the characteristics of the stationary phase of bacterial growth? (2 marks)
- (ii) With reference to the principle of optical density measurement, explain why CD is the stationary phase instead of DE with supporting evidence from the graph. (3 marks)
- (iii) With reference to the principle of optical density measurement, explain why the bacterial culture should be mixed well before measuring the optical density. (2 marks)

ONE MAJOR CHALLENGE IN SETTING QUESTIONS

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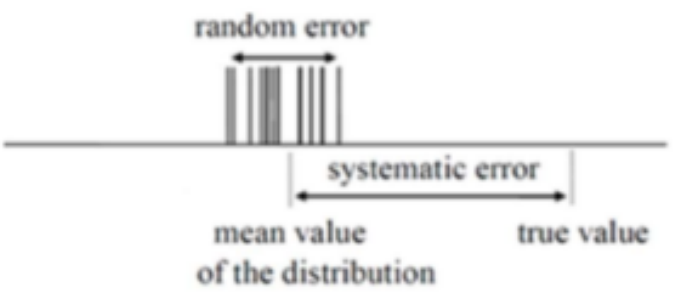
A common question concerns the confusion surrounding scientific terminology in the assessment guidelines.

		...al design is related ...derlying biological ...principles and/or concepts	
	G2. State the predicted results based on the hypothesis	E1. Elaborate how the predicted results give does not give support to the hypothesis	
	G3. Identify errors/issues related to the sampling method(s) and a small sample size	E2. Suggest and explain ways to reduce sampling errors (e.g., random sampling) and average out effect of variations within a sample (e.g., increasing sample size)	
	Identify the DV and IV	G4. Explain why the variables are DV and IV in the investigation	
		G5. Identify multiple IV/DVs	
	B4. State the methods of measurement(s)/manipulation(s)	G6. Explain how variables are connected with the manipulation(s) and measurement(s)	E3. Explain the limitations related to the manipulation/measurement method(s)/ instrument(s) for the variable(s)
			E4. Discuss the strengths and limitations of the alternative measurement method(s)
	B5. State the predicted results based on the relationship(s) between the variables		
	B6. Identify some CVs	G7. Identify important CVs	E5. Explain why some important CVs need to be controlled
(CV)	B7. Identify the control set-up(s)	G8. Explain why the control set-up(s) (e.g., multiple control set-ups in some investigations) is/are needed	E6. Discuss the limitations of the control set-up(s)
	B8. Identify important measurement errors	G9. Suggest ways to reduce measurement errors (e.g., using an instrument with a higher sensitivity)/enhance reliability (e.g., repeated measurements, using different measurement methods/instruments)	E7. Explain why some procedures can reduce measurement errors (e.g., repeated/averaging measurements for reducing random errors, calibration for reducing systematic errors, involving multiple observers to minimize individual bias, choosing an instrument that has a higher sensitivity to reduce measurement errors)
			E8. Identify the significant assumptions of the design
		G10. Explain why a specific step is conducted and its impact on the validity and reliability of the experimental design	E9. Discuss design decision(s) related to/ evaluate the overall validity and reliability of the experimental design
		G11. Suggest alternative designs	E10. Discuss the limitations and strengths of alternative designs (e.g., achieving the same investigation aim using different designs, within subject and between subject)

Science (Secondary 1-3) Curriculum Framework (Consultation Draft)

Glossary

Part I : Scientific Investigation

<u>Term</u>	<u>Description</u>
Control experiment	An experiment which compares two setups (i.e., experimental setup and control setup) that have all the influencing factors identical except one.
Control variable	Variable to be kept constant between the experimental and control groups.
Dependent variable	Variable which is being measured or observed in an experiment.
Hypothesis	A statement testable by scientific investigation that describes or explains an observed phenomenon.
Independent variable	Variable which is being changed in an experiment.
Significant figure	For representing the accuracy of a measurement.
Source of error	<p>Some examples include: (i.e. systematic error / random error)</p> <p>(a) Reading error – Taking measurements with quantities smaller than half of the limit of reading</p> <p>(b) Zero error – The measurement error incurred when adjusting of zero reading is not performed</p> <p>(c) Human error – Caused by flaws or mistakes in the investigation (e.g. parallax error)</p> 

Part II : Scientific Measurement

<u>Term</u>	<u>Description</u>
Accuracy	The closeness of agreement between a measured value to the true value or the reference value.
Error / Uncertainty	The difference between a measured value and the true value for a measurement to be conducted.
Extrapolation	Estimation of the value of one variable on a graph using a line of best fit that is extended beyond the range of the available data.
Interpolation	Estimation of the value of one variable on a graph using a line of best fit within the range of the available data.
Limit of reading	The smallest division on the scale of an instrument.
Outlier	A value in a set of results that differ significantly from the observed trends.
Precision	The closeness of agreement between measured values obtained by repeated measurements.
Random error	Random error result from unknown and unpredicted variations in experimental situations. The effect of random error can be reduced by improving experimental techniques and repeating measurement a sufficient number of times.
Reliability	The degree of consistency in scientific measurements.
Repeatability	Precision obtained when measurement results are produced by the same student group using the same sets of equipment.
Reproducibility	Precision obtained when measurement results are produced by a different student group or different sets of equipment.
Systematic error	Systematic error cause all measurements to be shifted systematically in one direction. They cannot be reduced by taking repeated measurements.

