LACHLAN ACCESS PROGRAM

Subject: Year 12 Biology	**Task Number: 3**
Type of Task: Depth Study	**Coordinating Teacher: Adam Quinn** **Cooperating Teachers: Jindrich Kavale**
Date Issued: Term 2 Week 3 **Monday 13th May 2024**	**Date Due: Term 2 Week 10** **Friday 5th July 2024**
Total Marks: 35	**Weighting: 35%**

Submission Instructions: Students are to email assessment to westernlap@det.nsw.edu.au prior to 9.00am on **Friday 5th July 2024**

Task Context:

In this topic, you have learnt about infectious disease, including the types of pathogens, layers of defence and methods used both locally and globally to prevent and control infection.

In this task, you will be required to demonstrate your understanding of infectious diseases by using simulations and your knowledge of the immune system to demonstrate your understanding of the factors affecting the spread and control of infectious diseases.

Syllabus Content:

Outcome	Description
BIO12-1	Develops and evaluates questions and hypotheses for scientific investigation
BIO12-3	Conducts investigations to collect valid and reliable primary and secondary data and information
BIO12-5	Analyses and evaluates primary and secondary data and information
BIO12-6	Solves scientific problems using primary and secondary data, critical thinking skills and scientific processes
BIO12-7	Communicates scientific understanding using suitable language and terminology for a specific audience or purpose
BIO12-14	Analyses infectious disease in terms of cause, transmission, management and the organism's response, including the human immune system

CONDOBOLIN HIGH SCHOOL

Task Description:

Depth Study Report (35 Marks)

In this task, you will take on the role of an epidemiologist, using data gathered from the popular infectious disease simulator “Plague Inc.” to explore a range of factors that can inhibit or cause the spread of pathogens.

You will need to download the Plague Inc. app from the app store on your mobile device and plan an effective sequence of modifications to a pathogen of your choice to maximise its infectivity and virulence.

In this task, you will be required to:

- **Hand in a report (maximum of 3000 words) that includes:**
    - Abstract
        - A succinct and clear description of the study
    - Introduction
        - A relevant and well-researched background of infectious disease, the human immune system and the investigation you are undertaking
    - Methods
        - A clear experimental design that includes all treatments, variables, repetition and analyses
    - Results
        - A succinct description of the findings from your experiment, including any calculations
        - A table and/or graph of the data you collected
    - Discussion
        - An analysis and explanation of the trends in the data you collected using appropriate references
        - An evaluation of the study and its real-world implications
    - Reference list
        - All references used correctly cited in text and in a list attached to the back of the study using APA-7 referencing.

To write your report, you will need to:

- **Research from multiple resources**
  During this depth study, you will need to access a range of literature and other resources to support your writing and arguments. This includes, but is not limited to: websites, videos, books, textbooks, documentaries, and articles from scientific journals. **At least 10** references must be included in your final submission.

- **Pose a scientific question and conduct a scientific simulation study**
  Using initial observations from the Plague Inc simulation and additional research, you will further utilise the Plague Inc simulation to develop and conduct a scientific study, establishing the features of disease that maximise its infectivity and virulence.

- **Analyse Data and Draw Links**
  After collecting data from the simulation, you will analyse this data to identify patterns, trends, and anomalies. Utilise statistical tools and methods to ensure the analysis is robust and meaningful. You will need to clearly link the results of the data analysis to the scientific question posed, demonstrating how the findings contribute to our understanding of infectious diseases.

- **Interpret Findings and Discuss Implications**
  Discuss the implications of your results for the protection of the human species from disease and consider how your findings relate to the existing body of knowledge and highlight any new insights your research has provided. Discuss any limitations of your study and suggest areas for future research.

A detailed scaffold and useful data will be provided to assist you in developing your report

Criteria for Assessing Learning

Students will be assessed on their ability to:

- Develop questions and hypotheses by applying knowledge about infectious disease to a real-world situation.
- Design and conduct investigations and secondary research to gather valid and reliable data.
- Process, analyse and evaluate gathered data and relate this to their research objective.
- Apply critical thinking skills and the scientific method to produce solutions to a posed question
- Communicate findings using detailed scientific language and correct terminology
- Analyse and explain the cause, transmission and management of infectious diseases and responses to these in humans.

