Disease Detectives

Name

High School

Team Number

Directions: The following examination contains a series of short answer questions. You will have fifty minutes to complete the test. Selected questions will serve as tie breakers. Approximately half of the questions within the examination will focus on food borne pathogens and disease.

1. What are the ten steps to investigating an outbreak? (5 pts)

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2. List the four types of study designs and two advantages associated with each. (12 pts)

3. Define primary, secondary, and tertiary disease prevention. (6 pts)

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_____

4. Classify the following diseases as bacterial, viral, fungal, or parasitic. (10 pts, 1 pt each)

A. Candidiasis _____

B. Yersinia _____

C. Botulism _____

D. Toxoplasmosis _____

E. Typhoid Fever _____

F. Listeriosis _____

G. West Nile _____

H. Giardiasis _____

I. Trichinellosis _____

J. Cholera _____

5. Hill's Criteria for Causation are nine criteria that must be met to establish a cause-and-effect relationship. List and describe the nine criteria. (9 pts)

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6. What are five methods of reducing the risk of food-borne illnesses? (5 pts)

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7. List and describe three types of epidemic curves and the epidemic transmission types they describe. (6 pts)

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8. List the 3 characteristics of an agent that define its potential to spread and cause disease (3 pts)

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Section II Data Analysis (87 pts)

A. Use these data to create an epidemic curve of a gastroenteritis outbreak in a daycare center. Stratify the results by age group and label the graph appropriately. (12 points)

Day	N cases < 1 year of age	N cases 1-2 years	N cases Teacher
day1	1		
day2	1	1	
day3	2	1	
day4	3		1
day5	4		.
day6	2	3	
day7	3		
day8	3		
day9	1		
day10	0		

If we assume that reporting is complete and accurate, and there are 25 children in each age category and 25 teachers, answer the following T/F questions: (6 points)

The incubation period is 5 days	T	F
The disease indicates a point source transmission	T	F
Secondary spread of the disease was common	T	F
Immunity is generally life long	T	F
The attack rate is highest in those < 1	T	F
The peak of the epidemic was on day 4	T	F

Bonus (2 points): the relative risk of disease in those < 1 years as compared to those over 1 year of age =

B. For Salmonella infections it can take 2-3 weeks for a case to be reported. Given this, answer the following true/false or short answer questions: (2 pts each)

|		
After 2-3 weeks, data collected for the epidemic represents the current situation	T	F
The index case is the case from which all other cases derived	T	F
The first case reported in the epidemic time period represents the first transmission in the epidemic	T	F

Tie breaker: Explain why or why not the first case in the above question is the first case of an outbreak. (3 pts)

Tie breaker: After an epidemic begins to decline, a new peak in cases could be caused by: (3 pts)

_____
_____
_____
_____
_____

C. The following table highlights some of the major differences in data and methodology between the 2011 estimates of food borne gastroenteritis disease and those published in 1999. In 1999, 211 million cases of food born gastroenteritis were reported and in 2011 – 178.8 million. Circle the differences in the study design that could explain the measured decline. (5 pts)

1999 Estimate	2011 Estimates
Respondents reporting any vomiting included in definition of acute gastroenteritis.	Respondents reporting vomiting for <1 day or whose illness did not restrict activities excluded from definition of acute gastroenteritis. 5 times larger 2011 sample size (>48,000) compared with 1999 estimates
25% = % respondents excluded because they reported cough or sore throat	38% = % respondents excluded because they reported cough or sore throat
Included international travel-related illnesses	Excluded international travel-related illnesses.
15% = Proportion of survey respondents with bloody diarrhea seeking medical care	35% = Proportion of survey respondents with bloody diarrhea seeking medical care