Accuracy vs Precision vs Reliability

Accuracy

The closeness of agreement between a measured quantity and a **true value** of the measure (**Correctness**).

Precision

- A measurement is 'precise' if values cluster closely (**Consistency**).
- Depends only on the extent of random effects – no indication of how close results are to the true value (i.e., accuracy).

Reliability

- A general concept that can be applied to an **individual measurement** or a **whole investigation**.
- Reliability depends on **precision**, **repeatability** and **reproducibility**.

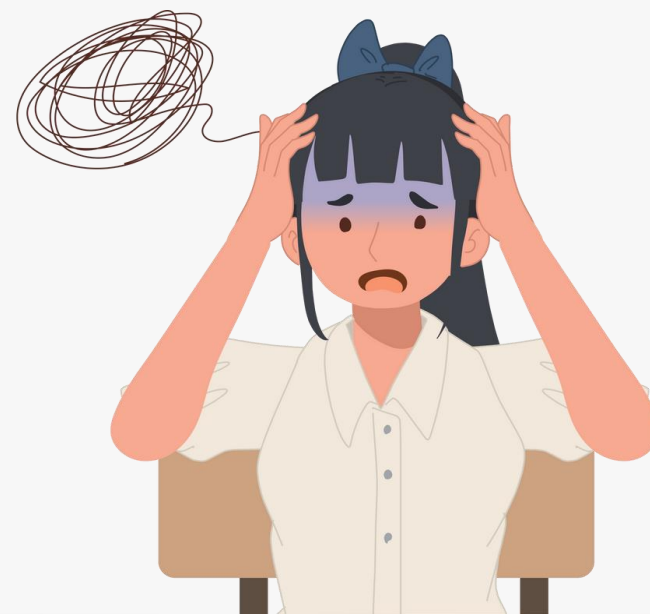


Figure obtained from: Professor Dave Explains.
(2018). *[Accuracy and Precision for Data Collection]*.
YouTube.
<https://www.youtube.com/watch?v=EeHtK5UYEMM>

ONE MAJOR LEARNING DIFFICULTY OF MY STUDENTS

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I'm able to identify which method/design is more accurate, but struggle to explain *why*.



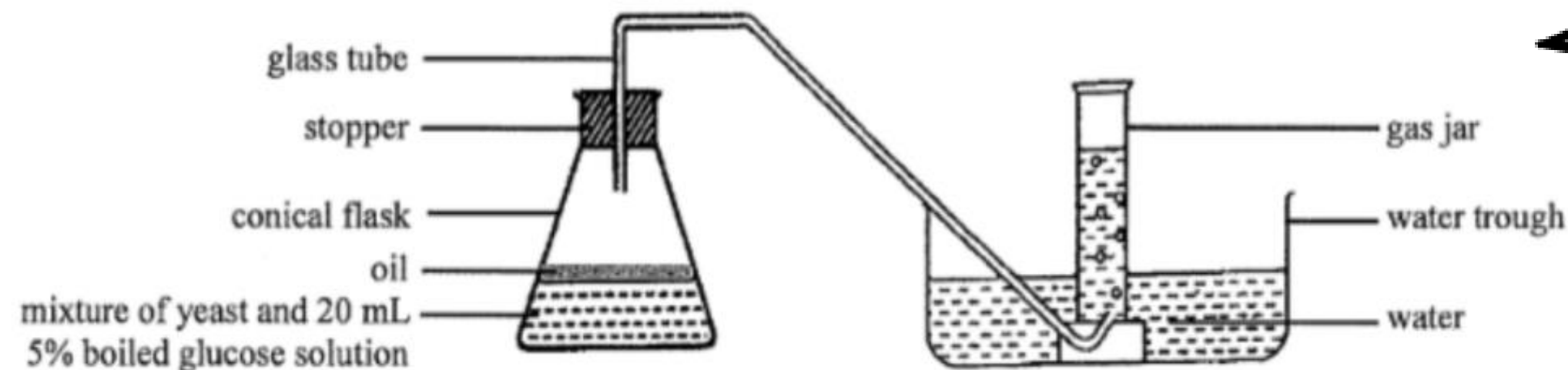
FACTORS AFFECTING ACCURACY IN AN INVESTIGATION

Category	Details
Choice of Measurement Method	<ul style="list-style-type: none">• Resolution of the tool: Analog vs Digital• Subjective: Color change vs Objective: Precise measurements• Qualitative: Descriptive data vs Quantitative: Numerical data
Properly Calibrated Instrument	<ul style="list-style-type: none">• Setting zero• Using standard reference
Experimenter's Skill and Technique	<ul style="list-style-type: none">• Reading the scale horizontally• Reading at the meniscus
Eliminating or Minimising Error	<ul style="list-style-type: none">• Reducing systematic error (e.g., bias)• Reducing the impact of random errors
Choice of Range and Interval	<ul style="list-style-type: none">• Considerations during interpolation or extrapolation

HKDSE 2023 Paper 1A 8.

