This is the **Disease Detectives C** exam for BEARSO 2020. There are three sections to this event:

1. Background and Surveillance
2. Outbreak Investigation
3. Patterns, Control and Prevention

Good luck on your investigation!

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1. (3.00 pts)
You're a time-traveling public health trainee, hoping to help those suffering from outbreaks in the past with the knowledge of the future! It's the day of your final exam to become an official Public Health Time-Wizard. To calm your nerves, you run through a possible test scenario in your head.

==

Consider a hypothetical disease (Cherry-Pox) that is somehow spread through cherry ice cream and person-to-person contact with the infected. For the following interventions, write **C** if the approach is clinical, **PH** if the approach is related to public health, and **B** if the intervention could be considered both.
    a. Banning inclusion of cherries in ice cream until the disease is contained. _____

    b. Implementing strict hygiene guidelines for ice cream workers. _____

    c. Development of free diagnostic tests for those that consumed cherry ice cream. _____

Fill out the blanks left to right for parts a to c.

PH	PH	B

---

2. (2.00 pts)   If the disease could not be spread from person-to-person, what answer(s), if any, would you change from the previous question? Explain.

Expected Answer: (c) would be primarily a *clinical approach* instead of *both* (focused on diagnosing individuals not on population-level disease prevention through contact tracing) if the disease isn't communicable.

[   ]

3. (6.00 pts)   Which of the following objective(s) would you hire an epidemiologist to help with?

(Mark **ALL** correct answers)

- ☑ A) Seeing if smoking puts people at higher risk for Cherry-Pox.
- ☑ B) Discerning whether pink food coloring or cherries themselves cause Cherry-Pox.
- ☐ C) Testing the effects of the Cherry-Pox agent on different kinds of cells in the body.
- ☑ D) Noting differences btwn those that recover fully and those who develop permanent disabilities.
- ☑ E) Determining whether social distancing is helpful for preventing spread of Cherry-Pox.
- ☐ F) Development of a vaccine to prevent Cherry-Pox in children.

4. (2.00 pts)

If you wanted to solve objective (b) from the previous question, fill in the missing step:

1. Collect data on Cherry-Pox rates for consumers of strawberry ice cream using the same pink food coloring. Collect the same type of data for the general population as well.
2. Based on the data, consumers of strawberry ice cream do not have statistically higher rates of Cherry-Pox than the general population. You infer that it must be the cherries themselves causing Cherry-Pox.
3. _____
4. To intervene, the government bans cherries from being included in ice cream.

Expected Answer: Test your hypothesis - see if consumers of cherry ice cream have higher rates of Cherry-Pox compared to the general population.

[   ]

5. (1.00 pts)   Order the following steps chronologically by listing the letter of each step in order from first to last (e.g. abcde):

   a. The ice cream consumer is diagnosed with Cherry-Pox disease.

   b. The cherries induce build up of particulates in the urinary and renal tracts.

   c. An ice cream enthusiast attends a spring cherry blossom festival and ingests contaminated ice cream.

   d. The ice cream consumer feels pain in their back and during urination.

   e. The ice-cream consumer recovers with chronic kidney complications.

Expected Answer: cbdae

[   ]

6. (1.00 pts)   The incubation period is between which two statements from the previous question?

Expected Answer: b and d

[   ]

7. (1.00 pts)   True or False: The incubation period is typically consistent within a given disease, but can vary widely between diseases

○ True   ● False

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8. (3.00 pts)
Answer the questions regarding the following facts about Cherry-Pox:

A cherry aphid is a pest that feeds on cherry juices. Due to climate change, their natural environment has shifted North to a region including Lake Cerise. A virus naturally found in Lake Cerise has been transmitted from the lake water into cherries by the cherry aphids. It has been found that sharing items such as straws or eating utensils with the infected leads to transmission of Cherry-Pox person-to-person.
==
    a. What is the vector?
    b. List the fomite(s).
    c. If the virus is ingested by the host but does not invade the tissue, what is this condition called?

| Cherry aphid | Straws, eating utensils | Contamination |

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9. (1.00 pts)
It was found that while exposure to the Cherry-Pox virus infected a high proportion of people, only a small amount of the infected developed clinical disease. However, only a small number of those with clinical disease did not become severely ill. How would you describe the level of infectivity, pathogenicity, and virulence for Cherry-Pox (**high** vs. **low**)?

