

Biology 067: Emerging Diseases Final

Friday, December 19, 2003

Instructions:

1. This exam is divided into three parts.

Part I focuses *mostly* on ideas we have talked about in class **since the midterm**.
(60 pts total)

Part II contains **six (6)** questions about the **group presentations**. Of these, you will **choose three (3)** to answer. Read them all carefully before making your choice. **If you write answers for more than three, I will read the first three, unless you clearly indicate which are the three you want to submit.**
(18 pts total)

Part III offers a chance for **you** to be a **microbe jock**--you will answer questions to investigate a **hypothetical outbreak** on Bowdoin campus.
(22 pts total)

2. For each question, numbers in brackets indicate the number of points. The **relative number of points** should give you a rough idea of **how much time to spend** per question.
3. Read through the **entire** question **carefully before starting to write** your answer. The **space** that has been left between questions **roughly approximates** how long your answers will be, depending on the size of your handwriting. You should also **feel free** to use **PICTURES** to **help explain ideas** when **appropriate**.
4. Aim for **CLEAR, CONCISE, COMPLETE** answers.

Part I

1. (16 pts) Microbes have developed numerous ways of evading the host immune response. One of the most successful pathogens to date has been HIV.

a) (1 pt) What does **HIV** stand for?

b) (6 pts) **Explain three ways** in which **HIV** can **evade** the **host immune response**.

i.

ii.

iii.

Given the devastation and wily ways of this virus, it is not surprising that people such as lawyer Boyd E. Graves have developed conspiracy theories linked to HIV and AIDS. An article in the World Weekly News described Boyd's theory that the US government developed HIV to control third world populations and included the statement:

"AIDS is one of the most important weapons in the government arsenal of biological terrorism."

c) (9 pts) Would HIV be a **good candidate** for biological terrorism? Include **two points** to **support** your argument and **one counterargument**.

2. (12 pts) Sociologists and biomedical researchers offer different perspectives on infectious diseases that can be important in understanding and controlling the spread of disease. Nancy Riley highlighted these issues in our discussion of the **cholera epidemic in Venezuela** in early 1990s. We also saw the importance of these different perspectives during the **beginning of the AIDS epidemic in the US** in the early 1980s.

Compare and contrast these two epidemics from sociological and biomedical perspectives. Include four points, two addressing societal factors and two addressing the biology of the two diseases.

Unfortunately, Nancy Riley did not have time to discuss cholera in Venezuela with us this year. You could think about contrasting AIDS with another epidemic we discussed.

3. (11 pts) Infectious Diseases in the News: Influenza has made the front page of many major newspapers over the past few weeks, most recently following the announcement from two pharmaceutical companies that they had shipped out all of their vaccine stocks. This announcement caused many people to flock to clinics with remaining supplies to receive a "flu shot."

a) (6 pts) Explain what happens in your body when you get a "flu shot." Include a description of what is in a vaccine and why vaccination helps protect you against flu.

b) (1 pt) Did you get a flu shot before Dudley-Coe ran out?

c) (4 pts) Explain why you did or did not get a flu shot. Justify your decision using your understanding of influenza biology.

4. (9 pts) What can *you* (second person singular) do to **help stop the spread of disease**? **Discuss three such measures** and **include why** they would **help** and an **example of a disease** that would be **affected by each action**.

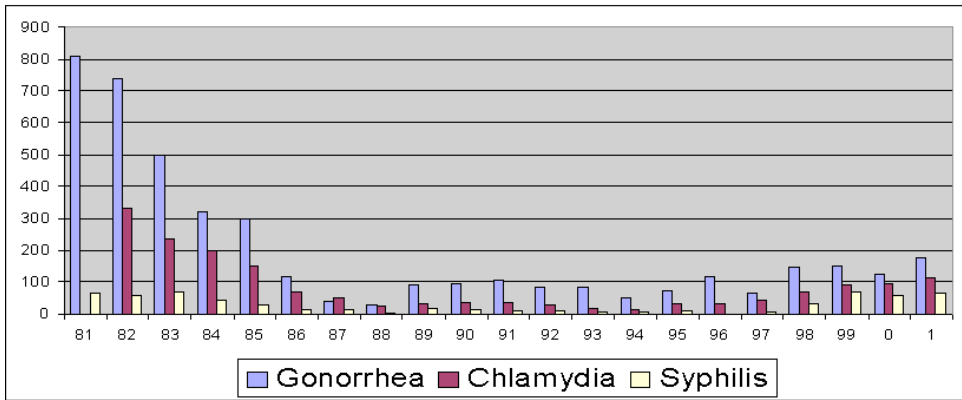
i.

ii.

iii.

