

Virtual Laboratory Assessment Task

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

Topic: Module 3: The Data, Evidence and Decisions

Due Date: In-class Before School Thursday 15th June 2023

Weighting: 40%

TASK OVERVIEW:

This assessment task contains 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 5 you will complete an in-class analysis of the investigation.
- 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 a chi-squared test and a student-t test.

What can you bring into the in-class part of the assessment?

- 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

Syllabus Outcomes:

- Interrogates relevant and valid peer-reviewed scientific research to develop a scientific research question, hypothesis, proposal and plan SE - 3
- Uses statistical applications, mathematical processes and/or modelling to gather, process, analyse and represent reliable and valid data sets SE – 4
- Analyses and applies the processes used in reliable and valid scientific research to solve complex scientific problems and inform further research SE - 5

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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

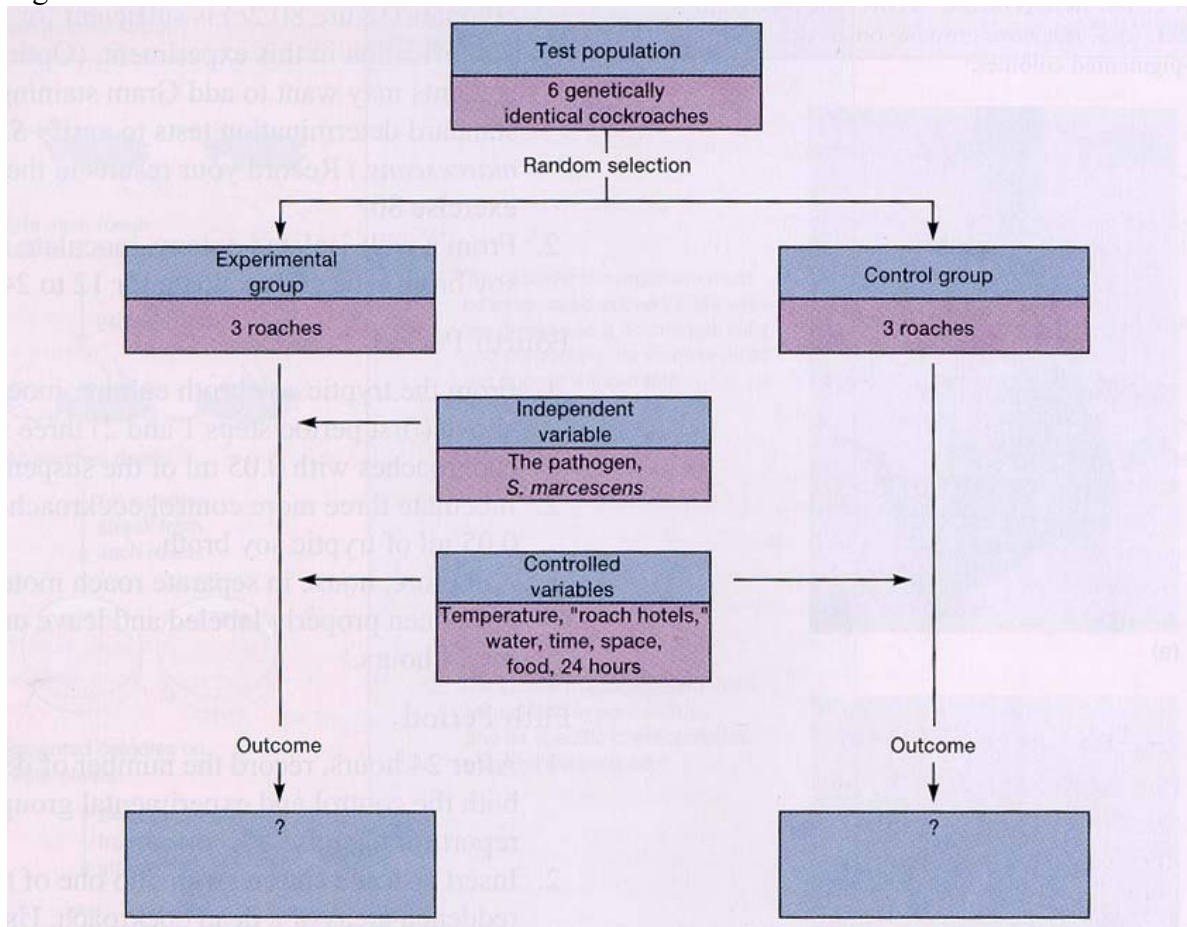
Serratia marcescens (see-RA-she-ah mar-SES-sens)

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).

