ORANGE HIGH SCHOOL

ASSESSMENT TASK NOTIFICATION

Subject	Science Extension
Task name	Scientific Research Portfolio - *Statistical analysis task*
Year	12
Weighting	40 %
Teacher	Ms Huggett
Head Teacher	Ms Huggett
Date given	Thursday 14th May Week 3 Term 2 2024
Date due	Thursday 20th June Week 8 Term 2 2024 (G3 at 8.15am)

Assessment Outline

This task has two parts.

Part 1: Analysing the data

- You are required to analyse and interpret the raw data from an experiment using appropriate statistical analysis. (The data will be provided to you)
- Perform a chi-squared test using the provided data
- Calculate a p-value for the investigation

Part 2: Complete an in-class component of the task

- In Week 8 (in G3 at 8.15 am) you will complete an in-class analysis of the investigation as well as statistical results from unseen investigations.
- You are required to bring with you your data analysis and you may refer to this document at any point during the in-class task.
- Questions will focus on the data analysis and your interpretation of the results of the investigation.
- You will be asked to answer questions to interpret and analyse results from chi- squared test's and a student-t test's.

Non-completion of Task:

If you know you are going to be away on the day that the task is due, you must make alternative arrangements with your classroom teacher beforehand. If you are away on the day the task is due, you must contact your classroom teacher or Head Teacher on your return to school make alternate arrangements. Documentation will be required in both cases.

Failure to follow the above procedures may result in a zero award.

Plagiarism: Plagiarism - using the work of others without acknowledgement - will incur serious penalties and may result in a zero award. Any cheating will also incur penalties.

Failure to follow the above procedures may result in a zero award. The policies and procedures that are outlined in the HSC Assessment Book will be followed regarding the non-completion of assessments.

What can you bring into your task?

- A copy of the raw data
- A contingency table and any working out to create the table
- Your calculated p-value
- Your null and alternate hypothesis

Outcomes assessed
SE-3 interrogates relevant and valid peer-reviewed scientific research to develop a scientific research question, hypothesis, proposal and plan **SE-4** uses statistical applications, mathematical processes and/or modeling to gather, process, analyse and represent reliable and valid data sets **SE-5** analyses and applies the processes used in reliable and valid scientific research to solve complex scientific problems and inform further research

Rubric - Descriptors

A	• demonstrates extensive knowledge and understanding of the development of scientific thinking and scientific methods of inquiry • designs, conducts and presents a scientific investigation involving extensive analysis and synthesis of complex qualitative and quantitative scientific information and evaluation of a range of scientific sources • determines and applies the processes used in reliable and valid scientific research to solve complex scientific problems and inform further research • communicates complex scientific arguments coherently, incorporating appropriate scientific language and referencing techniques
B	• demonstrates thorough knowledge and understanding of the development of scientific thinking and scientific methods of inquiry • designs, conducts and presents a scientific investigation involving thorough analysis of complex qualitative and quantitative scientific information and evaluation of a range of scientific sources • applies the processes used in reliable and valid scientific research to solve scientific problems and suggest further research • communicates scientific arguments logically, by incorporating appropriate scientific language and referencing techniques
C	• demonstrates sound knowledge and understanding of the development of scientific thinking and scientific methods of inquiry • designs and conducts a scientific investigation involving sound analysis of complex qualitative and quantitative scientific information and evaluation of related scientific sources • incorporates the processes used in reliable and valid scientific research to solve scientific problems and identify related issues • communicates scientific arguments by incorporating scientific language and referencing techniques
D	• demonstrates basic knowledge and understanding of the development of scientific thinking and scientific methods of inquiry • designs and conducts a scientific investigation involving basic analysis of qualitative and quantitative scientific information and identifies related scientific sources • incorporates processes in research to identify related issues • uses some scientific language and referencing techniques
E	• demonstrates limited knowledge and understanding of the development of scientific thinking and scientific methods of inquiry • designs and conducts a scientific investigation involving basic analysis of qualitative and quantitative scientific information and identifies related scientific sources • identify related issues to investigations • uses minimal scientific language

HSC Extension Science Assessment Task 2
Scientific Research Portfolio Statistical Analysis Task

KOCH'S POSTULATES

INTRODUCTION

This assessment task is a virtual laboratory. The aim is to understand the experiment, interpret and analyse the results using a chi-squared test and a p-value.
Read through the following scientific investigation and conduct a chi-squared analysis of the results.
You will then bring your analysis to class in week 5 and answer a series of unseen questions on your analysis of this investigation.