_____ infectivity, _____ pathogenicity, _____ virulence

| high | low | high |

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10. (8.00 pts)   Put the following steps in chronological order along with the name of each step in the public health approach (e.g. a - name, b - name, c - name, d - name):
    a. Tracing the disease to a virus living in a specific species of cherry that lay dormant in the cold temperatures of ice cream.
    b. Recording high numbers of ice cream enthusiasts falling ill during cherry season.
    c. Banning inclusion of cherries in all cold desserts.
    d. Preventing consumption of contaminated cherries and analysis of Cherry-Pox rates.

Expected Answer: b - surveillance, a - risk factor identification, d - intervention evaluation, c - implementation

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11. (1.00 pts)   What is the first step of the five steps of public surveillance?

○ A) Data analysis
● B) Data collection
○ C) Data dissemination
○ D) Link to action
○ E) Data interpretation

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12. (1.00 pts)   "Data dissemination" would be which step of the five steps of public surveillance?

○ A) First
○ B) Second

○ C) Third

● D) Fourth

○ E) Fifth

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13. (1.00 pts)   Every month, all health facilities are required to report certain diseases so that outbreaks can quickly be identified. What is this an example of?

○ A) Active surveillance

● B) Passive surveillance

○ C) Syndromic surveillance

○ D) Sentinel surveillance

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14. (1.00 pts)   A specific group of people who may have been exposed to Cherry-Pox is being monitored for the development of symptoms. What is this an example of?

○ A) Active surveillance

○ B) Passive surveillance

● C) Syndromic surveillance

○ D) Sentinel surveillance

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15. (3.00 pts)

Fill in the three blanks by matching the following terms to their definitions/properties. The first blank should contain the letter (eg. A, B, C, D...) for "host," the second blank should contain the letter for "fomite," and the third blank should contain the letter for "nosocomial." Please note that the following questions will also use this format.

i) Host: _____

ii) Fomite: _____

iii) Nosocomial: _____

| A. An organism's ability to cause disease. |
| B. Can spread between humans and animals. |
| C. Proportion of population affected by a disease. |
| D. Location in which an agent lives and multiplies. |
| E. Disease due to exposure at a hospital. |
| F. Possible exposure factors are being associated to a known disease after an outbreak has occurred. |
| G. An organism's ability to cause infection. |
| H. Causative agent of a disease. |
| I. Inanimate objects with the capacity to cause disease transmission. |
| J. Measure of the severity of the disease caused by an organism. |
| K. Shows joint probabilities based on exposure and presence of disease. |
| L. An organism that can be infected by an agent. |
| M. A disease is trying to be associated to exposure factors that are already known. |
| N. Shows distribution of cases over time. |
| O. Occurrences of new cases of a disease. |

L		I		E	

16. (3.00 pts)

Fill in the three blanks by matching the following terms to their definitions/properties.

i) Contingency table: _____

ii) Agent: _____

iii) Epicurve: _____

A. An organism's ability to cause disease.

B. Can spread between humans and animals.

C. Proportion of population affected by a disease.

D. Location in which an agent lives and multiplies.

E. Disease due to exposure at a hospital.

F. Possible exposure factors are being associated to a known disease after an outbreak has occurred.

G. An organism's ability to cause infection.

H. Causative agent of a disease.

I. Inanimate objects with the capacity to cause disease transmission.

J. Measure of the severity of the disease caused by an organism.

K. Shows joint probabilities based on exposure and presence of disease.

L. An organism that can be infected by an agent.

M. A disease is trying to be associated to exposure factors that are already known.

N. Shows distribution of cases over time.

O. Occurrences of new cases of a disease.

K		H		N	

17. (3.00 pts)

Fill in the three blanks by matching the following terms to their definitions/properties.

i) Case-control: _____

ii) Reservoir: _____

iii) Incidence: _____

A. An organism's ability to cause disease.

B. Can spread between humans and animals.

C. Proportion of population affected by a disease.

D. Location in which an agent lives and multiplies.

E. Disease due to exposure at a hospital.

F. Possible exposure factors are being associated to a known disease after an outbreak has occurred.

G. An organism's ability to cause infection.

H. Causative agent of a disease.

I. Inanimate objects with the capacity to cause disease transmission.

J. Measure of the severity of the disease caused by an organism.
K. Shows joint probabilities based on exposure and presence of disease.
L. An organism that can be infected by an agent.
M. A disease is trying to be associated to exposure factors that are already known.
N. Shows distribution of cases over time.
O. Occurrences of new cases of a disease.