HSC Key Verbs

Analyse
Identify components and the relationship between them; draw out and relate implications

Communicate
Sending information between groups of people using language appropriate for the audience

Conduct
organise and carry out

Design
to make or draw plans for something

Develop
grow or cause to grow and become more mature, advanced, or elaborate

Evaluate
Make a judgement based on criteria; determine the value of

Explain
Relate cause and effect; make the relationships between things evident; provide why and/or how

Process
Manipulate data to produce meaningful information

NESA "All My Own Work"

By signing for this assessment task and having completed the NESA course "All My Own Work" I confirm that this assessment task will be free from plagiarism and reflective of my own work. I understand that if I am found to have plagiarised or engaged in malpractice, I will be referred to the HT Access to engage the LAP Malpractice process.

Criteria	Grades
• Conducts exceptional secondary research to deliver an extensive analysis and explanation of the cause, transmission, and management of infectious diseases, with insightful discussions on human responses. • Formulates sophisticated testable questions and hypotheses and utilises a broad range of data to derive well-substantiated conclusions. • Conducts a meticulous and thorough investigation, gathering comprehensive and highly reliable data. • Processes, analyses and evaluates data with exceptional depth, articulating trends and their real-world implications with clarity and proposing innovative future steps. • Excellently communicates scientific findings, employing precise scientific language and flawless APA-7 referencing.	A 31 - 35
• Conducts comprehensive secondary research, analysing and explaining the cause, transmission, and management of infectious diseases and human responses in detail. • Poses detailed testable questions and hypotheses, using data to support conclusions effectively. • Plans and conducts a thorough investigation to collect substantial and relevant data. • Processes and analyses data to identify trends, discussing practical implications and suggesting future steps. • Communicates scientific findings clearly using mostly detailed scientific language and mostly accurate APA-7 referencing.	B 24 - 30
• Conducts sound secondary research, providing explanation of the cause, transmission, management and human responses of infectious diseases. • Poses clear testable questions and hypotheses, with conclusions supported by some data. • Carries out an appropriate investigation to collect relevant data. • Processes and performs some analysis of data to outline trends, with some discussion of real-world implications. • Communicates findings using some appropriate scientific language and some accurate APA-7 referencing.	C 14 - 23
• Conducts basic secondary research with some explanation of infectious diseases. • Poses basic questions and hypotheses, with minimal data support for conclusions. • Undertakes a basic investigation with some relevance to the questions posed, collecting basic data. • Processes some data with a basic analysis, with some discussion of implications or future directions. • Communicates findings with some inaccuracies in scientific language and some incorrectly formatted referencing.	D 7 - 13
• Conducts limited secondary research with some relevant information provided. • Poses simple questions and hypotheses, with conclusions not supported by data. • Undertakes a limited investigation, collecting minimal relevant data. • Processes limited data, with limited discussion of implications or next steps. • Communicates findings with limited scientific language and minimal referencing.	E 0 - 6

Depth Study Scaffold

Introduction

In this section, you should include detailed insights on:

- How various pathogens gain access to and cause disease in the human body
- How environmental and human factors limit or enhance the spread of infectious disease
- How the human body protects itself from disease using each of the layers of defence.
- Any questions and hypotheses you plan to investigate in this report and WHY (give the investigation meaning).

Methodology

In this section, you will need to write about how you tested your questions/hypotheses. This will require you to:

1. ***Select a Pathogen:*** Choose one of the following pathogens for your study: bacteria, fungus, virus, or macroparasite. Consider the unique characteristics and challenges each type presents.

2. ***Try to "Win"***: Perform simulations to observe the general behaviour and spread of your chosen pathogen in different countries. Note its initial infection rates, regions/countries your pathogen spreads faster/slower in, the response of the pathogen to mutations. Narrow down what works and what doesn't in your quest to infect the world's population.