Pronunciation Guide
Serratia marcescens (see-RA-she-ah mar-SES-sens)

Principles
The **scientific method** consists of a series of steps that begin with observations of natural phenomena. Based on these observations, the scientist poses questions, frames hypotheses, designs experiments to test the hypotheses, gathers and organises test results, and formulates explanations and generalisations from the test results (Figure 5.1).

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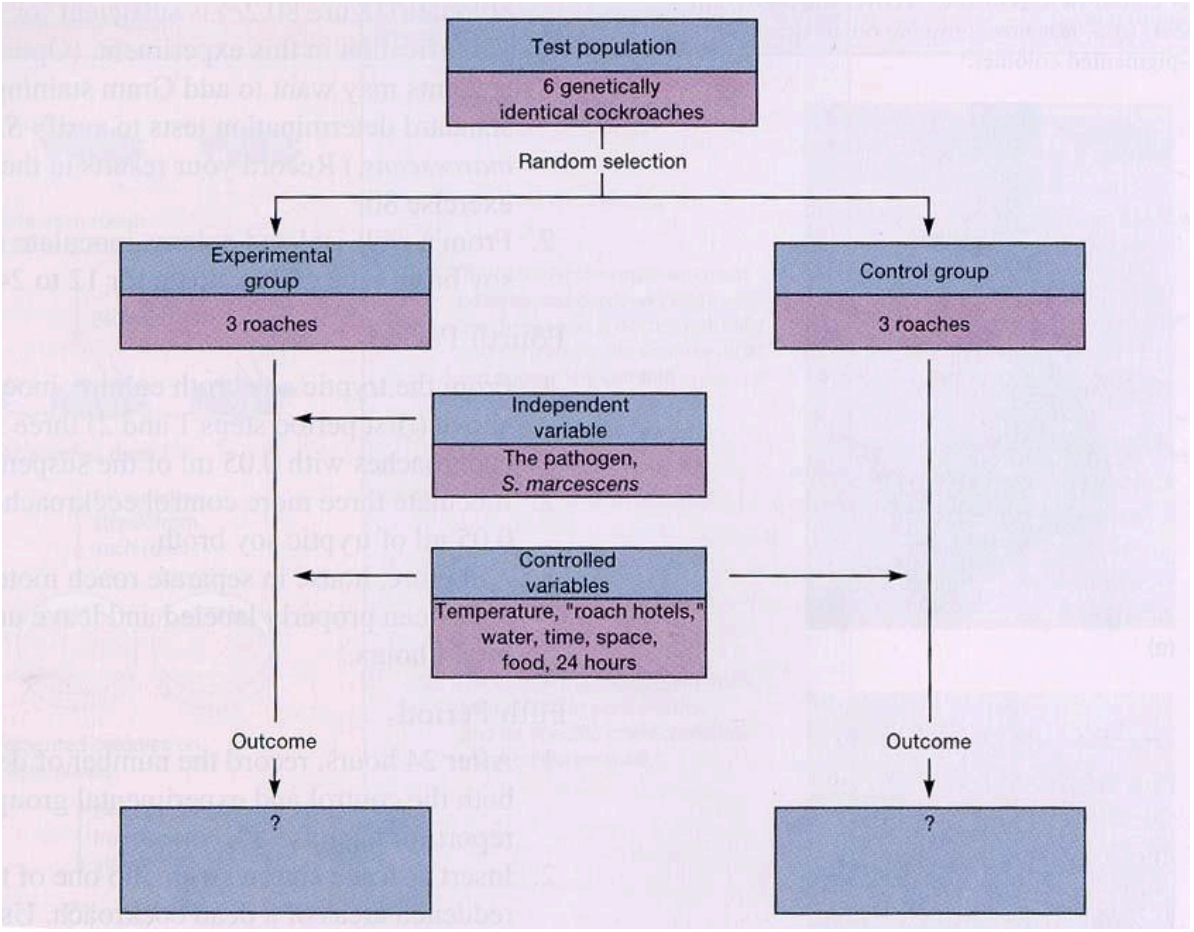
Figure 5.1



Koch's postulates are a series of rules used to establish the etiology of an infection. They have been the basis of medical microbiology since they were first developed in the nineteenth century by Robert Koch. These postulates can be summarised as follows:

1. The micro-organism must be present in every case of the disease but absent from healthy organisms.
2. The suspected micro-organism must be isolated and grown in pure culture.
3. The disease must result when the isolated micro-organism is inoculated into a healthy host.
4. The same micro-organism must be isolated again from the diseased host.