Correct rate: (67%)

Directions: Questions 7 and 8 refer to the diagram below, which shows a set-up used to investigate the rate of respiration in yeast:



8. Which of the following modifications about the set-up can improve the accuracy of the experiment?

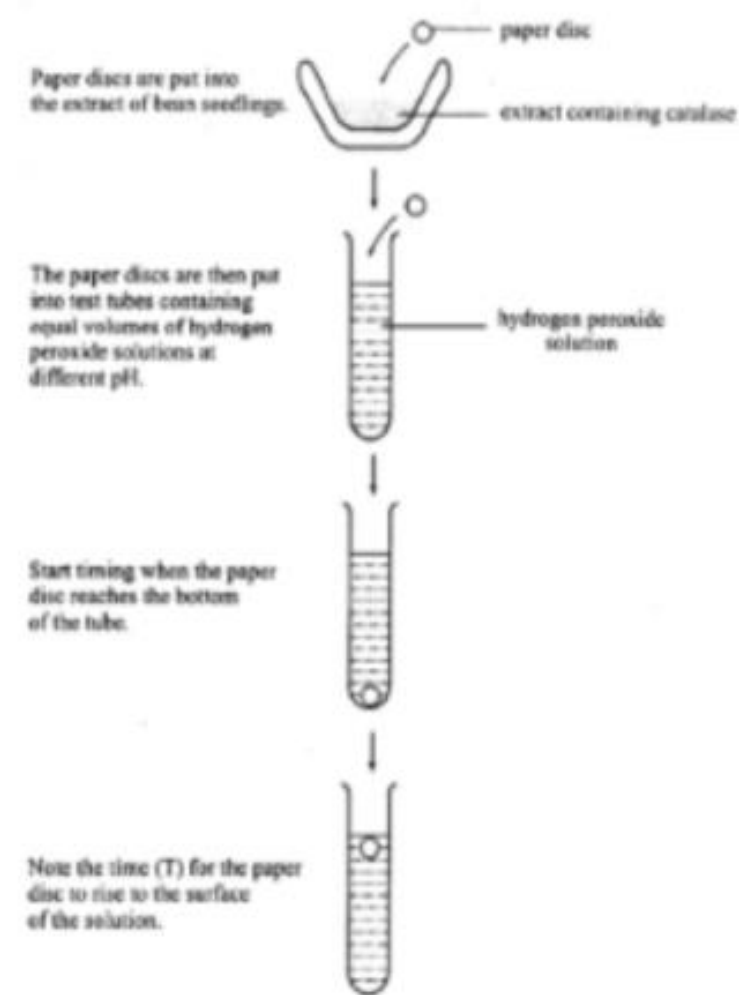
- A. use a measuring cylinder instead of a gas jar
- B. use a larger conical flask to contain the mixture
- C. use a glass tube with a smaller internal diameter
- D. use 30 mL instead of 20 mL of 5% boiled glucose solution

Answer: A

- Selection of measurement tool
- **Subjective** measurements (e.g., estimating “more or less gas”) can be made **objective** with numeric measurements.
- **Qualitative** observations can be transformed into **quantitative** data.

HKCEE 2003 Paper 1 Q.3b(ii)

3. (b) The following shows the procedure of an experiment to study the effect of pH on the activity of catalase extracted from bean seedling :

