Brookwood High School Science Olympiad Invitational
Disease Detectives Test Answer Key
January 14th 2017

1. Name up to 4 pathogens/bacteria that can contaminate food and cause illness and specify the example of illness each one causes. (8 points)

Gram-negative bacteria	**Diseases**
Salmonella species	Salmonellosis (Gastrointestinal illness), Typhoid fever
Campylobacter jejuni	Campylobacteriosis (gastroenteritis)
Coxiella burnetii	Q fever
Brucella species	Brucellosis
Vibrio cholerae Serogroups O1 and O139	Epidemic and pandemic cholera outbreaks
Francisella tularensis	Rabbit fever
Pathogenic E. coli (Escherichia coli) Group Enteroinvasive E. coli (EIEC) Enterohemorrhagic E. coli (EHEC)	Gastroenteritis or diarrhea or hemorrhagic colitis (HC),
Gram-positive bacteria	
Clostridium perfringens or C. perfringens	Gastroenteritis, enteritis necroticans (pig-bel disease)
Clostridium botulinum or C. botulinum	botulism
Staphylococcus aureus	Staphyloenterotoxicosis, staphyloenterotoxemia or Staphylococcal food poisoning
Bacillus cereus and other Bacillus species	Diarrhea, vomiting, gangrene
Listeria monocytogenes	Gastrointestinal illness
Streptococcus species	Strep throat or pharyngitis
Mycobacterium bovis or Mycobacterium tuberculosis	Causes tuberculosis in cattle which is zoonotic and affects humans, cuases tuberculosis because of culling of infected cattle.
Parasitic Protozoa and Worms	
Toxoplasma gondii or T. gondii	Toxoplasmosis or T. gondii infection
Giardia	giardiasis
Entamoeba histolytica or E. histolytica	amebiasis
Cryptosporidium parvum or C. parvum	cryptosporidiosis
Pork tapework (Taenia solnum), beef tapeworm (Taenia saginata), Asian tapeworm (Taenia asiatica)	taeniasis
Virus	
Noroviruses (can be transmitted by food and water)	Viral gastroenteritis, food poisoning, and winter vomiting disease

Hepatitis A virus	Hepatitis A or HAV
Hepatitis E virus	Hepatitis E or HEV
Rotavirus	Diarrhea and dehydration
Toxins: Shellfish toxins	Toxic poisoning

2. Pathogenic bacteria are divided into two main groups, based on **the structure of the microbes' cell wall**: Gram negative and Gram positive. (2 points)

3. **Spore** forming bacteria are temperature resistant and are special problems for the food industry. It is not always possible to apply enough heat during food processing to kill these? (2 points):

4. ***FALSE:*** Even though a food may be pasteurized, it still has to be stored properly afterwards; otherwise, harmful bacteria could grow in it. (1 points)

5. Describe between active, herd, and passive immunity? (6 points)

- **Active immunity: The production of antibodies against a specific disease by the immune system. Active immunity can be acquired in two ways, either by contracting the disease or through vaccination. Active immunity is usually permanent, meaning an individual is protected from the disease for the duration of their lives.**

- **Herd or Community immunity: A situation in which a sufficient proportion of a population is immune to an infectious disease (through vaccination and/or prior illness) to make its spread from person to person unlikely. Even individuals not vaccinated (such as newborns and those with chronic illnesses) are offered some protection because the disease has little opportunity to spread within the community. Also known as herd immunity.**

- **Passive immunity: Protection against disease through antibodies produced by another human being or animal. Passive immunity is effective, but protection is generally limited and diminishes over time (usually a few weeks or months). For example, maternal antibodies are passed to the infant prior to birth. These antibodies temporarily protect the baby for the first 4-6 months of life.**

6. Describe two main differences between cohort and case-control studies (4 points):

Cohort	***Case Control***
The cohort study design identifies a group of people exposed to a particular factor and a comparison group that was not exposed to that factor and measures and compares the incidence of disease in the two groups.	The case-control design uses a different strategy in which investigators identify a group of individuals who had developed the disease (the cases) and comparison of individuals who did not have the specific disease (controls). The cases and controls are then compared with respect to the frequency of one or more past exposures.

Cohort studies try to find association between a known exposure and risk of a disease	Case control studies try to find association between an identifiable disease to an exposure.
More suitable in well-defined populations.	More suitable in large ill-defined populations.
Suitable to study rare exposures.	Suitable to study rare diseases.
Cohort studies provide best information about causation of disease.	Less adept at showing causal relationship and are more prone to bias.
Suitable for diseases that happen frequently in a population and with smaller latent periods.	Suitable to study diseases with long latent periods such as cancer.
Expensive and requires long periods of follow-up	Relatively cheaper and takes less time to complete.