Once you have some initial findings, you can start to plan your investigation and sequence of mutations you will enact to maximise infectivity and virulence.

Example:

This study was conducted in the simulated environment of Plague Inc. on "Normal" mode and the "bacteria" pathogen was selected. No genetic code modifications were added to the pathogen. The outbreak was simulated to start in [Country] with [conditions]. Three mutation sequences were selected for testing, the first (Figure 1) focused on evolving transmission traits, the second (Figure 2) environmental resistance, and a third focusing on a mixture of the two (Figure 3). In all tests, symptom traits were evolved last.

Diagram 1
Figure 1: Transmission focused traits evolution sequence

Diagram 2
Figure 2: Resistance focused traits evolution sequence

Diagram 3
Figure 3: Mixed focused traits evolution sequence

[Reasoning behind the sequence of mutations selected and differences between each of the sequences]

In this study, the data collected included time taken until the world's population was fully infected or deceased, or the disease was cured. Rates of infection, countries not infected and disease control measures that prevented the spread of the pathogen were monitored.

Note: This section should be written in 3rd person AND in past tense.

Results

- Graphs and tables produced from your investigation, with appropriate figure captions.
    - For example, you may produce a graph of the number of infections over time, with annotations on the graph showing when different abilities were mutated and when different countries were affected.
    - Data should be shown for each sequence of mutations you test.
- Screenshots can be used if necessary.
- General observations can be included and are recommended.

The collection of data will require you to carefully use the simulator and keep detailed records of events.

Discussion

In this section, you should analyse your results and make links between your data and observations in the real-world.

This includes:

- Comparing the trends across each of the tests you have conducted
    - Why were particular sequences of mutations more effective than others?
- Explaining the occurrence of these trends with reference to your mutation sequences and literature
    - What does the research say about the spread of diseases? Does your data support this?
- Discussing the implications of these trends in the emergence of infectious diseases in the real-world
    - How can this data be used to make predictions about the spread of diseases and protect humans?
    - What measures should be implemented as a result of this study?
- Highlighting future areas of study if relevant.

Conclusion
Summarise your main findings and recommendations.

References

You should be using references to show where you gathered information from in this report.

All references should be provided using the APA-7 referencing style and in-text references should be present.

This is a common referencing style used across Australian universities.

An easy-to-use guide can be found here: https://www.newcastle.edu.au/library/study-skills/referencing/apa7

Useful data - Income

Low-Income Countries	Middle-Income Countries	High-Income Countries
Afghanistan	Argentina	Australia
Algeria	Balkan States	Canada
Angola	Baltic States	Central Europe
Bolivia	Brazil	Finland
Botswana	China	France
C. America	Greenland	Germany
Caribbean	Iceland	Italy
Central Africa	India	Japan
Central Asia	Indonesia	New Zealand
Colombia	Iran	Norway
East Africa	Iraq	Spain
Egypt	Korea	Sweden
Kazakhstan	Libya	UK
Madagascar	Mexico	USA
Morocco	Middle east	
New Guinea	Poland	
Pakistan	Russia	
Peru	Saudi Arabia	
Philippines	South Africa	
S.E Asia	Turkey	
Sudan	Ukraine	
West Africa		
Zimbabwe		

Useful data - Climate

Cold	Balanced	Hot	Humid	Arid
Balkan States	USA	Algeria	Balkan States	Afghanistan
Baltic States	Madagascar	Angola	Baltic States	Algeria
Canada	Korea	Australia	Bolivia	Australia
Central Europe	Japan	Botswana	Brazil	Central Asia
Finland	China	Brazil	Caribbean	Egypt
Germany	France	C. America	Central Europe	Iraq
Greenland	Italy	Caribbean	Colombia	Kazakhstan
Iceland	Argentina	Central Africa	Finland	Libya
Norway	New Zealand.	Colombia	Germany	Mexico
Peru		East Africa	India	Middle east
Poland		Egypt	Indonesia	Morocco
Russia		India	New Guinea	Pakistan
Sweden		Indonesia	Norway	Peru
UK		Iran	Philippines	Saudi Arabia
Ukraine		Iraq	Poland	South Africa
		Libya	Russia	Spain
		Mexico	S. E. Asia	Sudan
		Middle east	Sweden	
		Morocco	UK	
		New Guinea	Ukraine	
		Pakistan		
		Philippines		
		S.E Asia		
		Saudi Arabia		
		South Africa		
		Spain		
		Sudan		
		West Africa		
		Zimbabwe		