F	D	O

18. (3.00 pts)
Fill in the three blanks by matching the following terms to their definitions/properties.

i) Zoonotic: _____

ii) Retrospective cohort: _____

iii) Prevalence: _____

A. An organism's ability to cause disease.
B. Can spread between humans and animals.
C. Proportion of population affected by a disease.
D. Location in which an agent lives and multiplies.
E. Disease due to exposure at a hospital.
F. Possible exposure factors are being associated to a known disease after an outbreak has occurred.
G. An organism's ability to cause infection.
H. Causative agent of a disease.
I. Inanimate objects with the capacity to cause disease transmission.
J. Measure of the severity of the disease caused by an organism.
K. Shows joint probabilities based on exposure and presence of disease.
L. An organism that can be infected by an agent.
M. A disease is trying to be associated to exposure factors that are already known.
N. Shows distribution of cases over time.
O. Occurrences of new cases of a disease.

B	M	C

19. (3.00 pts)

Fill in the three blanks by matching the following terms to their definitions/properties.

i) Virulence: _____

ii) Infectivity: _____

iii) Pathogenicity: _____

A. An organism's ability to cause disease.

B. Can spread between humans and animals.

C. Proportion of population affected by a disease.

D. Location in which an agent lives and multiplies.

E. Disease due to exposure at a hospital.

F. Possible exposure factors are being associated to a known disease after an outbreak has occurred.

G. An organism's ability to cause infection.

H. Causative agent of a disease.

I. Inanimate objects with the capacity to cause disease transmission.

J. Measure of the severity of the disease caused by an organism.

K. Shows joint probabilities based on exposure and presence of disease.

L. An organism that can be infected by an agent.

M. A disease is trying to be associated to exposure factors that are already known.

N. Shows distribution of cases over time.

O. Occurrences of new cases of a disease.

J	G	A

20. (5.00 pts)

You passed your exam! For your first assignment, you travel to the year 541, the beginning of a 200-year-long pandemic: the Plague of Justinian. You have been sent back in time to Constantinople to try and aid the ailing European population with your knowledge of modern-day approaches to health care.

As outlined by the CDC, you prepare for fieldwork by gathering the supplies and accommodations you need around the empire. At first, Emperor Justinian does not believe that there is an outbreak occurring even though there is a rise in the number of recorded sick citizens.

==

Which of the following would support your claim that an outbreak is occurring?

(Mark **ALL** correct answers)

- ☐ A) There has been an improvement in reporting rates recently in the empire
- ☑ B) The population of the empire has remained constant for the past decade
- ☑ C) The increase in sick citizens does not seem to vary with seasonal changes
- ☐ D) The number of sick citizens is well predicted by the health and death records from the previous year
- ☐ E) After interviewing patients, it seems there is a variety of different exposures pre-illness

21. (2.00 pts) For the previous question, if the claim did not support the existence of an outbreak, explain why not (e.g. a - reason, b - reason, c - reason).

Expected Answer: a - The increased number of sick citizens may be due to more diligent reporting rather than a true uptick in disease, d - If the number of cases is similar to previous years then there is not an abnormal spike in reported disease (could be a seasonal fluctuation), e - An important part of verifying the diagnoses is to establish commonality in identifying a possible cause/source

22. (3.00 pts)

The Emperor relents and admits that there might be an outbreak occurring. He sends his advisors to gather information on the sick citizens. Given the following report, construct a complete case definition:

The physician's report notes that many patients have had a fever during the last two months and worked at the trading port in Constantinople. They also note the presence of several swollen lymph nodes nearly the size of chicken eggs under the skin. The physician also noted that there may be some link between fleas or rats and the spread of the disease.

Expected Answer: An illness with onset of fever and swollen lymph nodes among persons who worked at the trading port in Constantinople within the last two months.

23. (6.00 pts) Write a list of variables you would collect for a line listing for *this specific outbreak* given the information presented in the physician's report in the previous question.