D. Relative rates of laboratory-confirmed infections with *Campylobacter, E. coli* O157. *Listeria, Salmonella,* and *Vibrio,* compared with 1996--1998 rates, by year --- Foodborne Diseases Active Surveillance Network, United States, 1996--2010
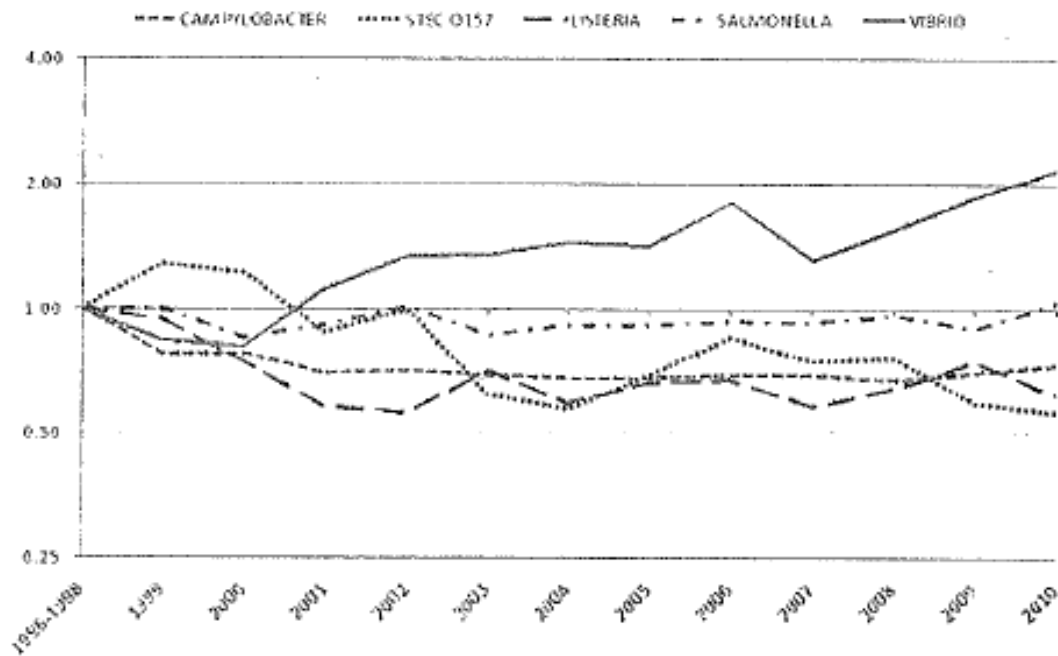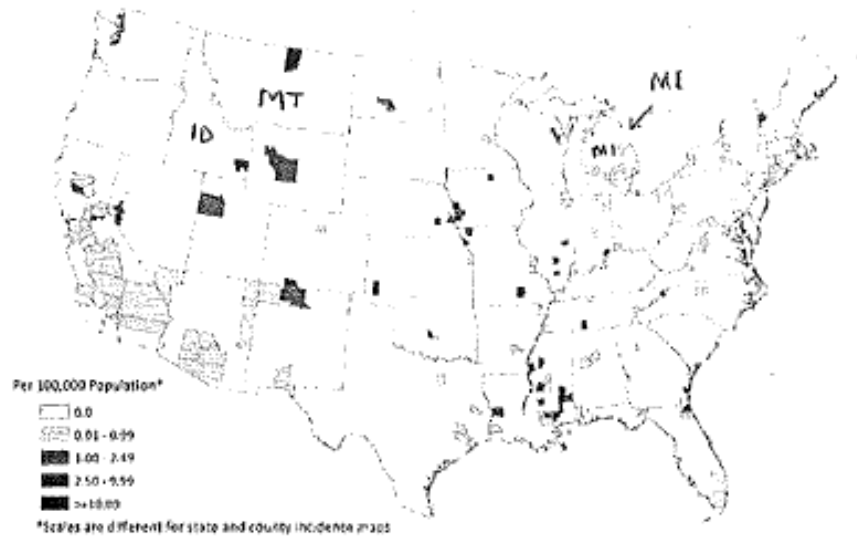

Abbreviation: STEC = Shiga toxin-producing Escherichia coli O157.

