

# Biology 067: Emerging Diseases Final 2003 Example 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? **Human immunodeficiency virus**

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

i. HIV infects and eventually kills helper T cells, which are required for activation of numerous other immune cells (cytotoxic T cells, B cells, macrophages), and therefore disables the immune system.

ii. HIV reverse transcribes its RNA genome into DNA and inserts it into the host cell DNA. At this stage no viral proteins are expressed so killer T cells can't recognize the infected cell to kill it (since no viral peptides are displayed on MHC molecules at the cell surface).

iii. HIV can mutate easily because reverse transcriptase makes errors in copying the viral genome. Mutations change gene sequences, leading to different protein sequences. Therefore, if the body has activated B- or T-cells that recognize HIV proteins, these mutations may make the virus unrecognizable by these memory cells.

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**.

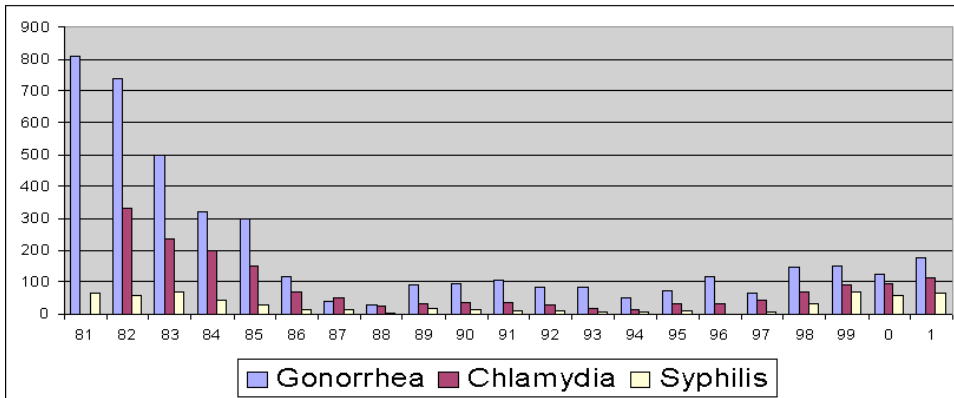
Advantages for HIV being used by terrorists include:

1. There is no known effective vaccine for HIV, so most of the world's population is susceptible to HIV.
2. HIV infection is mostly suspected by presence of opportunistic infections, so people couldn't detect infection early enough to treat it effectively (and it will continue to spread)

Disadvantages include:

1. HIV is transmitted through blood or sexual contact, so it will be hard to disseminate throughout a population (vs. a disease with respiratory spread).
2. The long incubation time for HIV means an attack wouldn't cause immediate panic/terror (although it would be able to be spread to a larger population before being detected).

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?

In gay and bisexual men, both of these diseases had high rates in the early 1980s that dropped to quite low levels in the early 1990s. However, over the past few years, the rates have started to rise again.

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

These trends may be explained by the AIDS epidemic. Sexual liberation in the 1970s, lack of condom use/high risk sexual practices in the gay community could have resulted in high levels of these two sexually transmitted diseases. Then as AIDS and HIV transmission characteristics became apparent, gay men may have started using condoms more frequently, protecting themselves from STDs. However, with effective anti-HIV drug treatments, the life threat from AIDS has appeared to lessen and unprotected sex may be rising, resulting in more bacterial STD infections.

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

If these trends were to be linked to sexual practices among gay/bisexual men, I would want to know:

- If there is a correlation between condom use in gay/bisexual men and the prevalence of these STDs (look at populations with and without the STDs and see whether condom use is higher in the healthy population).
- If similar trends are seen in the general population (women, heterosexual men), again comparing condom use and presence of STDs. A delay in the decrease in the late 1980s might be linked to people believing AIDS was a homosexual disease.
- If the gay/bisexual male population in the area remained constant during this period, since a decrease in this population would also decrease the number of cases, even if the percentage of the population that was infected remained the same.

## Part II: Group projects

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

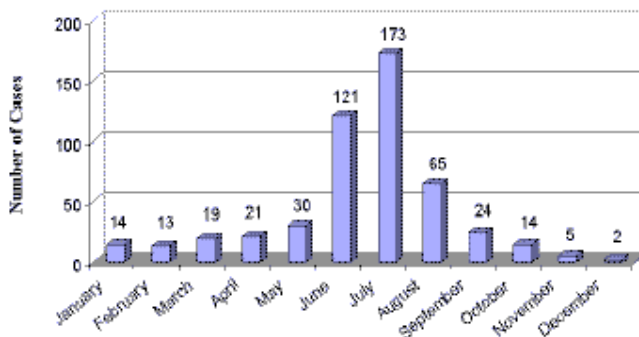
1. Read all the questions and decide which three you want to answer (3-4 min), then focus on each of your chosen questions.
2. People from the Hepatitis group cannot choose #2 and people from the West Nile group can choose either 4 or 6, but not both. These people can see me for an extra question from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

I would expect dengue and yellow fever to have similar patterns since they are both mosquito-borne (as Lyme disease is tick-borne) and humans come into contact with mosquitoes outside in the summer months. In contrast, diphtheria and whooping cough are respiratorily transmitted and would be more likely to be spread in the winter when people are inside in close quarters (and potentially suffering from other respiratory diseases).

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

Dengue and yellow fever can be prevented by getting rid of standing water that mosquitoes can breed in, using insect repellent and wearing clothing that covers one's body, all to prevent transfer from the vector. Diphtheria and whooping cough can be prevented by vaccines (as can yellow fever) and by good hygienic practices (covering one's mouth and washing hands).

**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).

There is an effective vaccine against poliovirus and no effective vaccine against the malarial parasite, as yet (in part because the parasite changes its surface antigens rapidly). Circle vaccination is key for eradication to eliminate susceptible hosts for the pathogen. Polio only infects humans and chimpanzees and is transmitted fecal-orally whereas malaria is mosquito-borne and can infect more animals, so it would be challenging (to say the least) to rid the world of all malarial vectors as well as monitoring hosts for the absence of the pathogen.

**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)?

If the agents can all replicate in and cause inflammation of the meninges (spinal cord and brain), multiple agents, viral or bacterial, can cause 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**.

West Nile fever is a mosquito-borne virus and there is no human vaccine yet. Therefore prevention is primarily through controlling the vector--getting rid of standing water, wearing insect repellent etc. However, "meningitis" can be caused by bacteria that are spread fecal-orally and for which there is a vaccine and by viruses that are spread respiratorily (with no vaccine), so good hygiene is critical for stemming its spread.

### **Part III**

**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.

The lab strain is more sensitive to lysol than the isolated strain (larger zone of clearing where cells have died). I only sequenced one part of one gene and this gene may not be responsible for the lysol resistance of the isolated strain (bacteria have thousands of genes). Another gene, either transferred from another bacterium or a normal *S. aureus* gene that has mutated, could cause lysol resistance.

**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 (d)? Make sure you **explain** how **where** a strain is found might be **linked** with **resistance**.

A possible source might be the counters or tables of the dining halls. These surfaces are regularly treated with antimicrobials such as lysol in order to kill microbes. However, some microbes have certain genetic mutations by chance (or particular genes) that favor survival of the bacteria in the presence of the antimicrobial agent. These resistant bacteria will then survive more and reproduce themselves, eventually shifting the population to display the same phenotype, as all the susceptible bacteria are killed and the resistant ones are left.