Figure

5.1



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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 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.

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Step 4:

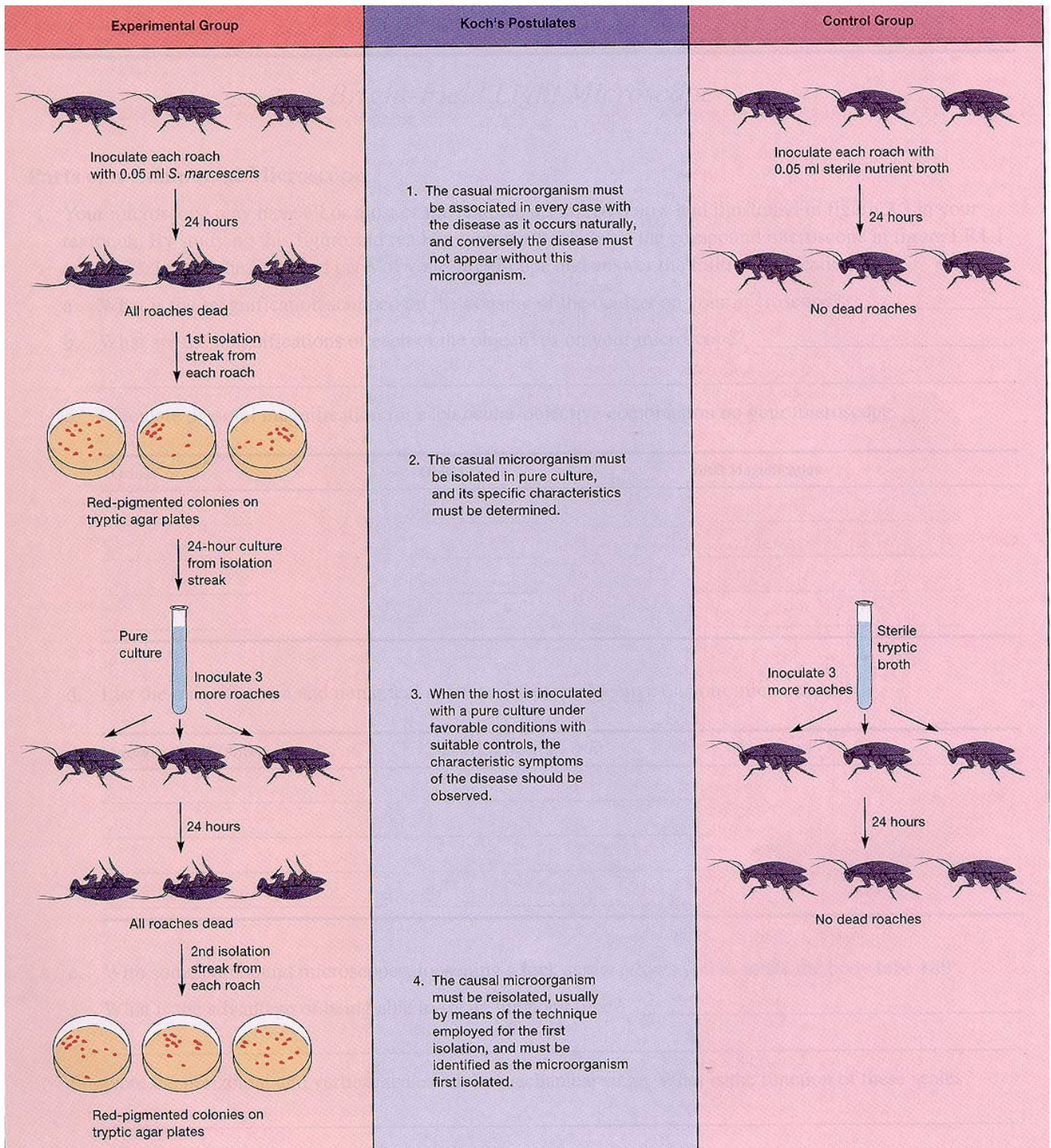
1. The tryptic soy broth culture is then inoculated into three more cockroaches as described above.
2. Three more control cockroaches are also prepared.
3. The two groups of cockroaches are housed separately for 24 hours.

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



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.

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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

Σ = sum of

Step 4 – Calculate the degrees of freedom

Step 5 – Determine the p-value

What can you bring into the in-class part of the assessment?

- A copy of the raw data and experiment (you will also be provided with a copy on the day for you to reference as needed)
- A contingency table and any working out to create the table
- Your calculated p-value
- Your null and alternate hypothesis