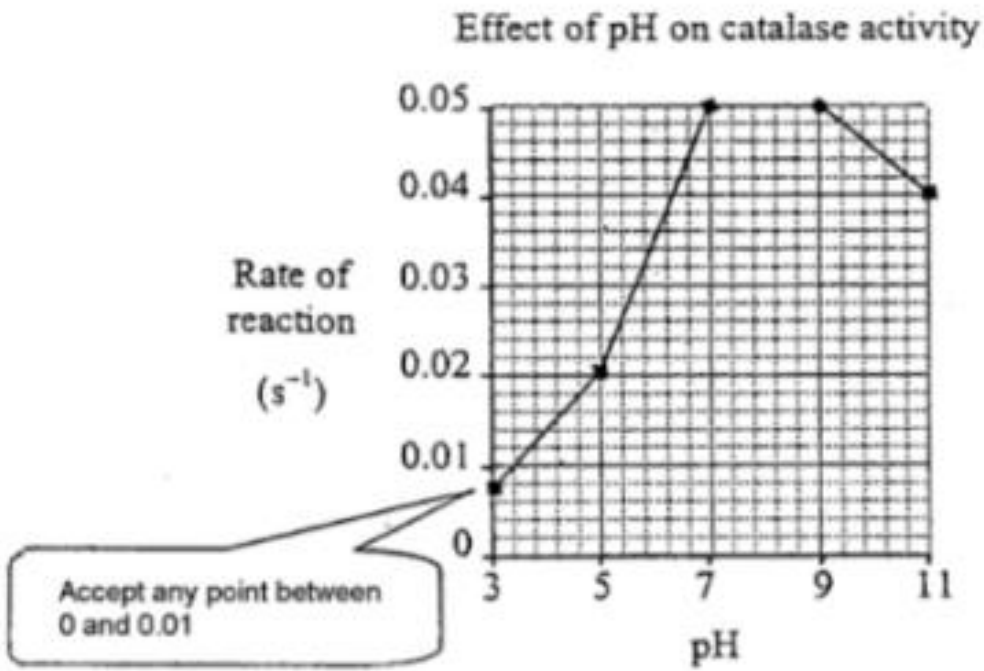


The results of the experiment are shown below :

pH of hydrogen peroxide solution	T (s)
3	>100
5	50
7	20
9	20
11	27

- (iii) (1) Based on your graph, estimate the optimum pH of catalase. (1)
- (2) In order to get a more accurate estimate of the optimum pH, what further work would you carry out in this experiment? (1)

(2)

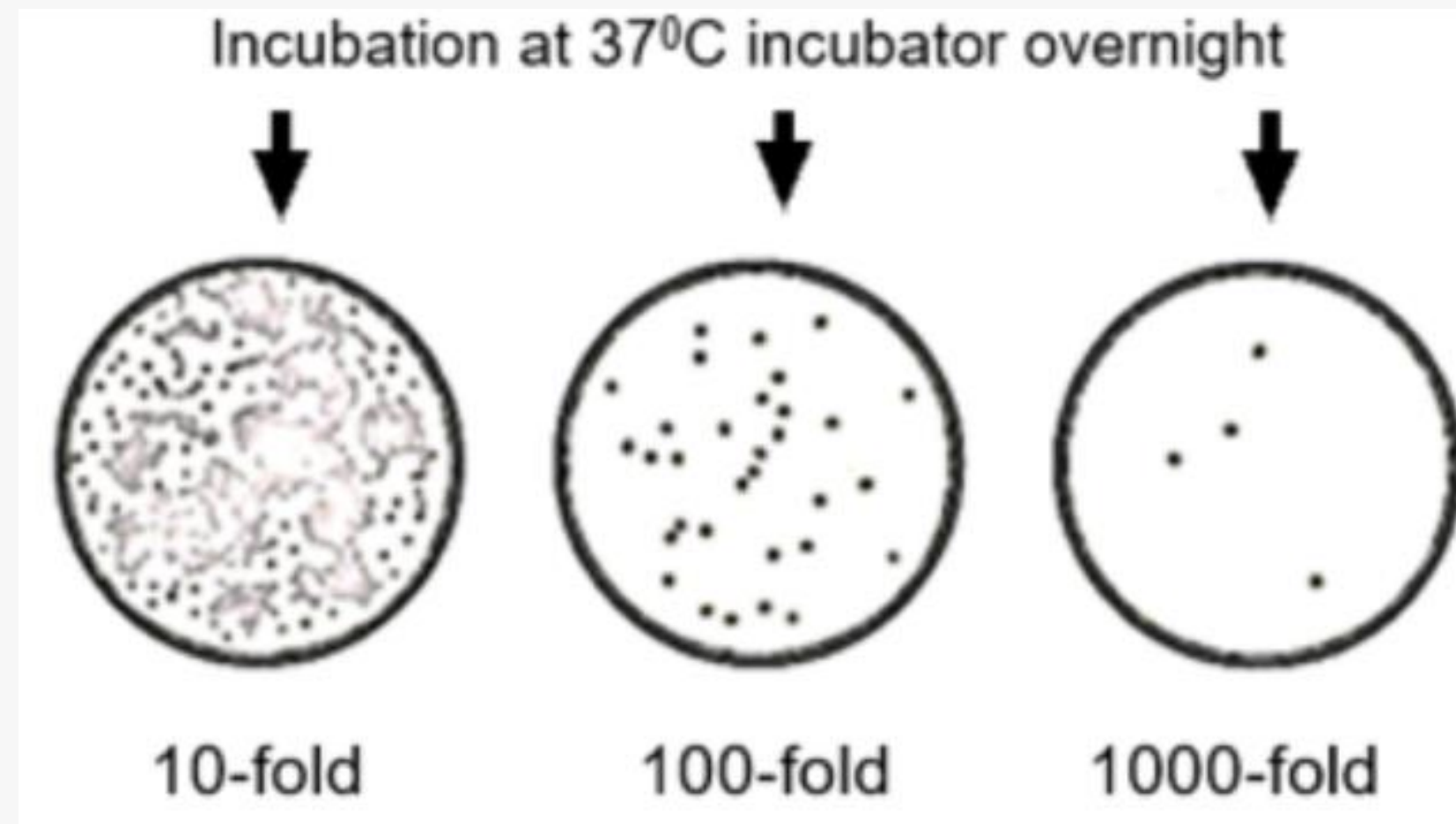


Title ($\frac{1}{2}$)
Correct choice of axes ($\frac{1}{2}$)
Correct labeling of axes with units ($\frac{1}{2}, \frac{1}{2}$)
Correct plotting and joining of points (1)

