Last Name: _____ **First Name:** _____ **Student ID#:** _____

University of Guelph
Department of Population Medicine

Midterm #1 Examination
POPM*3240
October 7th, 2013

This is exam is out of **25 marks** and is worth 20% of the total course grade.

VERSION A

INSTRUCTIONS:

1. Write your name & ID number on the top of EVERY page of the exam AND on the Computer Test Scoring sheet.
2. Communication with anyone other than the instructors or invigilators during the exam is not permitted.
3. Scientific or desk calculators may be used, but cannot be shared.
4. The use of other electronic devices like computers, cell phones and PDAs is NOT permitted. Cells phones must be turned off during the exam.
5. **All** pages of the exam AND the Computer Test Scoring sheet must be handed in at the end of the exam period. Please remove the formulae sheet from your exam.
6. **PART A: MULTIPLE CHOICE QUESTIONS (MCQ)**
   - Fill in the personal information on the Computer Test Scoring sheet
   - Each question is worth one (1) mark
   - There is only one correct answer for each MCQ - choose the most correct answer and circle on the exam page
   - Enter the correct answer for each MCQ on the Computer Test Scoring sheet
   - Use only an HB #2 pencil to fill in the Computer Test Scoring sheet. Make heavy black marks that fill the circle completely. Erase cleanly any answer you wish to change. Make no stray marks on the answer sheet.
7. **PART B: SHORT ANSWER QUESTIONS**
   - Answer ALL questions in the space provided on the (front of the) exam pages
     - DO NOT WRITE ON THE BACK OF THE EXAM PAGES!
   - Please write legibly (we cannot mark things we cannot read)
   - Answers written in pencil will not be eligible for any re-grade request

Multiple Choice (14 marks total)

1.) The time from when a person is exposed to a disease-causing agent to the point when there is clinical presentation of the disease is known as the _____ period. Any treatment after this clinical presentation is known as a _____ intervention.

a) Latent, Secondary
b) Latent, Tertiary
c) Incubation, Secondary
d) Incubation, Tertiary
e) None of the above

The next two (2) questions are based on the following scenario:
Methicillin-resistant *Staphylococcus aureus* (MRSA) infections can cause mortality in humans. However, pigs carry this bacterium without ever eliciting an immune response. Hospital-acquired methicillin-resistant *Staphylococcus aureus* (MRSA) infections occur at a stable rate of 0.35 infections per 10,000 patient-days at the Guelph General Hospital.

2.) This is an example of a(n) _____ temporal disease pattern in humans.

a) sporadic
b) endemic
c) epidemic
d) pandemic
e) outbreak

3.) A pig with MRSA is said to be _____ with this bacterium.

a) infected
b) sub-clinically affected
c) colonized
d) diseased
e) a vector

4.) Cattle plague is a highly communicable viral disease with a mortality rate of almost 100% in naïve (unexposed) cattle herds. Before its worldwide eradication in 2011, Canada wanted to ensure that foreign cattle coming into the country did not carry this disease. Given this mandate, what kind of test would you use to screen imported cattle?

a) Screening test with 99% sensitivity and 60% specificity.
b) Screening test with 90% sensitivity and 90% specificity.
c) Screening test with 60% sensitivity and 99% specificity.
d) Two screening tests with 90% sensitivity, used in series.
e) Two screening tests with 60% specificity, used in parallel.

The next <u>two (2)</u> questions are based on the following scenario:
A 55-year old female enters Guelph General Hospital and presents with clinical symptoms of acute gastroenteritis (known to be caused by a number of pathogens including *Escherichia coli* also referred to as *E. coli*, which is often a food-borne illness transmitted fecal-orally). She explains that she recently attended a wedding of a family friend on a hot summer day where a three-course meal was served over the duration of the late afternoon and early evening. The meal took place under a tent outside and the food was prepared on-site with limited refrigeration. The patient also explains that she is aware of at least twelve (12) other guests who have had symptoms similar to her. From the patient's description, the doctor isolates the following relevant information:

I. *Escherichia coli*
II. Three-course meal
III. Female, age 55

5.) Please describe each of the factors above in terms of components of the Epidemiological Triad.

a) I is Host, II is Environment, III is Agent
b) I is Host, II is Agent, III in Environment
c) I is Environment, II is Agent, III is Host
d) I is Agent, II in Environment, III is Host
e) I, II and III are agent or host characteristics

6.) In this scenario, disease transmission probably occurred through:

a) Direct contact
b) Indirect contact
c) Continuous exposure
d) Droplet
e) Common vehicle

7.) Which statement is TRUE about the concept of herd immunity?

a) The degree of random mixing dictates the degree of herd immunity.
b) Herd immunity requires that the infectious agent be restricted to a maximum of three host species.
c) The infectious agent does not need to induce immunity.
d) Herd immunity only applies to livestock animals.
e) None of the above statements are true.

