Directions

- You and your partner will have 50 minutes to complete the exam
- No penalty for guessing
- Work and units required for each calculation question
- Round answers as needed (preferably at least to the hundredth place)
- Allowed materials
    - One 8.5" x 11" sheet of notes
    - 1 non-programmable, non-graphing calculators
- You may take the test apart, but staple in the correct order at the end of the exam period
- Point values for a question are in parentheses after the question
- Tiebreakers are marked with an asterisk (*)
- DO NOT CHEAT. I'm not sure why this concept is so difficult.
- Write answers in the blanks spaces provided. Please *attempt* to write legibly and neatly.
- Contact info: Darren Chang dwc236@cornell.edu

Total: **205**/205

Vocabulary

Write the vocabulary term that corresponds to the definition.

1. A countable instance in the population or study group of a particular disease, health disorder, or condition under investigation. (1)

Case

2. The number or proportion of cases or events or conditions in a given population. (1)

Prevalence

3. The branch of science we disease detectives are studying. (1)

Epidemiology

4. Amount of agent that must be consumed to give rise to symptoms of foodborne illness. (1)

Infectious Dose

5. The number of deaths from a specific cause. (1)

Fatality Rate

6. The identification and diagnosis of people who may have come into contact with an infected person. (1)

Contact Tracing

7. The temporal course of disease from onset (inception) to resolution. (1)

Natural history of disease

8. An organism (such as an insect) that transmits a pathogen. (1)

Vector

9. An observational study that analyzes data collected from a population, or a representative subset, at a specific point in time (1).

Cross-sectional study

10. The systematic collection, analysis, interpretation, and dissemination of health data on an ongoing basis, to gain knowledge of the pattern of disease occurrence and potential in a community, in order to control and prevent disease in the community. (1)

Public Health Surveillance

11. Inadvertent and preventable induction of disease or complications by the medical treatment or procedures of a physician or surgeon. (1)

Iatrogenesis

12. An epidemic occurring over a very wide area (several countries or continents) and usually affecting a large proportion of the population. (1)

Pandemic

13. The traits of an individual person or animal that affect susceptibility to disease, especially in comparison to other individuals. (1)

Host factor

14. A comparison of the risk of some health-related event such as disease or death in two groups. Usually used in cohort studies. (1)

Relative Risk

15. The U.S. federal executive department responsible for developing and executing federal laws related to farming, agriculture, forestry, and food

United States Department of Agriculture

16. Any substance foreign to the body that evokes an immune response either alone or after forming a complex with a larger molecule (such as a protein) and that is capable of binding with a product (such as an antibody or T cell) of the immune response. (1)

Antigen

17. Classify each disease (bacterial, viral, fungal, parasitic, helminth, prion, or protozoan/protist). (12 total)

Disease	Type (1)
Tapeworm	**Helminth**
Chicken Pox	**Virus**
Chagas	**Protist**
Candidiasis	**Fungal**
Chikungunya	**Virus**
Legionellosis	**Bacteria**
Scrapie	**Prion**
Syphilis	**Bacterial**
Giardiasis	**Protist**
Apicomplexa	**Protozoan**
Poliomyelitis	**Virus**
Tuberculosis	**Bacterial**

Case Study 1

Adapted from: Scott *et al*. "Notes from the Field: Campylobacteriosis Outbreak Associated with Consuming Undercooked Chicken Liver Pâté — Ohio and Oregon, December 2013–January 2014." *Morbidity and Mortality Weekly Report*. April 17, 2015, vol. 64, no. 14, pp. 399. https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6414a7.htm

On January 8, 2014, the Ohio Department of Health notified the Oregon Public Health Division (OPHD) of campylobacteriosis in two Ohio residents recently returned from Oregon. The travelers reported consuming chicken liver pâté* at an Oregon restaurant. On January 10, OPHD received additional reports of campylobacteriosis in two persons who had consumed chicken liver pâté at another Oregon restaurant. Campylobacter jejuni was isolated in cultures of fecal specimens from three patients. OPHD investigated to determine the sources of the illnesses and to institute preventive measures.

Both restaurants reported using undercooked chicken livers to prepare their pâté; an environmental health investigation revealed that the livers were purchased from the same U.S. Department of Agriculture Food Safety and Inspection Service (FSIS)–regulated establishment in the state of Washington. The establishment reported that livers were rinsed with a chlorine solution before packaging. However, culture of five of nine raw liver samples from both restaurants and from the establishment yielded C. jejuni; none of three pâté samples from the restaurants yielded C. jejuni. One human stool specimen and three liver samples were typed by pulsed-field gel electrophoresis (PFGE); the human isolate and one liver sample had indistinguishable PFGE patterns when digested by the restriction enzyme SmaI. The human isolate was susceptible to all antimicrobials tested by CDC's National Antimicrobial Resistance Monitoring System.