- (iii) (1) any value between 1 and 9 / any value read from the graph drawn 1
- (2) Repeat the experiment using hydrogen peroxide with smaller pH intervals between 7 and 9 1

Choice of range and interval for interpolation

Microbiology Task Sheet Example Question B1 (d)(2)



**Minimising error
(Percentage error)**

- (2) Which dilution (10-fold, 100-fold or 1000-fold dilutions) should Steven choose such that he could measure the dependent variable accurately? Explain your answer.

E7: U ☐ B ☐ G ☐ E ☐

E7. Explain why some procedures can reduce measurement errors

PRECISION VS RELIABILITY

Precision

- The degree of closeness of measurements (the consistency).

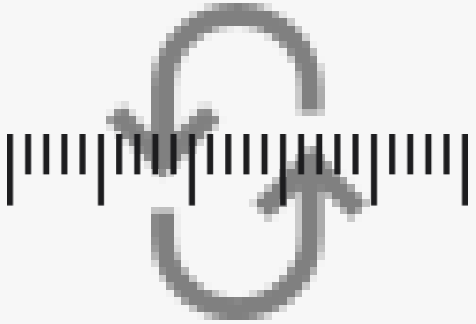
Reliability

- Can be applied to an individual measurement (**Precision**), a whole investigation by the same group and condition (**Repeatability**), or by other groups (**Reproducibility**).
- Reliability depends on **precision**, **repeatability** and **reproducibility**.

An experimental result can be precise when produced by one experimenter, yet it may not be reproducible by another experimenter, hence not reliable.

FACTORS AFFECTING RELIABILITY

Precision



Consistency of measurement results **within the same experiment.**



Repeatability

Precision obtained when measurement results are produced in **one laboratory, by a single operator**, using the **same equipment** under **same conditions**, over a short time scale.

Reproducibility



- Precision obtained when measurement results are produced by **different laboratories** (and therefore by **different operators** using **different pieces of equipment**).
- Assessing reproducibility makes it easier to **identify systematic errors.**

Date: Monday
Experimenter: Paul
Lab: Bio Lab

H2O2 concentration (%)	Oxygen collected after 5 minutes (cm3)			
	Trial 1	Trial 2	Trial 3	Mean
1				
2	2.85	3.11	3	2.99
3	3.51	3.48	3.49	3.49
4	5.29	5.32	5.3	5.30
5	7.00	6.75	6.81	6.85

Precise result (consistent values)

Repeatable
(high repeatability)

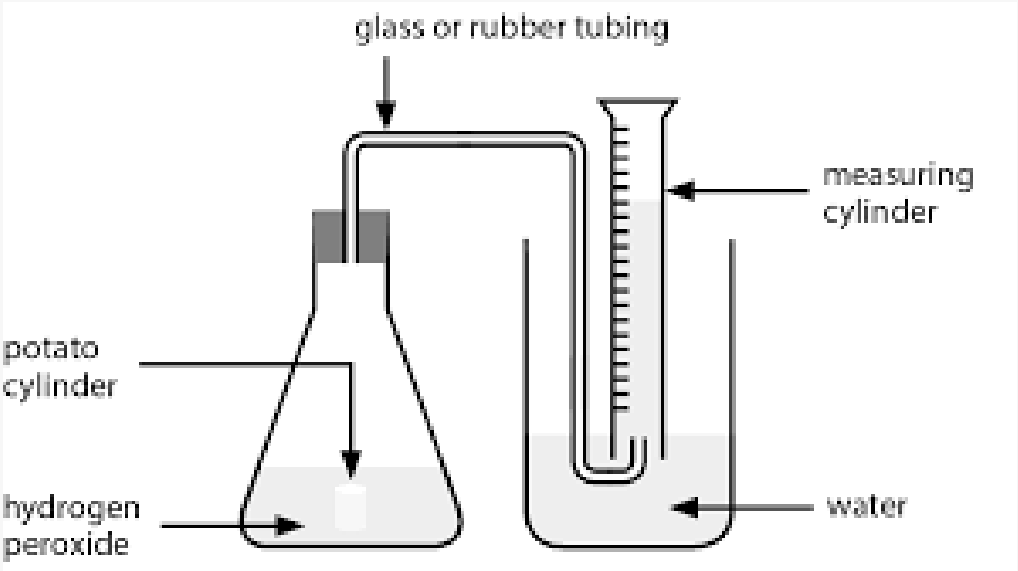
Reproducible
(high reproducibility)