Answer the following true/false 2 pts each

This graph shows that campylobacter is a relatively minor cause of foodborne disease in the US	T	F
The rates of most foodborne illness shown here have declined since 1998	T	F
In 1998 there was 1 case/100,000 US residents of Vibrio	T	F
The incidence of salmonella has not declined in the last decade	T	F
Control measures for Vibrio have either not been identified, or not taken up in the last decade	T	F
The actual burden of disease for these pathogens cannot be estimated from this graph	T	F

West Nile virus (WNV) Neuroinvasive Disease Incidence reported to ArboNET, by county, United States, 2011 (as of January 10, 2012)

Incidence by county map data description: West Nile virus neuroinvasive disease incidence maps reflect surveillance reports released by state and local health departments to CDC's ArboNET system for public distribution. Map shows the incidence of human neuroinvasive disease (encephalitis, and/or meningitis, and/or acute flaccid paralysis) by county for 2011 with shading ranging from .01-.99, 1.0- 249, 2.50-9.99, and greater than 10.0 per 100,000 population.

E. Based on the WNV map above:

l a. Based on your knowledge of the US and the data in the map, which state is likely to have the highest number of WNV cases? 1 pt

lb. what epidemiologic factors would lead to these high numbers of cases? 3 pts

2. Notice the high rate of WNV in Montana (MT) and Idaho (ID). What characteristics or these states might explain these rates? (2 Pts)

3. Levels of WNV are also high in Michigan (MI). What characteristic of Michigan might explain this? (2 pts)

F. At an influenza immunization clinic at a retirement community, residents were asked in how many previous years they had received influenza vaccine. The answers from the first 19 residences are listed below. Organize these data into a frequency distribution (5 pts). Find the mean, median, and mode of the data set. (3 pts)

Data Set: 2, 0, 3, 1, 0, 1, 2, 2, 4, 8, 1, 3, 3, 12, 1, 6, 2, 5, and 1

G. In an outbreak of tuberculosis among prison inmates in South Carolina in 1999, 28 of 157 inmates residing in the East wing of the dormitory developed tuberculosis, compared with 4 or 137 inmates residing in the west wing. Summarize the data in a two-by-two table and calculate the risk ratio. Show your work! (8 pts)

H. Bovine Spongiform encephalopathy (BSE) was first seen in cattle in the UK in 1987. An explosive epidemic in cattle followed. Below is a graph showing the Bovine Spongiform encephalopathy epidemic in cattle followed by the epidemic of New Variant Cruezfeldt Jacob's Disease (nvCJD) human cases in the United Kingdom.
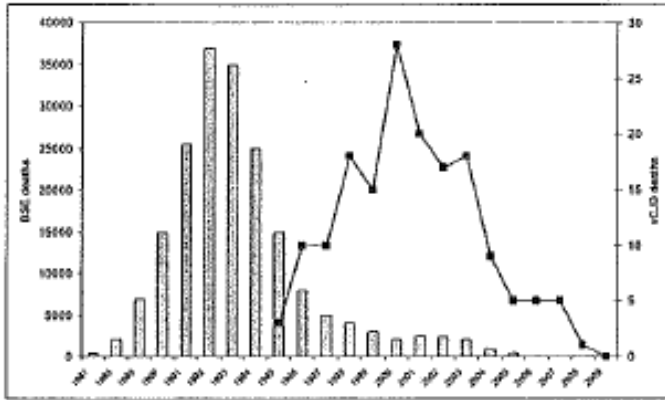
What is the causative agent of the disease? (2 pts) _____

The name is derived from characteristics of the agent, what does it stand for? (2 pts)

By what other names have diseases caused by these agents been called? (2 pts)

What is an estimate or the incubation period for nvCJD? (2 pts)

what biological factors might explain the relative size of the two curves? 4 pts

I. An outbreak occurs among Persons attending a wedding. Guests were interviewed to determine what behaviors may have lead to disease. The following data were found:

Calculate the risk specific attack rates (2pts each)

Risk Factor	Cases n=35	Not cases N=100	Risk specific attack rate
Swimming	15	39	_____
Volleyball	5	20	_____
Ate box lunch	20	95	_____
Ate Hors d'oeuvres	30	40	_____

What activity is the highest risk? (2 pts) _____

In a subsequent interview, guests were asked about what hors d'oeuvres they ate.