A presumptive case was defined as diarrhea lasting >2 days, within 7 days after consumption of undercooked chicken liver; a confirmed case was defined as laboratory evidence of C. jejuni infection within 7 days after consumption of undercooked chicken liver. In all, three laboratory-confirmed and two presumptive cases of campylobacteriosis following consumption of chicken livers were reported in Ohio and Oregon. Illness onsets ranged from December 24, 2013, to January 17, 2014. Patient age range

was 31–76 years; three were women. Based on OPHD's recommendation, both restaurants voluntarily stopped serving liver. The FSIS-regulated establishment also voluntarily stopped selling chicken livers.

During the outbreak investigation, OPHD learned of a campylobacteriosis case in a Washington state resident who had eaten raw chicken livers that had been chopped into pill-sized pieces and frozen, as prescribed by a naturopathic physician. The livers were from the same establishment that supplied the Oregon restaurants. No isolate from the case was available for subtyping, but culture of frozen pieces of liver collected from this patient yielded C. jejuni.

This report illustrates that follow-up of possible outbreaks identified by routine interviewing by health departments can identify sources of illnesses and result in control measures that protect public health. Campylobacter is thought to be the most common bacterial cause of diarrheal illness in the United States (6), and infection is now nationally notifiable.

18. Why would chicken liver pâté be considered a risky food for foodborne illness transmission? (1)

They are often prepared undercooked to preserve texture.

19. Why would consumers have a difficult time checking if foods like chicken liver pâté are fully cooked? A picture is of it is below, in the white serving dish. (2)

Chicken liver pâté is mixed with other ingredients (1) and extremely ambiguous in texture and color (1), so distinguishing uncooked ingredients is extremely difficult for consumers interested in food safety.

20. Why does USDA's Food Safety and Inspection Service does not require livers to be free from bacteria? (2)

The FSIS requires that chicken livers are inspected to be free from visible signs of disease which checks enough food illness signs for reasonably safe consumption of chicken livers (1). Chicken producers and their lobbyists would also balch of the prospect of ensuring every liver to be free of all bacteria because that is a time-consuming and nearly impossible task (1).

As per https://www.fsis.usda.gov/wps/wcm/connect/6042f608-c881-4da8-98eb-ed943972151d/PSIT_PostMortem.pdf?MOD=AJPERES (p. 20).

21. What temperature should chicken liver be cooked to in order to render it safe for consumption? (2)

165 degrees F or 74 degrees C (2).

22. "livers were rinsed with a chlorine solution before packaging." Why was this done, and what is another way chlorine is used in the food industry? (2)

Rinsing livers with chlorine kills much of the bacteria on the livers (1). Chlorine can also be used for washing vegetables (0.5) or for treating cooler water (1) or disinfecting food contact surfaces (1).

23. What is one of the compounds that use chlorine in the food industry? (1)

Chlorine is usually combined with inorganic compounds, such as sodium or calcium, to produce hypochlorites, which are effective disinfectants. Chlorine mixed with sodium is a liquid bleach known as sodium hypochlorite NaOCl. Chlorine mixed with calcium is usually in granular or tablet form and is called calcium hypochlorite - Ca(OCL)2. Chlorine may also be available as chlorine dioxide (ClO2).

24. "One human stool specimen and three liver samples were typed by pulsed-field gel electrophoresis." Explain how a sample would be typed, why PFGE typing is important to epidemiology, and what type of diseases PFGE can be used to type. (6)

Bacterial cells are taken from an agar plate (0.5), poured into a plug mold, lysed to free the DNA from the bacteria (0.5), loaded into a gel and separated by an electric field into DNA fragments by size (0.5), stained to be seen under UV light (0.5), imaged by camera (0.5), and compared by software to the PFGE fingerprint of a bacterial disease (0.5).

PFGE is a highly accurate method of laboratory testing to determine the disease in a sample and the upload of PFGE gel results to the national PulseNet database allows national notification of a disease (1).

PFGE detects bacterial diseases (1).

More about PFGE here: https://www.cdc.gov/pulsenet/pathogens/pfge.html

25. "A presumptive case was defined as diarrhea." What are two other symptoms of campylobacter? (2)* (tiebreaker #2)

Any 2: fever, abdominal cramps, nausea, vomiting, asymptomatic.

26. Assuming a typical incubation period for campylobacter, why is it irregular that the case definition included cases that started 7 days after contact? (1)

The typical incubation period of campylobacter is 2-5 days.

27. Specifically for campylobacter, what is the difference between a probable and confirmed case? (2)

A confirmed case is the isolation of Campylobacter spp. from a clinical specimen (1). A probable case is the detection of Campylobacter spp. in a clinical specimen using a culture-independent diagnostic test (CIDT), such as a polymerase chain reaction test (1).

28. "Patient age range was 31–76 years; three were women." Compare the risk factors in this study to typical risk factors for campylobacter (4).