Date: Tuesday
Experimenter: Paul
Lab: Bio Lab

H2O2 concentration (%)	Oxygen collected after 5 minutes (cm3)			
	Trial 1	Trial 2	Trial 3	Mean
1				
2	2.85	3.11	3	2.99
3	3.51	3.48	3.49	3.49
4	5.29	5.32	5.3	5.30
5	7.00	6.75	6.81	6.85

Date: Wednesday
Experimenter: Adam
Lab: Chem Lab

H2O2 concentration (%)	Oxygen collected after 5 minutes (cm3)			
	Trial 1	Trial 2	Trial 3	Mean
1				
2	2.83	3.02	2.99	2.95
3	3.52	3.48	3.5	3.50
4	5.34	5.29	5.31	5.31
5	7.00	6.70	6.83	6.84



nature > news feature > article

News Feature | Published: 25 May 2016

1,500 scientists lift the lid on reproducibility

Monya Baker

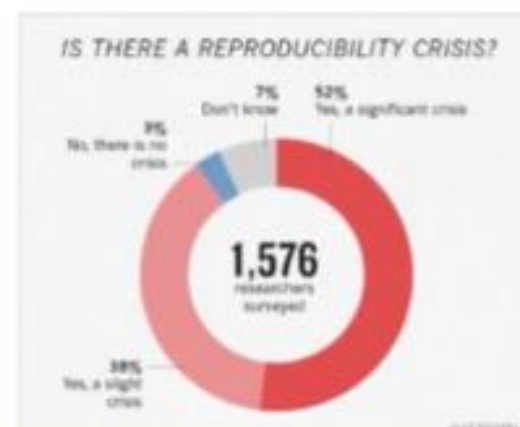
Nature 533, 452–454 (2016) | [Cite this article](#)217k Accesses | 2396 Citations | 5170 Altmetric | [Metrics](#)

i This article has been [updated](#)

Survey sheds light on the 'crisis' rocking research.

More than 70% of researchers have tried and failed to reproduce another scientist's experiments, and more than half have failed to reproduce their own experiments. Those are some of the telling figures that emerged from *Nature's* survey of 1,576 researchers who took a brief online questionnaire on reproducibility in research.

The data reveal sometimes-contradictory attitudes towards reproducibility. Although 52% of those surveyed agree that there is a significant 'crisis' of reproducibility, less than 31% think that failure to reproduce published results means that the result is probably wrong, and most say that they still trust the published literature.



Retracted article

See the [retraction notice](#)> [Nature](#). 2014 Jan 30;505(7485):641–7. doi: 10.1038/nature12968.

Stimulus-triggered fate conversion of somatic cells into pluripotency

Haruko Obokata¹, Teruhiko Wakayama², Yoshiki Sasai³, Koji Kojima⁴, Martin P Vacanti⁵, Hitoshi Niwa⁶, Masayuki Yamato⁷, Charles A Vacanti⁴

Affiliations + expand

PMID: 24476887 DOI: 10.1038/nature12968

Retraction in

[Retraction: Stimulus-triggered fate conversion of somatic cells into pluripotency.](#)

Obokata H, Wakayama T, Sasai Y, Kojima K, Vacanti MP, Niwa H, Yamato M, Vacanti CA.

Nature. 2014 Jul 3;511(7507):112. doi: 10.1038/nature13598.

PMID: 24990753 No abstract available.

Abstract

Here we report a unique cellular reprogramming phenomenon, called stimulus-triggered acquisition of pluripotency (STAP), which requires neither nuclear transfer nor the introduction of transcription factors. In STAP, strong external stimuli such as a transient low-pH stressor reprogrammed mammalian somatic cells, resulting in the generation of pluripotent cells. Through real-time imaging of STAP cells derived from purified lymphocytes, as well as gene rearrangement analysis, we found that committed somatic cells showed a substantial reduction in pluripotency marker genes. Blastocyst and to offspring via germ cells. STAP cells are self-renewable and expandable pluripotent cells that can undergo differentiation of mammalian cells in response to strong environmental cues.

[PubMed Disclaimer](#)

Microbiology Task Sheet Example Question B1 (d)(1)

E8. Identify the significant assumptions of the design

(1) What is the significant assumption of the colony counting method?

E8: U ☐ B ☐ G ☐ E ☐

ASSUMPTION

Something we **think is true**, though we **cannot be sure** and **cannot control in the scope of this experiment**.

- To simplify complex systems or variables (environmental factors are too many to be controlled).
- In broad terms, assumptions are so general and numerous that it is **impossible** to list them all.
 - **Example:** Assuming all instruments are functioning correctly during experiment; assuming that the materials are pure without contamination.

SIGNIFICANT ASSUMPTION

What is a “significant” assumption?

- **Directly relates** to the experimental **aim**.
- A **valid conclusion depends on the assumption** being true.
- **Cannot be directly proved or validated** within the scope of the investigation.
- Known to **directly impact the results or interpretation**, yet it **cannot be fully controlled** or eliminated.