Ate Stuffed Mushrooms			Ate Nachos			Drank Wine		
	Yes	No		Yes	No		Yes	No
Case	9	6	Case	8	7	Case	10	5
Control	6	24	Control	20	10	Control	15	15

What is the odds ratio for eating stuffed mushrooms? (2 pts) _____
Explain what this tells you (3 Pts)

What is the odds ratio for eating nachos? (2pts) _____
Explain what this tells you (3 pts)

What is the odds ratio for drinking wine? (2 pts)_____
Explain what this tells you (3 pta)

Tie-breaker: It was later determined that the contaminated product was the meat used to prepare the mushroom stuffing. Explain how the results for wine could have been as they were. What important epidemiologic concept is seen in this example? (5 pts)

_____
_____
_____
_____
_____

Disease Detectives (KEY)

Section I: Definitions and Terms (36 points)

1. What are the ten steps to investigating an outbreak? (5 pts)

Prepare for field work
Establish the existence of an outbreak
Verify the diagnosis
Define and identity cases
Describe and orient the data in terms of person, place, and time
Develop hypotheses
Evaluate hypotheses
Refine hypotheses and carry out additional studies
Implement control and prevent measures
Communicate findings

2. List the four types of study designs and two advantages associated with each. (12 pts)
Randomized Trial – best control of exposure (because you give it). Controls for bias because randomization should equally assign persons with both known and unknown confounders between the two (or more) groups. Measures EFFICACY.
Cohort study – Can measure exposure and outcome carefully. Good for studying long-term disease processes and to measure EFFECTIVENESS. Can demonstrate a temporal association between exposure and outcome. Cohort usually assembled based on EXPOSURE
Case-control study – can study rare diseases because patients are chosen based on OUTCOME not exposure, statistically powerful, so can use smaller sample sizes this makes it either less expensive – or you can spend the money to do more intensive evaluation of patients, relatively fast as you start at the outcomes and look back for exposures, so you don't have to wait for disease to develop.
Cross-sectional study – fast, can cover n large population so generalizable, shows associations but cannot demonstrate temporal association between exposure and outcome as they are measured together.

3. Define primary, secondary, and tertiary disease prevention. (6 pts)
Primary prevention – early intervention to avoid initial exposure to agent or disease preventing the process from starting
Secondary prevention – during the latent stage (when the disease has just begun), process or screening and instituting treatment may prevent progression to symptomatic disease
Tertiary prevention – during the symptomatic stage (when the patient shows symptoms), intervention may arrest, slow, or reverse the progression of disease

4. Classify the following diseases as bacterial, viral, fungal, or parasitic. (10 pts, 1 pt each)

A. Candidiasis   (Fungal)   F. Listeriosis   (Bacterial)

B. Yersinia   (Bacterial)   G. West Nile   (Viral)

C. Botulism   (Bacterial)   H. Giardiasis   (Parasitic)

D. Toxoplasmosis   (Parasitic)   I. Trichinellosis   (Parasitic)

E. Typhoid Fever   (Bacterial)   J. Cholera   (Bacterial)

5. Hill's Criteria for Causation are nine criteria that must be met to establish a cause-and-effect relationship. List and describe the nine criteria. (9 pts)