Campylobacteriosis is more common in males, children younger than 5 years, and people 65 years and older. Out of the three cases, three out of five were female, which contrasts (1) with the typically accepted higher correlation of campylobacteriosis with the male gender (1). The age range was also mostly within the less likely age range of younger than 5 and older than 65 (1), which contrasts with the age range of 31-76 (1) found in this study.

29. What are two reasons this study could have been biased or inaccurate? Use evidence from the study to support your answer. (6)

Three points for each of any two: Small sample size – only five cases, case definition was too large – the incubation period was 7 days, Case definition was too small – only included 1 symptom, diarrhea, selection bias – not all distributions of the chicken liver were followed and only cases that were flagged on PulseNet by returning Ohio travelers were used, selection bias – not all cases of campylobacter were reported, incorrect causative link chain – "culture of five of nine raw liver samples from both restaurants and from the establishment yielded C. jejuni; none of three pâté samples from the restaurants yielded C. jejuni."

30. What is the name of the infection caused by campylobacter jejuni? (1)

Campylobacteriosis

31. What was the total number of days in the period of onset days measured by this study? (1)

25

Disease Notification

32. What does it mean for campylobacter to be nationally notifiable, as in Case Study 1? (1)

Providers who see cases of the disease must report it to the Center for Disease Control.

33. What are the four types of reporting that is done at the state level? (2)

0.5 point for each of mandatory written reporting, mandatory telephone reporting, report of total number of cases, cancer.

34. What are the full names of these organizations, all related to food reporting? (6)*(tiebreaker #1)

1 point each

NNDSS: **National Notifiable Disease Surveillance System**

CDC: **Center for Disease Control and Prevention**

FoodNet: **Foodborne Diseases Active Surveillance Network**

NARMS: **National Antimicrobial Monitoring System**

NORS: **National Outbreak Reporting System**

CTSE: **Council of State and Territorial Epidemiologists**

35. What disease was added to the NNDSS for 2018? (2)

Carbapenemase Producing Carbapenem-Resistant Enterobacteriaceae or CP-CRE

36. Why would the specific form of this disease, i.e. Carbapenemase producing, be a matter of public health concern? (5)

This is a form of antibiotic resistance (2). Antibiotic resistance has been called one of the world's most pressing public health problems and could have a large impact (1). Antibiotic resistance can cause illnesses that were once easily treatable with antibiotics to become dangerous infections, prolonging suffering for children and adults (1). Antibiotic-resistant bacteria can spread to family members, schoolmates, and co-workers, and may threaten your community. Antibiotic-resistant bacteria are often more difficult to kill and more expensive to treat (1).

37. What are the two classifications for Salmonella necessary for the 2018 NNDSS? (2)

Salmonellosis (1) and paratyphoid fever (1).

38. What is the most recent CTSE case definition for a foodborne illness outbreak? (6)

An incident in which two or more persons (2) experience a similar illness (1) after ingestion of a common food (1), and epidemiologic analysis (1) implicates the food as the source of the illness (1).

39. What are the two exceptions to this case definition? (2)

One case of botulism (1) or chemical poisoning (1) linked to a food item constitutes a notifiable outbreak.

Case Study 2

Adapted from: Krishnasamy V, Mauldin MR, Wise ME, et al. Notes from the Field: Postexposure Prophylaxis for Rabies After Consumption of a Prepackaged Salad Containing a Bat Carcass — Florida, 2017. MMWR Morb Mortal Wkly Rep 2017; 66: 1154–1155. DOI: http://dx.doi.org/10.15585/mmwr.mm6642a7

On April 3, 2017, two Florida residents consumed part of the same prepackaged salad before reportedly discovering the partial remains of a bat carcass in the salad. Bats are known reservoirs for rabies virus, which causes rabies disease in both animals and humans (1). The persons who ate the salad contacted the Florida Department of Health (FLDOH), which notified CDC's Poxvirus and Rabies Branch. CDC and FLDOH determined that the immediate concern was for potential rabies virus exposure, because approximately 6% of bats submitted to U.S. public health departments annually test positive for rabies virus (2,3).

Although percutaneous exposures are more likely to result in successful transmission of rabies virus to humans (1), transmission can occur when infectious material, such as saliva or nervous tissue from an

infected animal, comes into direct contact with human mucosa (2). Infection with rabies virus causes an acute, progressive encephalitis that is nearly always fatal once clinical signs have begun. The disease is preventable if exposed persons receive timely postexposure prophylaxis (PEP), which includes human rabies immunoglobulin and 4 doses of inactivated rabies vaccine administered over 14 days (4).

FLDOH submitted the bat carcass to CDC for rabies virus testing on April 4. Polymerase chain reaction and direct fluorescent antibody tests were inconclusive because of the deteriorated condition of the carcass. However, because the cranium of the bat was intact, exposure to brain material by the persons who consumed the salad was unlikely, although exposure to the bat's organs or peripheral nervous tissue was possible. PEP was recommended because laboratory test results were inconclusive and exposure to nervous tissue could not be ruled out.