STUDENTS' COMMON MISTAKES

Category	Description	Examples
Assumptions Based on Established Principles	Assumptions that rely on well-known scientific principles or facts and do not need further verification.	<ul style="list-style-type: none">• Assuming that bacteria can form colonies.• Assuming that acidic solutions have a lower pH than alkaline solutions.
Conflating Predictions With Assumptions	Incorrectly treating a hypothesis or prediction as an assumption.	<ul style="list-style-type: none">• Assuming that bacteria grow slower in acidic conditions.• Assuming the higher the nutrient content, the higher the protective effect on bacteria in alkaline condition.
Assuming Control Variables	Making assumptions about variables that are already or can be controlled in the experimental setup.	<ul style="list-style-type: none">• Assuming that all bacterial plates were incubated at the same temperature (when they were all incubated at 37°C incubator).• Assuming that the bacteria concentration are the same in the initial culture.

STUDENTS' COMMON MISTAKES CONT'D

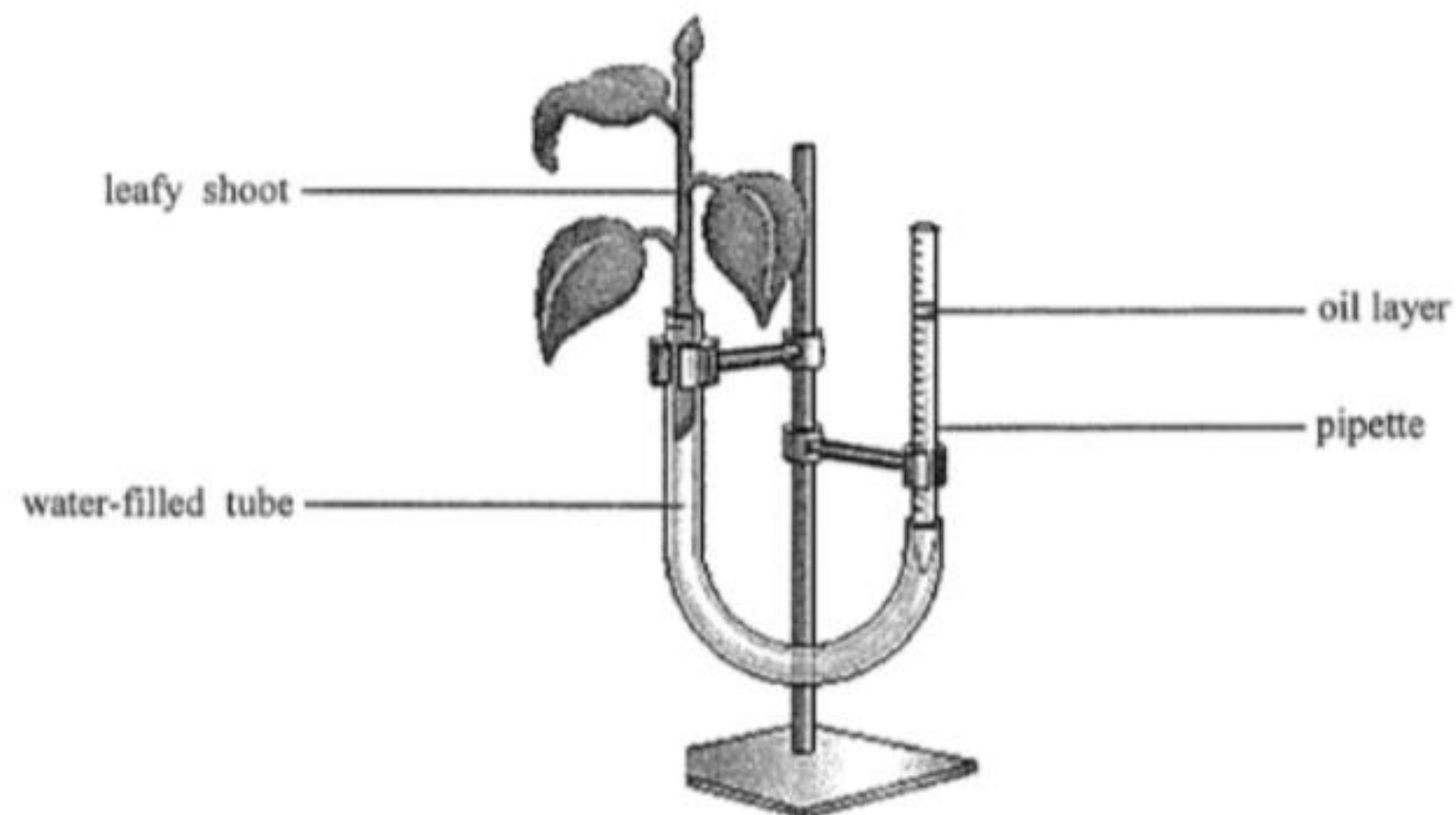
Category	Description	Examples
Assuming Outcomes That Can Be Verified	Making assumptions about results or conditions that can be directly checked or confirmed during the experiment.	<ul style="list-style-type: none">• Assuming that the bacteria are not dead and can grow into colonies.• Assuming the acidic condition of the culture does not change into alkaline.
Assuming No Human Errors	Making assumptions that there are no human mistakes/errors during the experiment.	<ul style="list-style-type: none">• Assuming that there is no mistake when spreading the plates.• Assuming that there is no error in counting the colonies.