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7. The proportion of people who tested negative and don't have the disease over all people without the disease and tested (1 point):

a) **specificity**

b) sensitivity

c) positive predictive value

d) negative predictive value

8. The probability that a person who tests positive actually has the disease is (1 point):

a) specificity

b) sensitivity

c) **positive predictive value**

d) negative predictive value

9. The probability that a person who tests negative does not have the disease is (1 point):

a) specificity

b) sensitivity

c) positive predictive value

d) **negative predictive value**

10. A study in which children are randomly assigned to receive either a newly formulated vaccine or the currently available vaccine, and are followed to monitor for side effects and effectiveness of each vaccine, is an example of which type(s) of study? (4 points)

a) Experimental

b) Observational

c) Cohort

d) Case-control

e) Clinical trial

11. The Iowa Women's Health Study, in which researchers enrolled 41,837 women in 1986 and collected exposure and lifestyle information to assess the relationship between these factors and subsequent occurrence of cancer, is an example of which type(s) of study? (4 points)

a) Experimental

b) Observational

c) Cohort

d) Case-control

e) Clinical trial

12. British investigators conducted a study to compare measles-mumps-rubella (MMR) vaccine history among 1,294 children with pervasive development disorder (e.g., autism and Asperger's syndrome) and 4,469 children without such disorders. (They found no association.) This is an example of which type(s) of study? (4 points)

a) Experimental

b) Observational

c) Cohort

d) Case-control

e) Clinical trial

13. What does MMWR stands for; a series published by CDC on weekly basis (2 points): (tiebreaker)

Morbidity and Mortality Weekly Report

14. Come up with 5 simple steps that can be followed to lower the risk of foodborne illnesses (10 points):

- **Washing your hands before and after handling food, and in between handling different foods, is one of the most important steps you can take. Do the same with equipment, utensils, and countertops.**
- **Wash raw fruits and vegetables under running water. These nutritious foods usually are safe, as you probably know from the many times you've eaten them, but wash them just in case they've somehow become contaminated. For the most part, the less of a pathogen on a food – if any – the less chance that it can make you sick.**
- **Cooking food to proper temperatures kills most bacteria, including *Salmonella*, *Listeria*, and the kinds of *E. coli* that cause illness, and parasites.**
- **Keep any pathogens that could be on raw, unwashed foods from spreading by keeping raw and cooked foods separate. Keep them in different containers, and don't use the same equipment on them, unless the equipment is washed properly in between. Treat countertops the same way.**
- **Refrigerate food at 40°F as soon as possible after it's cooked. Remember, the less of a pathogen there is in a food, the less chance that it can make you sick. Proper refrigeration keeps most types of bacteria from growing to numbers that can cause illness (although if a food already has high numbers of bacteria when it's put in the refrigerator, it could still cause illness).**

15. Name two brilliant scientists who established the germ theory of disease that each infectious disease is caused by a specific bacterium or other microorganisms. (4 points) (tiebreaker)

Louis Pasteur and Robert Koch.

16. Calculate the **odds ratio** given the following data and interpret the result in your own words. (2 points)

Ill/Sick	**Ate Watermelon**	**Did not eat Watermelon**	**Total**
Yes	69	111	180
No	5	120	125
Total	74	231	305

Ill/Sick	Ate Watermelon	Did not eat Watermelon	Total
Yes	a	c	a+c
No	b	d	b+d
Total	a+b	c+d	n

Odds Ratio = ad/bc
= 69 x 120 / 5 x 111
= 14.9189

The odds of having been exposed to the contaminated food (watermelon) in those who developed the disease was 14.9 times that of people who did not eat watermelon.

17. Kate collected the following data from the cafeteria and the sick children. She found that 105 students ate at the cafeteria on Friday, January 13, 2017. Calculate the **relative risk** and interpret the result in your own words. (2 points)

Ate Spinach Salad	**Got sick**	**Did not get sick**
Yes	26	29
No	6	44

Ate Spinach Salad	**Got sick**	**Did not get sick**
Yes	A	B
No	C	d

Relative Risk $= \frac{a}{a+b} \div \frac{c}{c+d}$

$= 26/55 \div 6/50$
$= 3.9393$

Relative risk of 3.9393 indicates that risk of getting sick is 3.9 times higher when Spinach Salad is eaten versus when spinach salad is not eaten.

18. A study was conducted to determine the association between obesity and cardiovascular disease (CDV). The data was split between people less than 50 years old and people 50 years old or greater. Use the data from the charts below and the Cochran-Mantel-Haenszel method to estimate the odds ratio. (5 points)

< 50	**CVD**	**No CVD**	**Total**		**> 50**	**CVD**	**No CVD**	**Total**
Obesity	15	96	**111**		**Obesity**	44	160	**204**
No Obesity	44	465	**509**		**No Obesity**	26	180	**206**
Total	59	561	**620**		**Total**	70	340	**410**

< 50	**CVD**	**No CVD**	**Total**		**> 50**	**CVD**	**No CVD**	**Total**
Obesity	a	b	**a+b**		**Obesity**	a	b	**a+b**
No Obesity	c	d	**c+d**		**No Obesity**	c	d	**c+d**
Total	a+c	b+d	**n**		**Total**	a+c	b+d	**n**

$$\text{CMH Odds Ratio} = \frac{\sum \frac{a_i d_i}{n_i}}{\sum \frac{b_i c_i}{n_i}}$$

$$= \frac{(15 \times 465)/620 + (44 \times 180)/410}{(96 \times 44)/620 + (160 \times 26)/410}$$

$$= 11.25 + 19.317073 \,/\, 6.812903 + 10.14634$$
$$= 30.567073 \,/\, 16.959243$$
$$= 1.8023$$