The salad was purchased from a company A store location. After being notified of the investigation, company A removed the lot of prepackaged salad from all store locations on April 5. Company B (the prepackaged salad supplier) recalled the affected lot of salads on April 8. CDC advised consumers to contact their local health department for PEP evaluation only if the consumer had eaten a recalled prepackaged salad and had found animal material in the salad. CDC was not notified of any other reports of dead bats in prepackaged salads.

To identify where the bat might have been introduced into the prepackaged salad, CDC performed genetic analyses on the bat to determine its subspecies. Based on morphology and phylogenetic analyses (Bayesian inference and haplotype network analyses) of mitochondrial DNA sequence data (Cytb and D-loop), the bat was identified as a Mexican free-tailed bat (Tadarida brasiliensis mexicana), which is found throughout the southwestern United States. It is genetically distinct from T. brasiliensis cynocephala, which occurs in the southeastern United States (Figure) (5).

Several factors likely reduced the risk for rabies virus transmission to the two Florida consumers. No rabies virus was detected in the specimen, the bat's cranium was intact, and the salad was rinsed before packaging, thereby diluting any potential virus. In addition, mucosal membrane exposures have rarely been proven to result in rabies disease, and rabies virus does not survive more than a few days outside a host (2). Although this exposure was likely of low risk, this investigation was an example of effective industry and government collaboration to remove a product of concern from the marketplace rapidly to protect consumers.

40. How can rabies be spread as a foodborne illness? (2)

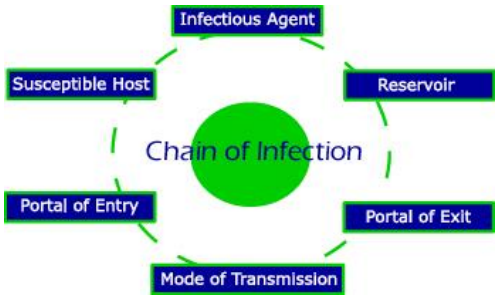
Transmission can occur when infectious material, such as saliva or nervous tissue from an infected animal, comes into direct contact with human mucosa, i.e. when ingestion occurs.

41. What is encephalitis? Classify it as viral, bacterial, fungal, parasitic, or any combination of the categories. (3)

Inflammation of the brain (1.5). All of the above (1.5).

42. "Bats are known reservoirs for rabies virus, which causes rabies disease in both animals and humans." Define a reservoir in the context of the rabies virus and draw the chain of infection (7).

The bat harbors the rabies virus without being infected and can transmit it to humans and animals (2).



1 point for structure of the chain (i.e. circular without beginning and end)

1 point for labeling with chain of infection

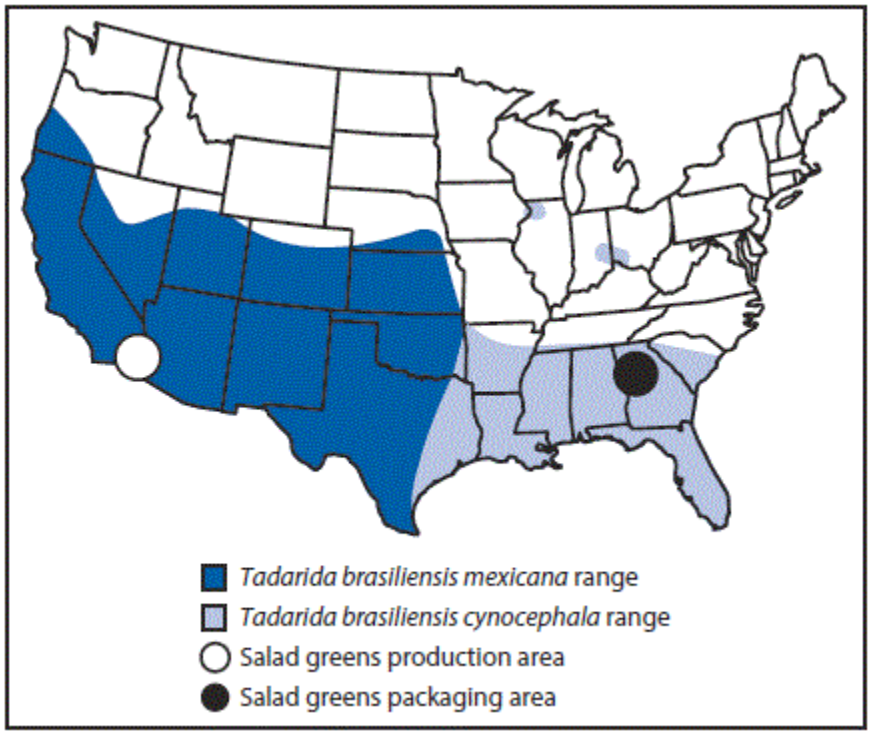
0.5 points for each correct point (i.e. infectious agent)