MAJOR CATEGORIES OF SIGNIFICANT ASSUMPTIONS

- **Relationship Between Measurement Method and Dependent Variable:**
 - Assuming that the chosen measurement method accurately reflects changes in the dependent variable and captures the intended data.
- **Influence of Uncontrollable Factors:**
 - Assuming that the uncontrollable variables or factors have a negligible impact on the experimental results or conclusions.
- **Relationship between the Empirical Model and the Phenomenon under Investigation:**
 - Assuming that the empirical model can represent or simulate the phenomenon under investigation.

HKDSE 2015 Paper 1A 17.

Directions: Questions 17 and 18 refer to the set-up below, which is used to measure the rate of transpiration of a leafy shoot:



17. The assumption behind the use of this set-up for measuring the rate of transpiration is that

- A. the connections in the set-up are sealed off.
- B. the rate of water uptake is equal to that of water loss.
- C. the stomata of the leaves remain open throughout the experiment.
- D. the cutting of the shoot does not introduce air bubbles into the xylem vessels.



A:

Precautionary step. Controllable.

B:

Correct answer: This relates to the relationship between the measurement method and the dependent variable. Without this assumption, the investigation's aim of "measuring the rate of transpiration" cannot be achieved.

C:

Can be controlled and can be verified from the result of the investigation.

D:

Precautionary step. Controllable.

HKDSE 2023 Paper 1A 17.

Directions: Questions 15 to 17 refer to an investigation about enzymes in fruits. Amy learned that some fruits contained proteases which can be used as meat tenderisers. She wanted to find a suitable fruit juice for the slow cooking of steak, i.e. mixing the steak with fruit juice in a sealed bag and then cooking it in a water bath set at around 50°C to 70°C for 1 hour. The procedure of her investigation is shown below:

1. Extract fruit juice from pineapple.
2. Add 15 mL of pineapple juice in 3 boiling tubes respectively with labels 50°C, 60°C and 70°C.
3. Put the tubes into water baths set at respective temperatures for 1 hour.
4. Let the tubes cool down to room temperature.
5. Add 3 egg white cubes of size 1 cm³ into each tube.
6. (Step for the measurement of the dependent variable)
7. Repeat the above steps with papaya, kiwi and lemon instead of pineapple.

17. Which of the following is the assumption for this investigation?

- A. The proteases are present in the fruits tested.
- B. The proteases remain active at high temperatures.
- C. The proteases are still functioning after extraction.
- D. The actions of the proteases on egg white cubes and steaks are similar.



A:

Verifiable from result. Assuming the prediction.

B:

Verifiable from the experiment. IR to the aim.

C:

Verifiable from the experiment. IR to the aim.

D:

Correct: This relates to the **representativeness** of the results to address the aim of the investigation. Assuming the egg white cubes **can simulate** the steaks. Without this assumption, the aim of identifying the “suitable fruit juice for cooking steak” cannot be achieved.

Protein Column Task



Amy

The length of the remaining egg white in the stem of the dropper is shorter in the beaker which contains protease A and HCl.

Assume that proteases can digest egg white.



Ben

The pH of the acidic and alkaline solution may be slightly different.



Chris

I have one more idea. The protease functions the same as in the digestive tract.



Doris

Formulating a significant assumption is conceptually difficult for most students; providing options would scaffold their performance and identify student difficulties based on distractors.



- Amy:**
Prediction of result.
- Ben:**
A scientific fact.
- Chris:**
A scientific fact.
- Doris:**
Correct. Generalising the result to answer the investigative question. Allowing the *in vitro* conditions to **simulate** the *in vivo* conditions. Otherwise, no conclusion can be drawn.



- Some questions test biological concepts that are **irrelevant** to the design.
- Questions are often **too broad** or written as full reports ***without clear guidance/structure***. This makes it hard for students to know what to focus on and show their SI skills for a higher score.
- Some questions are **too familiar or “canned”**, with answers already known from prior knowledge, such as textbook or past papers.
 - **Example:** “Why is it important to cover the test tubes with plastic film when measuring the water potential of potato strips?”
- Students may **already know the conclusion** from prior knowledge, reducing the need for analysing their data.
 - **Example:** “The rate of respiration increases when the temperature increases.”
- Many questions assess the **same category of SI skills**, leading to redundancy.
- Tasks are **reused across years and schools**, making it easy for students to share answers or find sources online, making it difficult to accurately differentiate their abilities.
- The **lack of number and diversity** in questions does not justify awarding high scores.

THANK YOU

We are currently forming task groups to discuss and design potential new tasks, particularly focusing on the development of **biotechnology-related** activities. If you are interested in joining, please contact me at **lp@yottkp.edu.hk**.