19. New challenges to food safety are continuing to emerge, come up with **2 food safety challenges** that food industry, FDA and/or CDC are facing currently (4 points):

- Changes in our food production and supply, including more imported foods.
- Changes in the environment leading to food contamination.
- Better detection of multistate outbreaks.
- New and emerging bacteria, toxins, and antibiotic resistance.
- Changes in consumer preferences and habits.
- Changes in the tests that diagnose foodborne illness.
- Unexpected sources of foodborne illness, such as ice cream and raw sprouted nut butter

20. What is the difference between foodborne illnesses that are classified as ***intoxication*** and those that are classified as an ***infections***? (4 points) (tiebreaker)

Intoxication: types of illnesses that are caused by toxins that may be in the food we eat; the symptoms generally occur soon after eating the contaminated food; the toxins may be produced by bacteria, result from chemicals, heavy metals, or other substances, concentrated toxins in the flesh of some animals.

Infection: types of illnesses that are caused by foodborne pathogens, like bacteria, parasites, or viruses; usually take much longer to produce symptoms and last longer.

21. Information below is based on an outbreak of gastroenteritis following a church supper, Oswego, New York, April 1940. Of the 80 persons attending the supper, 75 were interviewed. Forty-six met the case definition. Attack rates were calculated for those who did and did not eat each of the 6 food items.

a) ***Calculate the attack rates*** by food items served at the church supper. (3 points)

	# of people who ate				***# of people who did not eat***		
Food Item	***Sick***	***Total***	***Attack Rate%***		***Sick***	***Total***	***Attack Rate%***
Baked Ham	29	46	**63**		17	29	**59**
Spinach	26	43	**60**		20	32	**62**
Mashed Potatoes	23	37	**62**		23	37	**62**
Brown Bread	18	27	**67**		28	48	**58**
Vanilla Ice cream	43	54	**80**		3	21	**14**
Fruit Salad	4	6	**67**		42	69	**61**

Excludes one person who was unsure of consumption.

b) Find out most likely vehicle for the illness by looking at the attack rates. Create 2x2 table for the food item which caused the illness and ***calculate the relative risk***. (2 points)

	Sick	***Well***	***Total***	***Attack Rate%***
Ate Food Item	43	11	54	**79.6**
Did Not eat Food Item	3	18	21	**14.3**
Total	46	29	75	**61.3**

RR = 79.6 / 14.3 = 5.6

To determine the probability that the relative risk of 5.6 could have occurred by chance alone a statistical significance test can be calculated.

c) ***Calculate the statistical significance using the chi-square (χ^2) test*** to determine that the relative risk (of getting sick by eating the food item) could have occurred by chance alone or not. (5 points)

We can calculate the expected numbers of ill and well that would occur if exposure were not related to becoming ill and the division into ill and well were by chance alone:

The chi-square tests compare the observed numbers with the expected numbers for each of the four cells using the following formula:

	Sick	***Well***	***Total***	***Observed***
Exposed	$O_1 = a$	$O_2 = b$	n_1	
Not Exposed	$O_3 = c$	$O_4 = d$	n_2	
Total	n_3	n_4	N	

	Sick	***Well***	***Total***	***Expected***
Exposed	$E_1 = n_1n_3 / N$	$E_2 = n_1n_4 / N$	n_1	
Not Exposed	$E_3 = n_2n_3 / N$	$E_4 = n_2n_4 / N$	n_2	
Total	n_3	n_4	N	

The chi-square tests compare the observed numbers with the expected numbers of each of the four cells using the following formula.

$$\chi^2 = \sum \frac{(observed - expected)^2}{expected} = \sum \frac{(O_i - E_i)^2}{E_i}$$

An easier way to calculate the χ2 for a 2x2 table which leads to the same result can be obtained with the following formula:

$$\chi^2 = \frac{N(ad - bc)^2}{n_1 n_2 n_3 n_4}$$

The results for χ2 are compared with theoretical values for the chi-square distribution.

Chi-square value	Probability (p)
≥ 10.83	≤ 0.001
≥ 6.64	≤ 0.01
≥ 3.84	≤ 0.05
< 3.84	> 0.05

$$\chi^2 = \frac{75(43x18 - 11x3)^2}{54x21x46x29} = 27.2$$

Since the χ2 value of 27.2 > 10.83, the *p*-value is <0.001. This means that the probability of finding the distribution presented in this 2x2 table by chance alone is small – less than 1/1000. In other words, it can be assumed that vanilla ice cream is strongly associated with the risk of becoming ill.

22. Looking for a ***dose response*** is particularly important in outbreaks where cases and the comparison group were exposed to the same risk factors. What is a ***dose response?*** (2 points) (tiebreaker)

A dose response is present if the risk of illness increases with increasing amount or duration of exposure.