43. The disease is preventable if exposed persons receive timely postexposure prophylaxis. What is prophylaxis? (2)

Action taken to prevent a disease

44. What's an example of percutaneous exposure that might cause rabies? (2)

Bat bite or bite from any animal that has rabies



45. Title the above image. (4)

Something related to "Distribution of Tadarida brasilliensis Mexicana and Tadarida brasiliensis cynocephala in salad greens production and salad greens packaging areas"

46. Where do you think the bat carcasses entered the salad preparation carcass? Explain in detail. (10)

The investigation determined that cutting and harvesting of greens for the recalled salad occurred in fields in the west and southwest United States before they were transported to a processing plant in Georgia. At the processing plant, the greens were washed with chlorinated water and packaged. Given the physical condition of the bat (e.g., decomposed, bisected) (2) and the geographic location of the fields (1) and the processing plant (1), along with the genetic identification of the bat (2), investigators concluded the bat most likely came into contact with the salad material in the field during harvesting and cutting (2) and was then transported to the processing facility. (2)

47. What are the top five germs that cause foodborne illness in the US? (4)

Norovirus, Salmonella, Clostridium perfringens, Campylobacter, Staphylococcus aureus

Case Study 3

Adapted in sections from: Long, M., Yu, H., Chen, L., Wu, G., Zhao, S., Deng, W., . . . Zou, L. (2017). Recovery of Salmonella isolated from eggs and the commercial layer farms. Gut Pathogens, 9(1). doi:10.1186/s13099-017-0223-8

48. How often is human salmonellosis transmitted via a foodborne method? (2)
    a. 100%
    b. 95%
    c. 80%
    d. 60%
    e. 20%
49. How often does human salmonellosis occur in the US annually? (2)
    a. 7.6 million
    b. 5.2 million
    c. 3.1 million
    d. 1.4 million
    e. 500000
50. If Salmonellosis occurs in East Asia at the rate of 3980 cases per 100,000 person-years, how does this compare to a global incidence of 570 per 50000 person-years? (2)

Salmonellosis occurs in East Asia more commonly because the global incidence is 1140 per 100000 person-years, and 570 is larger than 1140. (1) Work of 570*2=1140. (1)

51. Why are person years used to compare different incidence rates? (3)

Allows conversion into 1 standard unit to compare different diseases (1) and allows comparison in large and whole understandable numbers (2).

Salmonella has been frequently recovered from laying hen house environments, suggesting that the environment of the poultry farm can act as a reservoir for Salmonella and contribute to the horizontal dissemination of Salmonella via animal-to-animal contact and contaminated feed [7–9]. In addition to feed, the water, feces, dust, cages and litter contaminated with Salmonella are important sources of infection [9–15]. Many studies focused on the distribution of Salmonella among different sample origins in poultry environments, or on antibiotic resistance, virulence, and control strategies [9, 14, 16, 17].

However, there have been few investigations of the association between Salmonella isolates recovered from the internal and external poultry environment and the relationship between isolates obtained from sequential points along the production chain. Recognition of these aspects is important in controlling the spread of Salmonella and reducing the prevalence of Salmonella in production settings.

52. What is horizontal dissemination, and through what means does horizontal dissemination occur? (4)

Dissemination between different, typically neighboring, animals of the same species (2). Occurs through animal to animal contact and contaminated supplies such as water, feces, dust, etc (2).

53. Why is the recognition of aspects of Salmonella along sequential points of the production chain vital to reducing the prevalence of Salmonella? (3)

Allows researchers to understand where Salmonella is coming from, which makes it much easier to stop in the short and long term at the source of infection.

54. What are the two most common serotypes of Salmonella? (4)

Salmonella Enteritidis (2) and Salmonella Typhimurium (2)

55. What serotype of Salmonella has there been concern raised about due to multi drug resistant phenotypes? (2)

Salmonella typhimurium (2)

56. List two other salmonella serovars that have been known to cause outbreaks. (2)

1 point each for S. Braenderup, S. Derby, S. Jerusalem, S. Indiana, and S. Bovismorbificans

Table 1

The prevalence and distribution of *Salmonella* in the old layer farm

Origins	N[a]	*Salmonella* serotypes					
		S. Derby	*S.* Braenderup	*S.* Enteritidis	*S.* Jerusalem	*S.* Bovismorbificans	Un-identified
External environment of the henhouse							
Disinfection system	5	1					
Soil	15	5		3	2		
Feces	13	11			1		
Dust	6	5					
Gutter	3	1					1
Internal environment of the henhouse							
Wet curtain cooling system	3	2				1	
Cage	6	5					
Egg nest	6	6					
Total	57	36		3	3	1	1