Strength of association – relationship is clear and risk estimate is high
Consistency – observation or association must be repeatable in different populations at different times
Specificity - single cause produces a specific effect
Alternative explanations --- consideration or multiple hypotheses before making conclusions about whether an association is causal or not
Temporality – cause/exposure must precede the effect/outcome
Dose-response relationship – an increasing amount or exposure increases the risk
Biological plausibility – the association agrees with currently accepted understanding or biological and pathological processes
Experimental evidence – the condition can be altered, either prevented, or accelerated, by an appropriate experimental process
Coherence — the association should be compatible with existing theory and knowledge, including knowledge of past cases and epidemiological studies

6. What are five methods or reducing the risk or food-borne illnesses? (5 pts)

Cook to proper temperatures
Separate – don't cross contaminate one food with another
Chill – refrigerate leftovers promptly
Clean – wash produce; wash hands and surfaces often
Report suspected food borne illnesses to the local health department

7. List and describe three types of epidemic curves and the epidemic transmission types they describe. (6 pts)

Point source epidemics occur when people are exposed in the same exposure over a limited, well-defined period of lime.

Continuous common source epidemics occur when the exposure to the source is prolonged over an extended period of time and may occur over more than one incubation period.

Propagated epidemics occur when a case or disease serves later as a source or infection for subsequent cases and those subsequent cases, in turn, serve as sources for later cases.

8. List the 3 characteristics or an agent that define its potential to spread and cause disease (3 pts)

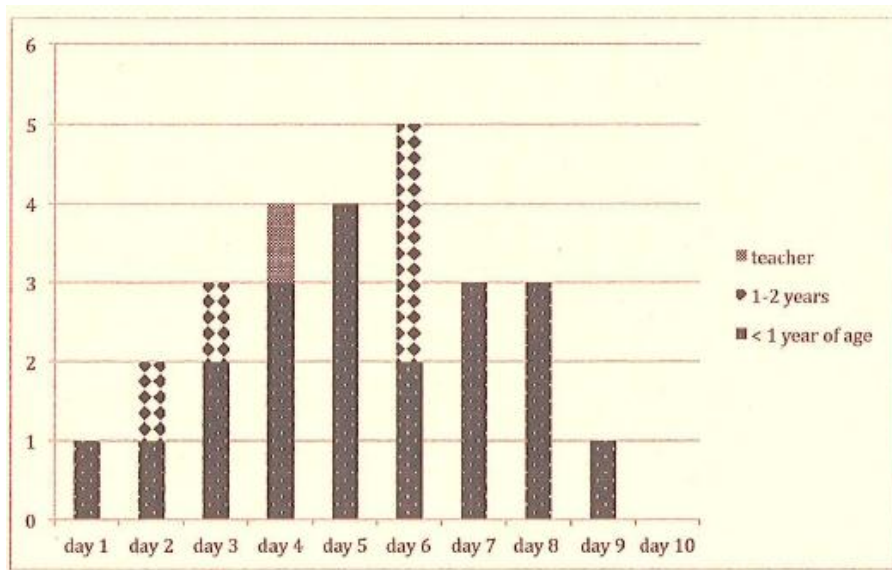Infectivity - capacity to cause infection in a susceptible host
Pathogenicity - capacity to cause disease in a host
Virulence - severity or disease that the agent causes to host

Section II   Data Analysis (87 pts)

A. Use these data to create an epidemic curve of a gastroenteritis outbreak in a daycare center. Stratify the results by age group and label the graph appropriately. (12 points)

Day	N cases < 1 year of age	N cases 1-2 years	N cases Teacher
day1	1		
day2	1	1	
day3	2	1	
day4	3		1
day5	4		.
day6	2	3	
day7	3		
day8	3		
day9	1		
day10	0		

Title: Number of cases of gastroenteritis over 10 days
Y axis: number of cases, stratified by age group
X axis: Day of illness report or onset
(points for axes, key, correct data plotting. Bar and line graphs acceptable.)