Clearly, if all of these criteria can be met, one knows that the micro-organism is capable of causing the disease.

Serratia marcescens is a Gram-negative rod belonging to the family *Enterobacteriaceae.* A distinguishable characteristic of one strain is the production of a red pigment. Unlike other *Enterobacteriaceae,* its habitat is not restricted to the host's intestine. In humans, *S. marcescens* is an opportunistic pathogen in compromised individuals. However, when inoculated into the hemocoel (body

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cavity) of insects it is highly virulent. It multiplies rapidly and kills its host within 24 hours.

Experimental procedure:
The experimental procedure is demonstrated in Figure 5.2, and outlined below.

Step 1:

1. Cockroaches "roach motels" are anaesthetised with ether.
2. 0.05 ml of the stock *S. marcescens* culture is injected directly into the hemocoel of three cockroaches between the second and third abdominal sternites. These three cockroaches are called the **experimental group.**
3. A second group of three cockroaches is injected with 0.05ml of sterile tryptic soy broth. These three cockroaches are called the **control group.**
4. Experimental and control groups of cockroaches are put in separate housing with appropriate food and water for 24 hours.

Step 2:

1. After 24 hours, the number of deaths from both the control and experimental groups are recorded.
2. A cotton swab culture is taken of the reddened areas (due to the prolific growth of *S. marcescens)* of each dead cockroach and inoculated and streaked onto tryptic soy agar plate.
3. The plates are incubated for 24 hours at room temperature (Figure 5.2).

Step 3:

1. *S. marcescens* colonies are pigmented red, and in this experiment the colour is sufficient for identification.
2. A single, well-isolated colony is inoculate into a tryptic soy broth tube and incubated for 12 to 24 hours.

Step 4:

1. The tryptic soy broth culture is then inoculated into three more cockroaches as described above.
2. Three more control cockroaches are also prepared.
3. The two groups of cockroaches are house separately for 24 hours.

Step 5:

1. After 24 hours, the number of deaths in both the control and experimental groups are recorded.
2. Once again, the reddened areas of each dead cockroach are swabbed and cultured on a tryptic soy agar plate.
3. The plates are incubated for 24 hours at room temperature, and the presence of red colonies recorded.

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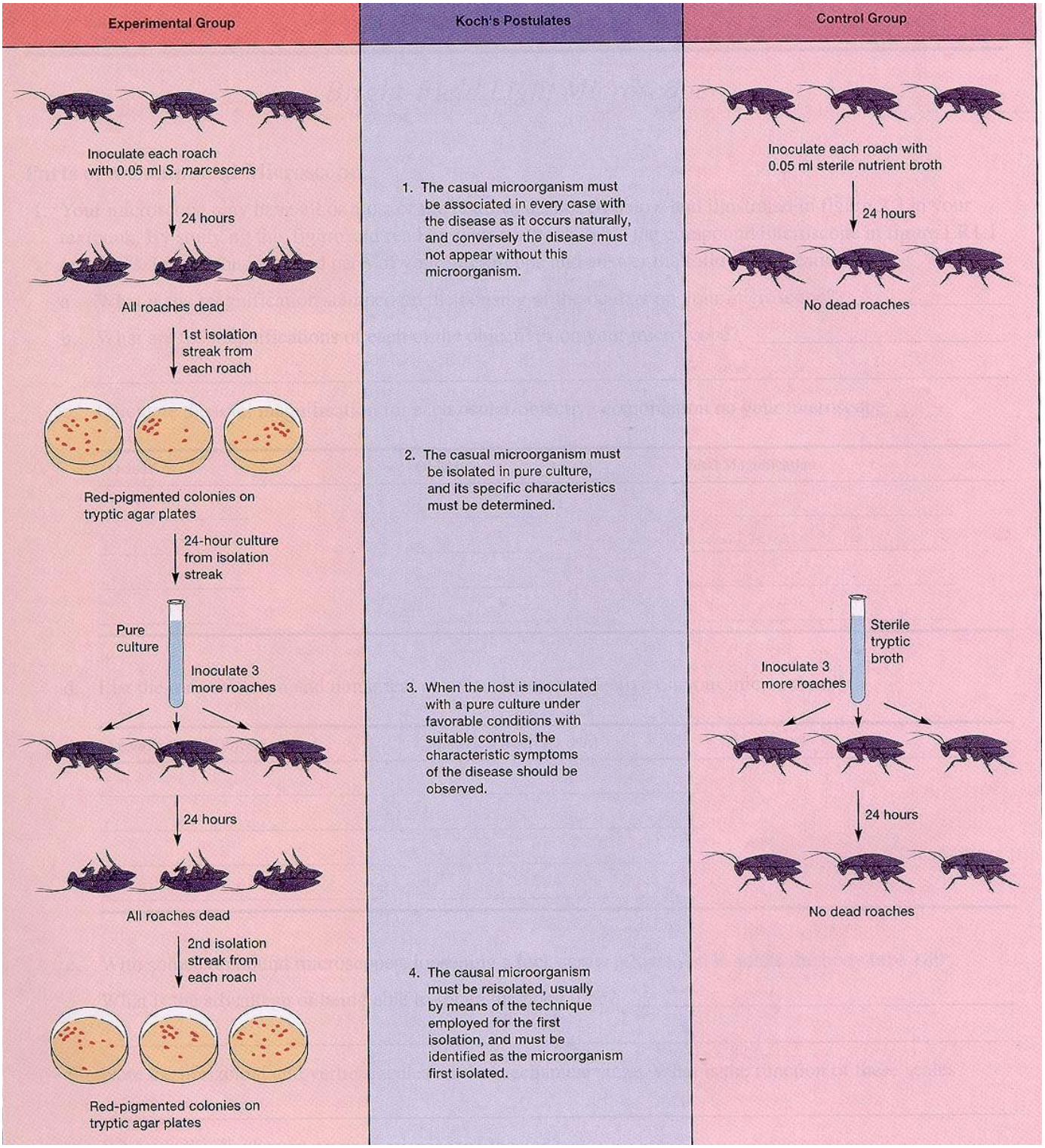
Figure 5.2