[a]Sample number

[b]The prevalence of *Salmonella* was among the samples in different sampling site

57. Calculate the prevalence of Salmonella in each environment. (9)

Note: this could be better worded as “Calculate the prevalence of Salmonella in each environment (in other words, for each row in the table). (9)”

0.5 point for each row for work, 0.5 point for correct answer

Table 1

The prevalence and distribution of *Salmonella* in the old layer farm

Origins	N[a]	*Salmonella* serotypes						Prevalence[b]
		S. Derby	*S.* Braenderup	*S.* Enteritidis	*S.* Jerusalem	*S.* Bovismorbificans	Un-identified	
External environment of the henhouse								
Disinfection system	5	1						20.0% (1/5)
Soil	15	5		3	2			66.7% (10/15)
Feces	13	11			1			92.3% (12/13)
Dust	6	5						83.3% (5/6)
Gutter	3	1					1	66.7% (2/3)
Internal environment of the henhouse								
Wet curtain cooling system	3	2				1		100% (3/3)
Cage	6	5						83.3% (5/6)
Egg nest	6	6						100% (6/6)
Total	57	36		3	3	1	1	77.2% (44/57)

[a]Sample number

[b]The prevalence of *Salmonella* was among the samples in different sampling site

58. Choose THREE (3) of the following types of epidemiology and define them for full credit. CIRCLE the types you define. (6)

    Classical Epidemiology
    Clinical Epidemiology
    Experimental Epidemiology
    Infectious Disease Epidemiology
    Descriptive Epidemiology
    Shoe Leather/Gum Boots Epidemiology
    Theoretical Epidemiology

Two points per definition

Classical Epidemiology: population oriented, studies community origins of health problems

Clinical Epidemiology: studies patients in health care settings

Infectious Disease Epidemiology: examines the epidemiology of infectious diseases using a laboratory based method

Descriptive epidemiology: information about the occurrence of a disease, some of it mathematical, but with no attempt to establish relationships between cause and effect.

Experimental epidemiology: prospective population experiments designed to test epidemiological hypotheses, and usually attempt to relate the postulated cause to the observed effect. Trials of new anthelmintics are an example.

Observational epidemiology: based on clinical and field observations, not on experiments.

Shoe-leather epidemiology: epidemiology conducted as a field study. Called also gum-boots epidemiology.

Theoretical epidemiology: the use of mathematical models to explain and examine aspects of epidemiology, e.g. computer simulation models of outbreaks.

59. Rank the following types of study designs in order of increasing usefulness in proving causation. Choose TWO (2) to define. (5)

    A. Cross-Sectional Study
    B. Ecological Study
    C. Cohort Study
    D. Case Study
    E. Case-Control Study
    F. Randomized Controlled Trial

Two points for correct ranking: D B A E C F (all or nothing)

1.5 points each for correct definition

Case Study - A study of one diseased individual, providing a detailed description of an uncommon disease; provides timely or rare information.

Ecological Study - A study in which at least one variable is measured at the group (not individual) level. The occurrence of disease is compared between groups that have different levels of exposure, thus offering a comparison group for this study design.

Cross-Sectional Study - A study with individual-level variables that measures exposure and disease at one point in time. A snapshot of the study population. This study design provides weak evidence of causal association between exposure and outcome because the exposure may not have preceded the disease. A patient survey is an example of a cross-sectional study.