Useful data - Evolutions (Transmission)

Transmission Trait	Description
Bird 1	Birds become susceptible to infection. Avian carriers increase infectivity, land transmission and mutation
Rodent 1	Common flea susceptible to infection. Increase infectivity, especially in urban regions and mutation
Livestock 1	Livestock susceptible to infection. Increase infectivity, especially in rural regions and mutation
Blood 1	Gives organism ability to spread through blood to blood contact. Increases infectivity, especially in poor regions and mutation chance
Insect 1	Insects susceptible to infection. Carrier insects increase infectivity, especially in hot climates and chance of mutation
Air 1	Gives pathogen ability to travel on dust particles. Increase infectivity, especially in arid environments and plane transmission
Water 1	Pathogen can survive outside the body in fresh, warm water. Increase infectivity, especially in humid environments and ship transmission
Bird 2	Avian brain tissue compromised causing birds to attack other species. Increases mutation, infectivity and land based transmission.
Rodent 2	Rodents directly susceptible to infection. Increase infectivity, especially in urban regions and mutation.
Livestock 2	Wildlife susceptible to infection. Increase infectivity, especially in rural regions and mutation.
Blood 2	Infected bodily fluids able to pass through mucous membranes. Increases infectivity, especially in poor regions and mutation chance.
Insect 2	Increases rate of transfer between insects. Increase infectivity, especially in hot climates and chance of mutation.
Air 2	Gives organism ability to survive suspended in air for a long time. Increase infectivity, especially in arid environments and plane transmission.
Water 2	Pathogen able to survive in chemically treated water. Increase infectivity, especially in humid environments and ship transmission.
Extreme Zoonosis	Infection crosses multiple species barriers. Increases infectivity, especially in rural and urban areas, mutation chance and cross-country transmission.
Extreme Hematophagy	Pathogen uses host lymphocytes to replicate. Increase in infectivity, especially in poor regions and mutation chance.
Extreme Bioaerosol	Pathogen bypasses air/water filters due to adaptive cellular shell. Increase infectivity, especially in humid & arid climates and plane/ship transmission.

Useful data - Evolutions (Resistance)

Ability	Description	Effects
Cold Resistance 1	Pathogen evolves to withstand cold temperatures and climate	Cold Country Effectiveness +0.3
Cold Resistance 2	Lower intracellular water volume prevents freezing. Increased effectiveness in cold climates	Cold Country Effectiveness +0.6
Heat Resistance 1	Pathogen evolves to withstand hot temperatures and climates	Hot Country Effectiveness +0.3
Heat Resistance 2	Pathogen avoids cellular breakdown in high temperatures. Increased effectiveness in hot climates	Hot Country Effectiveness +0.6
Environmental Hardening	Pathogen develops hardened coating-becoming highly weather resistant and extremely comfortable in both hot and cold climates	Hot Country Effectiveness +1, Cold Country Effectiveness +1
Drug Resistance 1	Pathogen develops resistance to class 1 and 2 antibiotics. Increases effectiveness in wealthy countries	Wealthy Country Effectiveness +0.3
Drug Resistance 2	Pathogen develops resistance to class 3 and 4 antibiotics. Increases effectiveness in wealthy countries	Wealthy Country Effectiveness +0.7

Useful data - Evolutions (Symptoms)