If we assume that reporting is complete and accurate, and there are 25 children in each age category and 25 teachers, answer the following questions T/F questions: (6 points)
1. The incubation period is 5 days F
2. The disease indicates a point source transmission T
3. Secondary spread or the disease was common F

4. Immunity is generally lifelong T
5. The attack rate is highest in those < 1 T
6. The peak of the epidemic was on day4 F

Bonus (2 points): the relative risk of disease in those < 1 years as compared to those over 1 year of age = (0.8/0.12) = 6.67

B. For Salmonella infections it can take 2-3 weeks for a case to be reported. Given this, answer the following true/false or short answer questions: (2 pts each)

After 2-3 weeks, data collected for the epidemic represents the current situation. F
The index case is the case from which all other cases derived. F
The first case reported in the epidemic time period represents the first transmission in the epidemic. F

Tie breaker: Explain why or why not the first case in the above question is the first case of an outbreak. (3 pts) The first case could be an underlying case of disease in the community unrelated to the current epidemic.

Tie breaker: After an epidemic begins to decline, a new peak in cases could be caused by: (3 pts)
Failure to keep maintain control measures
Secondary transmission
A new epidemic unrelated to the first
Original hypothesis of how infection was occurring was wrong

C. The following table highlights some of the major differences in data and methodology between the 2011 estimates of food borne gastroenteritis disease and those published in 1999. In 1999, 211 million cases of food born gastroenteritis were reported and in 2011 – 178.8 million. Circle the differences in the study design that could explain the measured decline. (5 pts)

1999 Estimate	2011 Estimates
Respondents reporting any vomiting included in definition of acute gastroenteritis.	Respondents reporting vomiting for <1 day or whose illness did not restrict activities excluded from definition of acute gastroenteritis. 5 times larger 2011 sample size (>48,000) compared with 1999 estimates. *No, larger sample size resulted in more precise data, not lower rate.*
25% = % respondents excluded because they reported cough or sore throat	38% = % respondents excluded because they reported cough or sore throat
Included international travel-related illnesses	Excluded international travel-related illnesses.
15% = Proportion of survey respondents with bloody diarrhea seeking medical care	35% = Proportion of survey respondents with bloody diarrhea seeking medical care. *No, same criteria, higher percentage are very sick.*

D. Relative rates of laboratory-confirmed infections with *Campylobacter, E. coli* O157. *Listeria, Salmonella,* and *Vibrio,* compared with 1996--1998 rates, by year --- Foodborne Diseases Active Surveillance Network, United States, 1996--2010
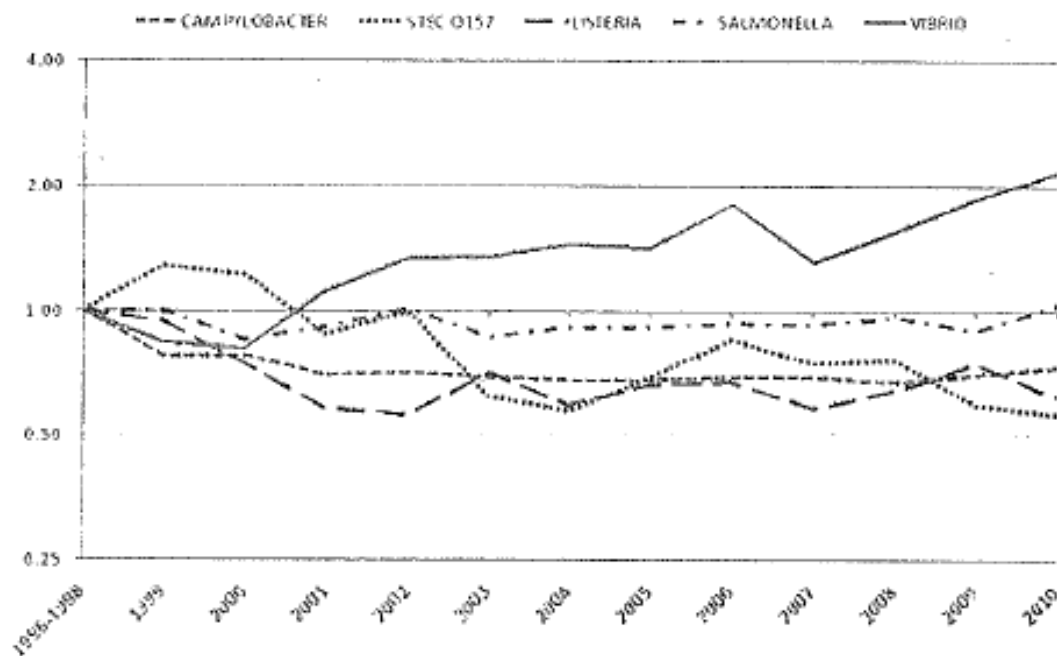
Abbreviation: STEC = Shiga toxin-producing Escherichia coli O157.