Experimental Group
Koch's Postulates
Control Group
Inoculate each roach with 0.05 ml S. marcescens
24 hours
All roaches dead
1st isolation streak from each roach
Red-pigmented colonies on tryptic agar plates
24-hour culture from isolation streak
Pure culture
Inoculate 3 more roaches
24 hours
All roaches dead
2nd isolation streak from each roach
Red-pigmented colonies on tryptic agar plates
1. The casual microorganism must be associated in every case with the disease as it occurs naturally, and conversely the disease must not appear without this microorganism.
2. The casual microorganism must be isolated in pure culture, and its specific characteristics must be determined.
3. When the host is inoculated with a pure culture under favorable conditions with suitable controls, the characteristic symptoms of the disease should be observed.
4. The causal microorganism must be reisolated, usually by means of the technique employed for the first isolation, and must be identified as the microorganism first isolated.
Inoculate each roach with 0.05 ml sterile nutrient broth
24 hours
No dead roaches
Sterile tryptic broth
Inoculate 3 more roaches
24 hours
No dead roaches

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Results:

Table 1: Class data set of the survival of cockroaches following abdominal inoculation

Replicate Number	Results from first inoculation				Results from second inoculation			
	Control		Treatment		Control		Treatment	
	Alive	Dead	Alive	Dead	Alive	Dead	Alive	Dead
1	3	0	1	2	3	0	1	2
2	3	0	0	3	3	0	2	1
3	3	0	0	3	3	0	1	2
4	2	1	1	2	2	1	0	3
5	2	1	0	3	3	0	1	2
6	3	0	0	3	3	0	1	2
7	2	1	1	2	3	0	1	2
8	2	1	1	2	3	0	1	2
9	3	0	0	3	2	1	0	3
10	3	0	0	3	3	0	0	3
11	3	0	0	3	3	0	0	3
12	3	0	0	3	3	0	0	3
13	2	1	2	1	3	0	1	2
14	3	0	1	2	3	0	0	3
15	2	1	0	3	3	0	2	1
16	2	1	1	2	3	0	1	2

Reference Source: JP Harley, LM Prescott, 1999, Laboratory Exercises in Microbiology, 4th Edition WCB / McGraw-Hill, Sydney. 30

Analysis of results:

You are required to use the data provided from the experiment to conduct a chi-squared test to calculate a p-value.

How to conduct a Chi-Squared test:

Step 1 – Calculate the expected value (E)

Step 2 – Calculate O-E (the difference between the observed and expected result)

Step 3 – Calculate the value of X^2 using:

$$X^2 = \sum \frac{(O-E)^2}{E}$$

Where:
O = Observed result
E = Expected result
$\sum$ = sum of

Step 4 – Calculate the degrees of freedom

Step 5 – Determine the p-value