Expected Answer: ID, date-onset, diagnosis, age, sex, region/town, exposure to fleas, exposure to rats, occupation, presence of swollen lymph nodes, presence of fever

24. (1.00 pts)
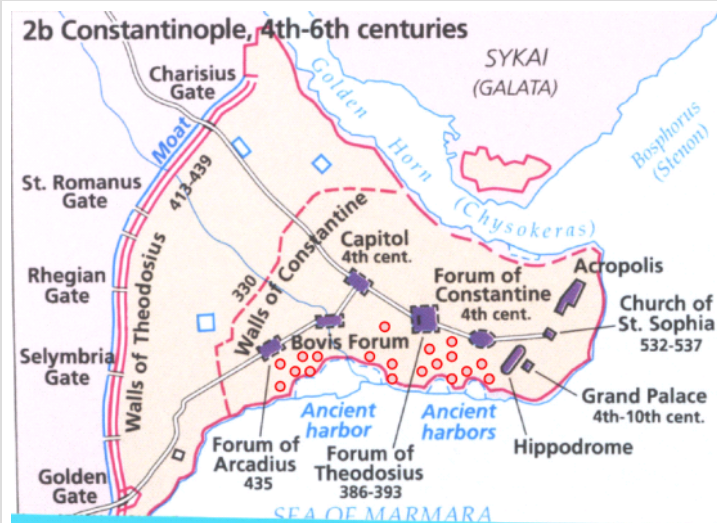*After several weeks of collecting data systematically on each case, you receive the following data:*

Figure 1	Figure 2

2b Constantinople, 4th-6th centuries

THE BYZANTINE EMPIRE IN THE SIXTH CENTURY

What is the name of the data shown in the figures?

Expected Answer: Spot/cluster map

25. (1.00 pts) What do the circular red symbols mean in Figure 1?

Expected Answer: Individual cases of plague in Constantinople

26. (2.00 pts) Based on the distribution of points in Figure 1 and Figure 2, what conclusion can you draw about how the disease is spreading? Explain.

Expected Answer: Presence of disease in coastal nations in Figure 2 and clustering of cases near harbors in Figure 1 suggest the disease is spreading via ship trading routes.

27. (2.00 pts) Do the clusters of cases in Figure 1 necessarily indicate that the rate of infection is higher in those areas? Why or why not?

Expected Answer: No, it could be that a majority of the population lives in those areas.

28. (2.00 pts) If you wanted to determine which regions had the highest rates of plague cases, would you prefer to use the map above or an area map? Explain.

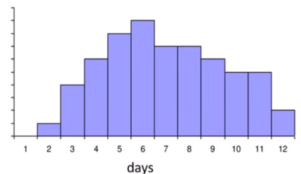**Expected Answer:** Area map - will show cases in proportion to the total population.

29. (1.00 pts)
To track the number of cases, you have the Emperor's assistants construct epi curves. Knowing that the bubonic plague is rarely transmitted person-to-person and that trading shipments arrive in Constantinople on a periodic basis, which curve would you expect?
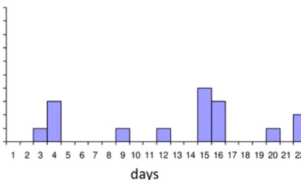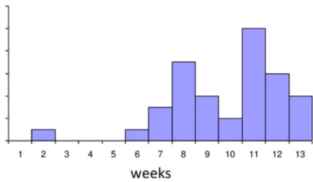
A)

B)

C)

D)

weeks
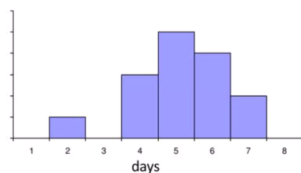
Expected Answer: C

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30. (1.00 pts) Has your investigation so far been an experimental or observational epidemiology study?

Expected Answer: Observational

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31. (3.00 pts)

Match each of the following studies to one of the types of observational epidemiology studies:

1. You give orders to the Emperor's assistant to record whether a random group of citizens has encountered rats or been bitten by fleas and whether or not they have the plague.
2. You give orders to the Emperor's assistants to gather information on a group of citizens and whether they've encountered rats or been bitten by fleas. They record if and when the citizens become ill with the plague at a later time.
3. You give orders to the Emperor's assistants to record the rate of plague cases amongst those who have been bitten by fleas in the past two months.

| Cross sectional | | Cohort | | Ecological | |

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32. (2.00 pts) The Emperor's assistants return with the data below. What are 2 conclusions you can draw about the relationship between plague case rate, gender, and flea bite exposure?