Answer the following true/false 2 pts each
1. This graph shows that campylobacter is a relatively minor cause of foodborne disease in the US. F
2. The rates of most foodborne illness shown here have declined since 1998. T
3. In 1998 there was 1 case/100,000 US residents of Vibrio. F
4. The incidence of salmonella has not declined in the last decade. T
5. Control measures for Vibrio have either not been identified, or not taken up in the last decade. T
6. The actual burden of disease for these pathogens cannot be estimated from this graph. T

West Nile virus (WNV) Neuroinvasive Disease Incidence reported to ArboNET, by county, United States, 2011 (as of January 10, 2012)

Incidence by county map data description: West Nile virus neuroinvasive disease incidence maps reflect surveillance reports released by state and local health departments to CDC's ArboNET system for public distribution. Map shows the incidence of human neuroinvasive disease (encephalitis, and/or meningitis, and/or acute flaccid paralysis) by county for 2011 with shading ranging from .01-.99, 1.0- 249, 2.50-9.99, and greater than 10.0 per 100,000 population.

E. Based on the WNV map above:

l a. Based on your knowledge of the US and the data in the map, which state is likely to have the highest number of WNV cases? 1 pt   California

lb. what epidemiologic factors would lead to these high numbers of cases? 3 pts

- Warm state with year round mosquito biting
- Large population at risk
- Workers at risk
    - Agricultural workers – long days outside, low wage workers unlikely to take preventative measures
    - Agriculture area of high mosquito burden - particularly in organic farms where pesticides are not used
- Lots of outside activities – play outside get exposed
- Poor uptake of prevention by low SES people
- High level of awareness by health department – good reporting
- Retirement destination state – older people at higher risk or neuroinvasive disease

2. Notice the high rate of WNV in Montana (MT) and Idaho (ID). What characteristics or these states might explain these rates? (2 Pts) Low population, outdoor activity

3. Levels of WNV are also high in Michigan (MI). What characteristic of Michigan might explain this? (2 pts) Many lakes, lots of mosquitoes

F. At an influenza immunization clinic at a retirement community, residents were asked in how many previous years they had received influenza vaccine. The answers from the first 19 residences are listed below. Organize these data into a frequency distribution (5 pts). Find the mean, median, and mode of the data set. (3 pts)

Data Set: 2, 0, 3, 1, 0, 1, 2, 2, 4, 8, 1, 3, 3, 12, 1, 6, 2, 5, and 1

Frequency Distribution

Previous Years	Frequency
0	2
1	5
2	4
3	3
4	2
5	2
6	2
7	0
8	2
9	0
10	0
11	0
12	1

The mean is 3.0 previous vaccinations, the median is 2 previous vaccinations, and the mode is 1 previous vaccination.