5. (12 pts) Public health officials in the Seattle area have a website with the following graph:

King County Cases of Gonorrhea, Chlamydia & Syphilis
In Gay & Bisexual Men, 1981-2001



a) (3 pts) What does this graph demonstrate about **rates of gonorrhea and syphilis over the past 20 years** in the Seattle area?

b) (6 pts) How would you **explain these trends**?

c) (3 pts) What **other data** (controls) would you want to collect to **support your explanation** and **why**?

Part II: Group projects: **These questions will give you a flavor of final project questions (although you do not have the information to answer these questions, since they are based on a different set of posters)**

Guidelines for question choice (6 pts each; 18 pts total)

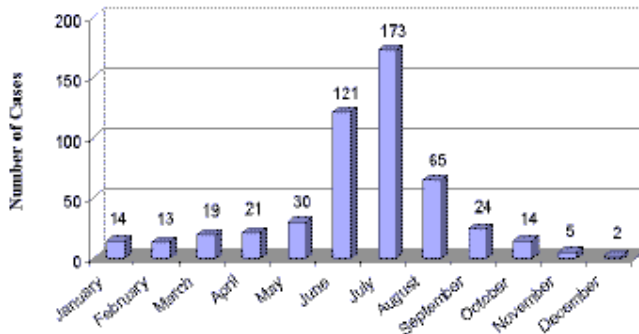
1. Read all the questions and decide which three you want to answer (3-4 min), then focus on each of your chosen questions.
2. People from the Hepatitis group cannot choose #2 and people from the West Nile group can choose either 4 or 6, but not both. These people can see me for an extra question from which to choose.

For reference, here are the diseases and countries:

AIDS/South Africa	Dengue	Diphtheria	Hepatitis	Malaria	Meningitis
Polio/India	Prion diseases	West Nile Fever	Whooping Cough/Colombia	Yellow Fever	

1. (6 pts) Here is a graph from the Rhode Island Department of Health indicating the timing of diagnosis of cases of Lyme disease in 2001.

**Lyme Disease by Month of Diagnosis*,
Rhode Island, 2001**



http://www.healthri.org/disease/communicable/lyme_data.htm

a) (3 pts) Which of the following other diseases would you expect to have **similar** or **different patterns** (in the Northern hemisphere) and **why**? **Dengue, diphtheria, whooping cough, yellow fever.**

b) (3 pts) How do **prevention methods** differ among the **four diseases in (a)**?

2. (6 pts) In "And the Band Played On" Don Francis was excited about using the hepatitis data he had collected in the late 1970s to analyze the beginning of the AIDS epidemic. In particular, he encouraged the blood banks to screen donations for the presence of **anti-hepatitis B antibodies**, a test that was **88% effective** in identifying **donors with AIDS**.

Do you think that screening blood samples for **anti-hepatitis A antibodies** would have been **just as effective** in **identifying donors with AIDS**? What about **anti-hepatitis C antibodies**? **Why or why not?**

3. (6 pts) Malaria has been a worldwide problem for centuries. Although polio has also been a problem, efforts to eradicate polio seem closer to fruition than for malaria. **Describe two differences between malaria and polio** that make **polio a more likely candidate for eradication** than **malaria** (think about the biology of the two diseases).

4. (6 pts) One possible outcome of **West Nile Fever** is **meningitis**, yet the **prevention methods** discussed on the **West Nile Fever** and **Meningitis** posters were very different.

a) (2 pts) How can **two** (or more) **agents** cause **meningitis** (i.e. what is meningitis)?

b) (4 pts) How do the **prevention methods** for **West Nile Fever** and non-West Nile-related **meningitis** differ? **Explain why** the **methods** are **effective** in the context of the **biology of the causative agents**.