	Confirmed Plague Case	Confirmed Plague Case	Healthy	Healthy
Gender	Bitten by flea in past 2 mo.	No recorded flea bites	Bitten by flea in past 2 mo.	No recorded flea bites
Female	7	0	3	14
Male	13	1	8	12

Expected Answer: There is no difference in susceptibility between men and women to the plague that can be seen in this table. There is a correlation between exposure to flea bites and incidence of the plague. Men seem to have a higher number of flea bites compared with women.

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33. (1.00 pts) We are now trying to determine whether the plague disease can be associated with exposure to fleas. What type of study would this be?

○ A) Retrospective cohort

○ B) Prospective cohort

○ C) Case-control

○ D) Cross-sectional

○ E) None of the above

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34. (3.00 pts)
Combine the data for both genders into one 2x2 contingency table shown below. Some blanks are missing. Please fill in the first blank for (a), the second blank for (b), and the third for (c).

	Plague disease present	Plague disease absent
Flea bite	(a)	(b)
No flea bite	(c)	26

20	11	1

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35. (1.00 pts)   To determine the strength of the association between flea bites and the plague, what metric should you use?

○ A) Attack rate

○ B) Mortality rate

○ C) Odds ratio

● D) Relative risk

○ E) None of the above

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36. (3.00 pts)   Perform the calculation for the metric you chose in the previous question. Round to two decimal places.

19.02

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37. (1.00 pts)   Let "x" be the value you calculated for the previous question. What is the correct interpretation of this value?

○ A) Exposure to flea bites creates a (x*100)% higher chance of contracting the plague disease.

● B) The probability of contracting the plague disease is "x" times higher if you've been exposed to flea bites.

○ C) The value of "x" suggests that no conclusion can be drawn.

○ D) None of the above.

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38. (1.00 pts)   Let "x" be the value you calculated for the previous question. Does its value suggest that there is a significant association between flea bites and the plague disease?

● A) Yes

○ B) No

○ C) Inconclusive

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39. (2.00 pts)

Suppose that an imperfect diagnosis test for the plague disease has been developed, and you want to assess the usability of this test. The test will either return positive or negative for a person; HOWEVER, this test will wrongly return some results (ie. there will be false positives and false negatives in addition to true positives and true negatives). Fill out the following table with the following: TP, TN, FP, FN.

Please only use the abbreviations when filling the blanks. Note that they stand for "true positive," "true negative," "false positive," and "false negative," respectively.

	Positive test result	Negative test result
Disease present	(a)	(b)
Disease absent	(c)	TN

TP		FN		FP

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40. (1.00 pts) One of the measures that is used to evaluate diagnostic tests is the positive predictive value. Which of the following best describes the PPV?

○ A) The ability of a test to detect whether a person has the disease.

○ B) The ability of a test to determine whether a person does NOT have the disease.

● C) The probability that a subject with a positive test result truly has the disease.

○ D) The probability that a subject with a negative test result truly does not have the disease.

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41. (1.00 pts) One of the measures that is used to evaluate diagnostic tests is the sensitivity. Which of the following best describes the PPV?

● A) The ability of a test to detect whether a person has the disease.

○ B) The ability of a test to determine whether a person does NOT have the disease.

○ C) The probability that a subject with a positive test result truly has the disease.

○ D) The probability that a subject with a negative test result truly does not have the disease.

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42. (1.00 pts) One of the measures that is used to evaluate diagnostic tests is the specificity. Which of the following best describes the PPV?

○ A) The ability of a test to detect whether a person has the disease.

● B) The ability of a test to determine whether a person does NOT have the disease.

○ C) The probability that a subject with a positive test result truly has the disease.

○ D) The probability that a subject with a negative test result truly does not have the disease.

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43. (9.00 pts)
The table has now been filled with the following values. Calculate the following **to two decimal places**, and express decimal values less than 1 with a preceding "0." (eg. 0.25, not .25).

First blank: sensitivity

Second blank: specificity

Third blank: positive predictive value

|	Positive test result	Negative test result
Disease present	25	3
Disease absent	9	50

| 0.89 | 0.85 | 0.74 |

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44. (2.00 pts)

The Emperor's assistants return with even more data and insist you must begin to control the spread of the disease! It is a graph of the distribution of plague cases in the southern district of Constantinople.