G. In an outbreak of tuberculosis among prison inmates in South Carolina in 1999, 28 of 157 inmates residing in the East wing of the dormitory developed tuberculosis, compared with 4 or 137 inmates residing in the west wing. Summarize the data in a two-by-two table and calculate the risk ratio. Show your work! (8 pts)

	Developed tuberculosis?		Total
	Yes	No	
East Wing	28	129	157
West Wing	4	133	137
	32	262	296

Risk of tuberculosis among East wing residents: 17.8%
Risk of tuberculosis among West wing residents: 2.9%

Risk ratio is 6.1

H. Bovine Spongiform encephalopathy (BSE) was first seen in cattle in the UK in 1987. An explosive epidemic in cattle followed. Below is a graph showing the Bovine Spongiform encephalopathy epidemic in cattle followed by the epidemic of New Variant Cruezfeldt Jacob's Disease (nvCJD) human cases in the United Kingdom.
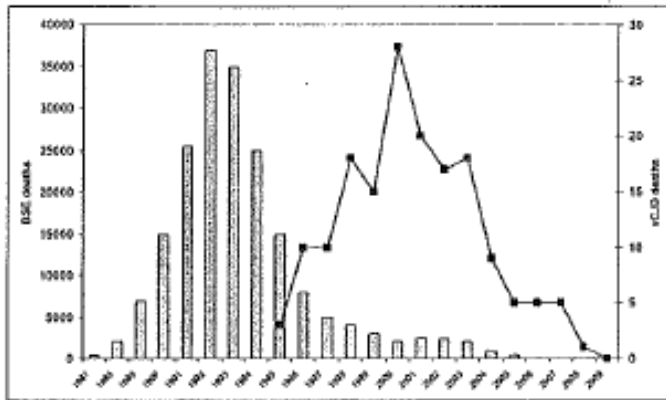
What is the causative agent of the disease? (2 pts)   Prions

The name is derived from characteristics of the agent, what does it stand for? (2 pts)

Proteinaceous infectious agent – they are made of proteins only, no nucleic acid

By what other names have diseases caused by these agents been called? (2 pts)

Scraple, wasting disease, kuru

What is an estimate or the incubation period for nvCJD? (2 pts)

BSE peak 1992, nvCJD peak 2001 = 9 years

what biological factors might explain the relative size of the two curves? 4 pts

- There is a substantial species barrier, but not total
- Cooking beef denatures the prions and makes them non-infectious
- Eating is not an efficient means of transmitting prions between cows and humans

I. An outbreak occurs among Persons attending a wedding. Guests were interviewed to determine what behaviors may have lead to disease. The following data were found:

Calculate the risk specific attack rates (2pts each)

Risk Factor	Cases n=35	Not cases N=100	Risk specific attack rate
Swimming	15	39	27.7%
Volleyball	5	20	20%
Ate box lunch	20	95	17.3%
Ate Hors d'oeuvres	30	40	42.9%

What activity is the highest risk? (2 pts)   Eating hors d'oeuvres

In a subsequent interview, guests were asked about what hors d'oeuvres they ate.

Ate Stuffed Mushrooms			Ate Nachos			Drank Wine		
	Yes	No		Yes	No		Yes	No
Case	9	6	Case	8	7	Case	10	5
Control	6	24	Control	20	10	Control	15	15

What is the odds ratio for eating stuffed mushrooms? (2 pts)   6.0
Explain what this tells you (3 Pts)   Your risk of illness went up.

What is the odds ratio for eating nachos? (2pts)   0.6
Explain what this tells you (3 pts)   There is a protective effect, that is, a lowered risk

What is the odds ratio for drinking wine? (2 pts)   2.0
Explain what this tells you (3 pts)   You are twice as likely to get sick if you drank wine.

Tie-breaker: It was later determined that the contaminated product was the meat used to prepare the mushroom stuffing. Explain how the results for wine could have been as they were. What important epidemiologic concept is seen in this example? (5 pts)

Wine drinkers had a higher odds of disease. Wine drinkers may have been more likely to eat mushrooms. Maybe those drinking beer were more likely to eat the nachos. The risk of disease for wine drinkers was *confounded* by their also being mushroom eaters.