5. (6 pts) Governmental policies and international efforts can have a large **impact on the spread of disease**. **Explain two examples** from the **posters** that show **measures** that have been instituted to **help stem the spread of disease**. Make sure to **include why these measures should help**.

6. (6 pts) You join a biotechnology company and have the choice of working on **two different animal vaccine projects**: one developing a vaccine for **West Nile Fever** for **birds** and the other developing a vaccine for **bovine spongiform encephalopathy** for **cows**.

a) (2 pts) How will **these animal vaccines** affect **human health**?

You want to choose the project that appears **easier** or **more likely to succeed**.

b) (4 pts) **Which project** would you choose and **why**? **Justify** using your **knowledge of the biology** of these two diseases.

Part III

(22 pts total) There is an outbreak of food poisoning on campus causing numerous people to experience nausea and vomiting. You have just studied *Staphylococcus aureus* and are **wondering whether this nefarious microbe** might be at the bottom of the outbreak.

a) (6 pts) Given this hunch, **outline 4-5 steps** you would take to **isolate** and **identify** the **microbe responsible** for the outbreak.

When you stain a sample of the microbe you isolated and look under the light microscope, you see a form consistent with *Staphylococcus aureus*.

b) (2 pts) What **total magnification** would you use to see the microbe and what **shape** is it?

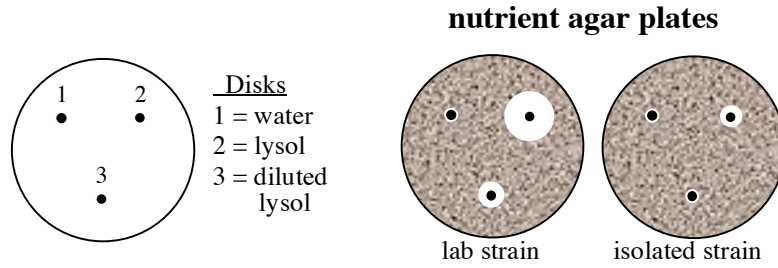
You determine the sequence a 100 nucleotide piece of one of the microbe's genes and find that it is identical to that from a laboratory strain of *S. aureus*.

c) (1 pt) What **type of molecule** is a **gene** in *S. aureus*?

d) (3 pts) If the outbreak had been caused by **Norwalk virus** (as on the cruise ship last summer) **rather than S. aureus** would the **experiments in parts a and b work? Why or why not?**

e) (2 pts) **What** would you have to **change** to **identify** and **isolate this causative agent?**

You decide to test the antimicrobial resistance of the strain you isolated in (a) and compare it to that of the laboratory strain using the techniques we employed in the lab, and you find the following results:



f) (4 pts) What do **these results show** about the **two strains of *S. aureus***? **Explain why** you might see such a **difference in spite of the fact** that your **sequencing results were the same** for the two strains.

g) (4 pts) **Describe** one **place** you might consider as a **possible source** of the outbreak **strain** and **how this source** could be **connected to the difference** seen in (f)? Make sure you **explain** how **where** a strain is found might be **linked** with **resistance**.

Extra credit (2 pts)

Before you are given the flu vaccine, you are asked whether you are allergic to eggs. Why?

Extra poster question for Hepatitis and West Nile Fever groups

7. (6 pts) In the story of Balto, a heroic sled dog led a team to Nome to deliver "serum" to save people suffering in a diphtheria outbreak. This "serum" was produced as follows: the **causative agent of diphtheria** was **injected** into **horses** and several weeks later **blood was drawn** from the horses and **separated** into liquid and cellular parts. The **liquid part** was the **serum**.

a) (2 pts) What **part** of the **causative agent** of diphtheria causes **damage** to the **host**?

b) (4 pts) **How** did **the horse serum help** people already suffering from diphtheria? Make sure to include **what component of the serum** offered relief and **how** it helped patients.