Name	Info	Infectivity	Severity	Lethality
Abscesses	Pockets of infected flesh are painful and act as breeding grounds for the pathogen, increasing infection rates when burst	4	4	0
Anaemia	Decrease in red blood cells or haemoglobin in the blood can lead to hypoxia in the organs	1	1	0
Coma	Neuropathic effects in the brain stem cause loss of consciousness and sometimes death. Significantly harder to cure	0	15	2
Coughing	Chance of infection by spreading pathogen into surroundings, especially in high density, urban areas	3 (+0.05 urban effectiveness)	1	0
Cysts	Painful lumps containing pockets of the pathogen. Slight chance of bursting which can spread disease	2	2	0
Diarrhoea	Pathogen active in digestive tract, causing infection through faeces and potentially lethal dehydration. Poor countries v. vulnerable.	6 (+0.05 poor effectiveness)	4	1
Dysentery	A complete breakdown in the digestive system causes infected sewage, dehydration, starvation and death	8	15	8
Fever	Increase in temperature, contagiousness and severe dehydration, which can be fatal	4	3	3
Haemophilia	Immune system produces inhibitors that destroy factor VIII, preventing blood clotting. Infectivity costing, increased lethality	3	4	0
Hemorrhagic Shock	Severe loss of blood volume causes oxygen deprivation, loss of consciousness and death	0	15	15
Hyper Sensitivity	Increases likelihood of allergic reactions which can distract the immune system. Rich regions particularly vulnerable	1 (+0.04 wealthy effectiveness)	2	0
Immune Suppression	Pathogens attach to lymphocytes, suppressing the immune system and allowing significantly greater freedom of mutation. Can be fatal	2	6	4
Inflammation	Inflammation obstructs bodily processes. Swelling can obstruct breathing and be fatal	2	2	2
Insanity	Neuropathic action of the pathogen in the frontal cortex causes severe emotional and behavioural abnormalities. Significantly harder to cure	6	15	0
Insomnia	Inability to sleep makes people irritable and less productive	0	3	0

Internal Haemorrhaging	Arterial membranes break down, causing rapid internal bleeding and death	0	9	7
Nausea	Irritated stomach lining leads to discomfort. Slight chance of infection when kissing	1	0	0
Necrosis	Large swathes of infected tissue lose blood supply and become food sources of gangrene. Decomposed bodies remain a vector of transmission	10 (+10 corpse transmission)	20	13
Paralysis	Pathogen destroys motor neurons to cause paralysis. Significantly harder to cure and can be lethal	1	5	1
Paranoia	Serious mistrust of others makes them unlikely to seek treatment or cooperate with others	0	4	0
Pneumonia	Serious fluid build up and discharge from the lungs. People in cold climates especially vulnerable	3 (+0.05 cold effectiveness)	2	0
Pulmonary Fibrosis	Scarring of the lungs causes shortness of breath and extreme coughing. Can be fatal when combined with intense exercise	3 (+0.05 humid effectiveness)	2	2
Pulmonary Oedema	Potentially fatal heart abnormality causes breakdown of respiratory system, releasing pathogen into the air	5	4	2
Rash	The skin becomes blistered and painful, slightly increasing infectivity	2	1	0
Seizures	Random blackouts and fits reduce the patient's ability to function independently. Can be fatal	1	7	3
Skin Lesions	Breakdown in the epidermis causes large open wounds which significantly increase infectivity	11	4	0
Sneezing	Fluid discharge through sneezing greatly increases infection rates.	5	1	0
Sweating	The loss of fluid through sweating also increases infection rates due to poor hygiene. More dangerous in cold countries	2 (+0.05 cold effectiveness)	1	0
Systemic Infection	Pathogen affects multiple organ and tissue types, causing body-wide infections that spread fast and can be fatal	6	7	6
Total Organ Failure	Catastrophic cell death of multiple tissue types causes body-wide organ failure and rapid death	0	20	25
Tumours	Pathogen disrupts cell growth pathways, causing uncontrolled, eventually fatal tumour growth	2	4	0
Vomiting	The expulsion of infected material through projectile vomiting increases the risk of infection	3	1	0