Green = healthy population, **red** = pre-existing plague cases prior to start of observation time, **blue** = new plague cases since the start of the observation time
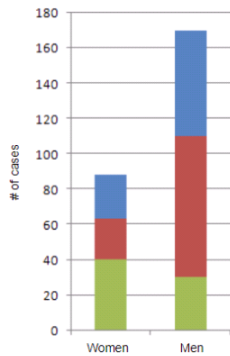
According to the graph, what is the prevalence of plague at the point of observation for both men and women (round to the nearest 0.01)?

Expected Answer: Women = 0.53, Men = 0.81 Both +/- 0.04

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45. (2.00 pts)   What is the incidence rate of plague at the point of observation for both men and women (round to the nearest 0.01)?

Expected Answer: Women = ~26/88 = 0.30 (+/- 0.04), Men = ~60/170 = 0.35 (+/- 0.04)

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46. (2.00 pts)   Given the prevalence and incidence rates for men, what conclusion can you draw about the length of survival without cure? Explain.

Expected Answer: The prevalence rate is much higher than the incidence rate, suggesting prolonged survival without cure.

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47. (1.00 pts)   What is the ratio of males with the plague to healthy males? Round to the nearest 0.1 if expressing your answer as a decimal.

Expected Answer: 138:32 ~ 4.3

48. (2.00 pts)

If the number of deaths attributed to plague during the observation period is 15 and 40 for women and men, respectively, calculate the death to case ratio from the point of observation (round to the nearest 0.01).

Expected Answer: Women = ~15/26 = 0.58, men = ~40/60 = 0.66 Both +/- 0.04

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49. (2.00 pts) What can you say about the severity of the disease given the death to case ratio? Explain.

Expected Answer: The severity is high as over half of the people who have the plague die from it.

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50. (1.00 pts) Given the table below, calculate the proportionate mortality for the plague (round to the nearest 0.01).

Cause	Number of Deaths
Bubonic plague	65
Heart disease	4
Pneumonia	2
Accidents	2
Septicemia	1
Cancer	6
All other	70

Expected Answer: 65/150 = 0.43

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51. (1.00 pts) Why is the value calculated in the previous question not considered a rate?

Expected Answer: The denominator is all deaths, not the size of the population in which the deaths occurred.

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52. (1.00 pts) Propose a set of three prevention strategies for the plague given the previously identified cause.

Expected Answer: Block transmission - use insecticide or other methods to kill fleas, disinfect ships, quarantine infected persons, educate the public on how the disease spreads, training physicians on warning signs of plague (flea bites), rehabilitating those with the plague to prevent further complications

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53. (1.00 pts)

Consider a person who has been diagnosed with the plague disease after developing symptoms. Doctors at the time immediately treat him with a mixture of spices in an effort to prevent further worsening of the disease. Regardless of whether this treatment is effective, what stage of disease prevention would this action be considered?

○ A) Primary

○ B) Secondary

● C) Tertiary

○ D) Quaternary

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54. (1.00 pts)   Which of the following scenarios would be an example of secondary prevention?

● A) Giving treatment to prevent the disease from becoming symptomatic.

○ B) Giving treatment to slow the progression of disease after symptoms have already appeared.

○ C) Implementing control measures to prevent the disease from being contracted in the first place.

○ D) Educating the public about the dangers of the disease.

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55. (1.00 pts)

An epidemiologist investigates the plague disease by visiting a farm. He notices that almost none of the working farmers show any symptoms of the disease, and concludes that the prevalence of the plague disease is not as common as he originally anticipated. However, his conclusion is flawed due to…

○ A) Indication bias

○ B) Attrition bias

○ C) Information bias

● D) Healthy worker effect

○ E) None of the above

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56. (1.00 pts)

The same epidemiologist continues his investigation by counting the number of plague cases he observes in the surrounding villages. Upon entering a new village, he counts the total number of cases using an abacus (aka counting frame). However, he fails to realize that his abacus is missing a bead, causing the total count for each village to be off by one. This is an example of…

○ A) Random error

● B) Systematic error

○ C) Type I error

○ D) Type II error

○ E) None of the above

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57. (1.00 pts)

After visiting all the villages, the epidemiologist finally realizes that his abacus was broken. In an attempt to reduce the effect of the counting errors, he decides to average all his counts. Considering your response to the previous question, was this an effective way to reduce the error in his investigation?

○ A) Yes

B) No

C) Not enough information

This is the **END** of the exam.