

Biology 067: Emerging Diseases Midterm

Thursday, October 16, 2003

Instructions:

1. 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.
 2. 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**.
 3. Aim for **CLEAR, CONCISE, COMPLETE** answers.
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1. (15 pts total) Exposure, infection and disease

You are watching the "Influenza, 1918" video with your grandparents. When the epidemiologist Dr. Shirley Fannin says "You **can't barrier** yourself from **being exposed** [to influenza], because the **person who looks healthy** may be the one **spreading the disease**," your grandparents are confused. **They ask you** the following **questions**, which **you proceed to answer**:

A. (3 pts) What does Dr. Fannin mean by "**spreading the disease**?" **What exactly is being spread** from person to person?

B. (6 pts) What is the **difference** between being "**exposed**" and being "**infected**?"

C. (6 pts) **How** can a person who **appears healthy** "**spread a disease**?" **At what stage of disease** is this type of **spread likely to happen**?

2. (18 pts total) Identifying disease causes in the 19th century

In the early 1890's, Dr. Friedrich Johann Pfeiffer was studying **influenza** and he **isolated** a **bacterium** he called "*Hemophilus influenzae*" he **thought caused the disease**.

A. (12 pts) Assuming he **listened to Robert Koch's** proposal for **identifying causative agents**, what **experimental steps** do you think Pfeiffer would have taken to identify his bacterium?

B. (6 pts) As it turned out, **Pfeiffer misidentified the cause of influenza**. What is the **real causative agent for influenza** and what would **you** do differently to identify this agent and **why** (assuming you had all the right experimental tools)?

3. (67 pts total) Anthrax, antibiotics and immunity

Twin sisters were born and raised on a dairy farm in Huxley, Iowa. Helen moved to Minneapolis after college and Imogene stayed in Huxley to run the family farm. In 1990, **Imogene** noticed an **infected cut** on her arm but **waited several days** to go to the doctor. After **taking a sample** for future study, the **doctor diagnosed the infection as cutaneous (skin) anthrax** and prescribed a 60-day course of **ciprofloxacin** (an **antibiotic**), which **completely cleared the infection**.

A. (6 pts) What is an **antibiotic** and **how** does it help **clear an infection**?

B. (6 pts) If the infection on Imogene's arm **had been diagnosed** as a **smallpox** infection, would **ciprofloxacin** have been used to **treat her**? **Why or why not**?

In 1991, Helen was working in the central Minneapolis post office when she discovered a letter that was leaking a fine, white powder. She was immediately **treated** with the **new anthrax anti-toxin called "Abthrax"** (in combination with antibiotics). This **anti-toxin** consists of **purified human antibody that recognizes the "A" subunit of the anthrax toxin**.

C. (12 pts) Describe what Abthrax would do in the body to help prevent the damage caused by *B. anthracis*. Highlight how this process differs from antibiotic treatment.

Later laboratory analysis revealed that the powder was talcum powder and contained **no *Bacillus anthracis***. In 1996 Helen retired from the post-office and moved back to the family farm. When a few cows on the farm became terribly sick, the sisters worked side-by-side to care for the animals. Shortly thereafter, **Helen** developed a **severe case of cutaneous anthrax** whereas **Imogene** showed **no symptoms of infection**.

D. (18 pts) Assuming both sisters were exposed to *B. anthracis* at this time, why would Imogene be immune to infection while Helen was susceptible? Explain the differences in the cells of their immune systems and why Abthrax treatment did not confer lasting immunity.

Helen was immediately given **ciprofloxacin**, but the **infection persisted** until they switched to a **different antibiotic**. Worried about the emergence of a **ciprofloxacin-resistant *B. anthracis* strain**, researchers used PCR and DNA sequencing to determine **gene sequences for the strains that infected Imogene (in 1990) and Helen (in 1996)**. They **only** found **one gene** whose **sequence differed** between the two strains, as shown on the next page.

E. (15 pts) Predict the amino acid sequence of the proteins encoded by the different bacteria, using the transfer RNAs shown below.

Imogene's strain

Protein:













<u>GAU</u>	<u>UAU</u>	<u>UCU</u>	<u>AUC</u>	<u>UAU</u>	<u>GAU</u>	mRNA
CTA	ATA	AGA	TAG	ATA	CTA	DNA
GAT	TAT	TCT	ATC	TAT	GAT	

Helen's strain

Protein:

<u>GAC</u>	<u>UAU</u>	<u>UUU</u>	<u>AUC</u>	<u>UAU</u>	<u>GAU</u>	mRNA
CTG	ATA	AAA	TAG	ATA	CTA	DNA
GAC	TAT	TTT	ATC	TAT	GAT	

transfer RNAs

Phe  AAA	Asp  CUA	Leu  GAC	Ile  UAG	amino acid
Ser  AGA	Asp  CUG	Leu  GAU	Ile  UAU	amino acid
Val  AUA			Arg  UCU	amino acid
Sto  AUC			Lys  UUU	amino acid

F. (10 pts) Circle the DNA mutation that you think is responsible for the antibiotic-resistance of Helen's strain and explain your reasoning.