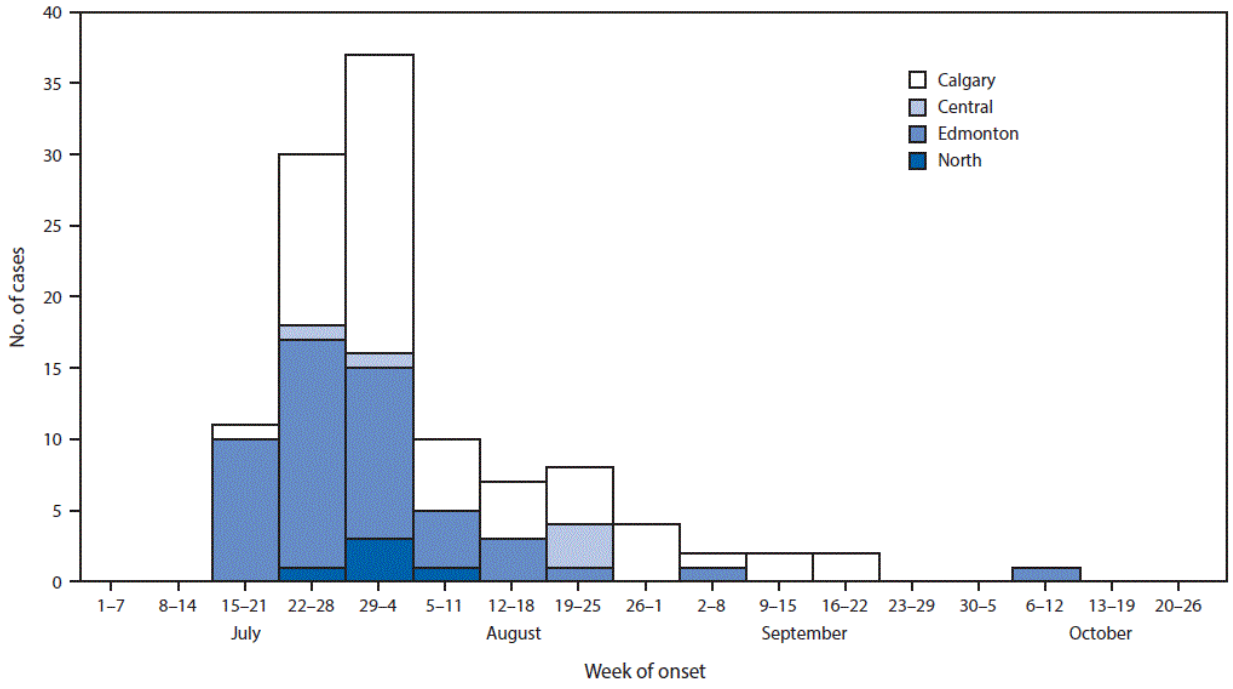
Case-Control Study -A study that identifies individuals who develop the disease (cases) and individuals without the disease (controls), and then determines the previous exposure of both cases and controls. The case group is composed only of individuals known to have the outcome; the control group is drawn from a comparable population who have not experienced the outcome. We compare the odds of exposure between cases and controls. A case-control study is stronger than a cross-sectional study in establishing individual-level causality because we are certain that exposure preceded the disease outcome. The association is reported as an odds ratio.

Cohort Study - A study that begins with exposed and non-exposed persons who do not have the disease. The study sample is drawn only from individuals at risk of developing the outcome. Individuals are followed through time until some of them develop the disease. We then compare the

rate of the outcome for the exposed group to the rate of the outcome for the non-exposed group. The association is reported as a relative risk, attributable risk or depicted with survival analysis. Incidence rates can be calculated. A cohort study takes more time, money and subjects than does a case-control study, but will also provide stronger evidence of individual-level causation because we are measuring incidence rates of the disease. Longitudinal surveys may be considered a cohort study.

Randomized Controlled Trial - In this study, the researcher controls the exposure that individuals receive. A prime example is a clinical trial, in which patients may be randomized to a receive a treatment. Measurements are made on the individual, and do not typically measure the effect that might come from a group-level exposure.

Adapted from: Honish L, Punja N, Nunn S, et al. Escherichia coli O157:H7 Infections Associated with Contaminated Pork Products — Alberta, Canada, July–October 2014. MMWR Morb Mortal Wkly Rep 2017;65:1477–1481. DOI: http://dx.doi.org/10.15585/mmwr.mm6552a5



60. What type of graph is this? (2)

Epi curve

61. What should be the axes labels? (2)

Note: this could be better worded as "What are the axes labels?"

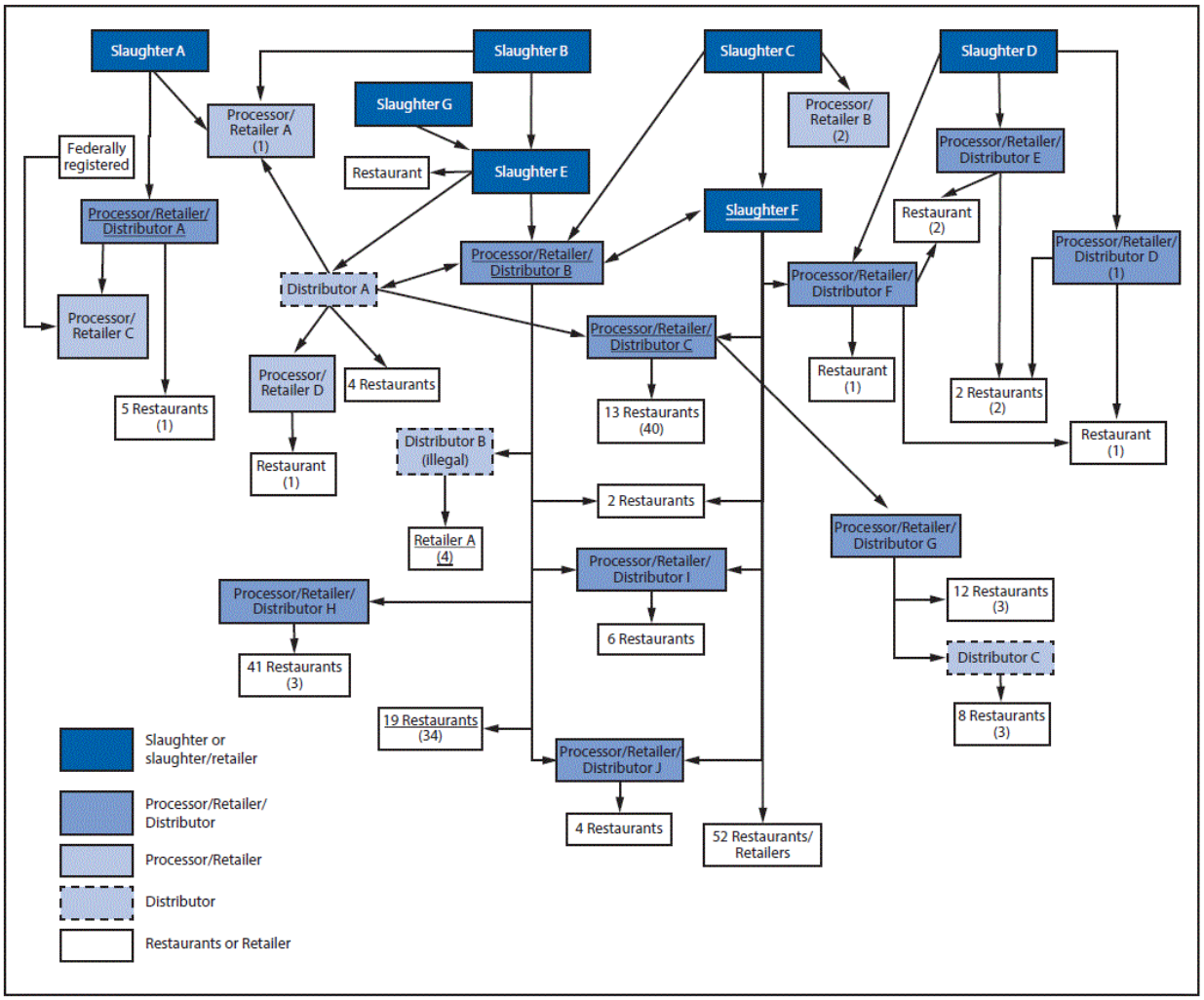
X axis: week of onset (1), Y axis: Number of cases (1)

62. Why is each bar split up into four parts? What purpose does it serve? (5)

The stacked bar graph (2) is a combination of data from the different regions specified in the key, thus showing both the combination of cases but also some data on the location of the cases (3).

63. What type of outbreak is occurring? How can you tell? How does this match up in the context of foodborne diseases? (5)

A point source outbreak is occurring (1) because all the cases come all at once but neatly taper down (2). In the context of foodborne diseases, this is not unusual because all of the exposures could have come from a single exposure site. (2)



64. Why does this graph show that foodborne disease surveillance is often difficult? How does this complicate the jobs of researchers and public health officials? (8) Put specifics of explanation in your answer.* (tiebreaker #3)

Answers may vary, but should include information about the complexity of the chain, especially specifics about the long process of slaughter, the timeframe of the distribution, the probability of cross-contamination, and the process of transportation that drastically complicate the job for public health officials, who must test all the internal links in order to solve a large public health problem.

Table. Exposure characteristic for pork-associated E. coli O156:H7 – Alberta, Canda, July-November 2014

Potential exposure sites	Number of people who had visited	Number of patients who had visited
Asian-style restaurant	21	4
American Market	121	89
Sausage Festival	4	2
Meat processing plant	44	7
Christkindlmarkt Alberta	189	19
Total	379	121

65. What measure of risk should be used in this study, and why? (3)

Odds ratio (1) because this is a case-control study that is retrospective and looks at the relationship between exposure and disease (2).

66. Calculate the measure of risk you identified in the question above for the first two potential exposure sites. Make 2x2 tables and interpret each OR. (10)

Correct result of calculated risk (1)

Work for risk (1)

2x2 table (1)

Interpretation (2)

Asian-style restaurants:

	Case	**Control**
Exposure	**4**	**17**
No Exposure	**117**	**358**

OR=ad/bc=(4*358)/(117*17)=0.72

The odds of contracting e coli from being exposed to the Asian-style restaurant are 0.72 or 72% the odds of contracting e coli with no exposure to the Asian-style restaurant.

American Market

	Case	**Control**
Exposure	**89**	**32**
No Exposure	**117**	**347**

OR=ad/bc=(89*347)/(117*32)=8.25

The odds of contracting e coli from being exposed to the American Market are 8.25 or 825% the odds of contracting e coli with no exposure to the American Market.

67. Calculate the average and standard deviation of the first column. (5)

Correct answer for average (1) = 109.67

Correct work for calculating average (1) = all numbers in first column/5

Correct SD (1) = 141.87

Correct SD work (2) = takes the squared sum of all values subtracted from the average, divides it by n-1, and takes the square root