8.) Which of the following is a related concept to a Type II statistical error?

a) A false negative test result
b) Low specificity
c) High positive predictive value
d) $p < 0.05$
e) None of the above

The next <u>two (2)</u> questions are based on the following scenario:
Q fever is a worldwide disease caused by the bacteria *Coxiella burnetii*. Cattle, sheep, and goats are the primary reservoirs. Infection of humans usually occurs by inhalation of these pathogens from air that contains barnyard dust contaminated by dried placental material, birth fluids, and excreta of infected animals. Given their occupational hazards, livestock handlers are most at risk of infection with a true prevalence of one in twenty-five. During the acute phase of illness, a sample of whole blood can be tested by polymerase chain reaction (PCR) assay to determine if a patient has Q fever; the PCR has a test sensitivity of 90% and a test specificity of 75%. Specimen biopsy (liver or heart tissue) can also be used to diagnose Q fever, which has a test sensitivity and specificity of 80%. While most infected people experience mild symptoms, some complications of illness may include pneumonia, granulomatous hepatitis (inflammation of the liver), myocarditis (inflammation of the heart tissue) and central nervous system complications. The Chief Public Health Officer would like to ensure that there are no missed Q fever infections during a screening program of 250 livestock handlers in the region.

9.) What is the negative predictive value of the PCR test for Q fever?

a) 72%
b) 87%
c) 90%
d) 96%
e) 99%

10.) In order to best serve the Chief Public Health Officer's objective, _____ would be the best recommended screening protocol as it provides an _____.

a) Series testing; increase in net sensitivity
b) Parallel testing; increase in net sensitivity
c) Series testing; increase in net specificity
d) Parallel testing; increase in net specificity
e) None of the above are correct.

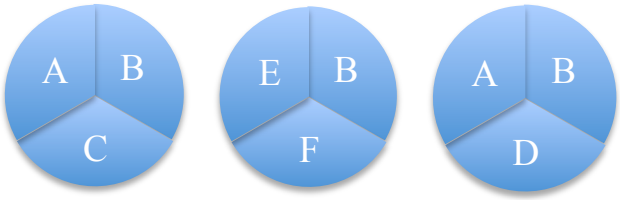
11.) Non-differential misclassification is a type of _____ bias and can result in _____.

a) Selection Bias; bias towards the null
b) Selection Bias; bias towards or away from the null
c) Information Bias; bias towards the null
d) Information Bias; bias towards or away from the null
e) None of the above

12.) Which of the following is FALSE about confidence and confidence intervals?

a) The confidence of a study can be calculated by (confidence = 1-α)
b) A wide confidence interval would make us less certain about our computed estimate compared to a narrow confidence interval
c) Statistical significance can be assessed using confidence intervals
d) The industry standard for confidence is set at 95%
e) All of the above are true about confidence and confidence intervals

The next <u>two (2)</u> questions are based on the following scenario:
Each of the circles below represents a sufficient cause for disease with a respective Population Attributable Risk (PAR) indicating the percentage of disease due to that specific sufficient cause in the whole population.



PAR = 30% **PAR = 15%** **PAR = 55%**

13.) If component cause "A" was removed using a primary intervention, what proportion of disease would be averted in the population?

a) 15%
b) 30%
c) 45%
d) 55%
e) 85%

14.) As a result of worldwide public health efforts, Factor D should be eradicated in 2015. If successful, after 2015 what factor, if any, would be considered a necessary cause?

a) Factor A
b) Factor B
c) Factor C
d) Factor E
e) None of the above

Short Answer (11 marks total)

15.) Thinking broadly about defining and measuring health, please name one domain of Huber *et al.*'s (2011) definition of health (0.5 marks). Using any disease example or health outcome, state why the inclusion of the domain you specified improves our understanding of the disease/health outcome. (1 mark)

16.) Iron-deficiency anemia is often caused by low dietary intake and absorption of iron, which leads to low haemoglobin levels in the blood. Common clinical symptoms include light-headedness and weakness. Iron-deficiency anemia represents a serious global health concern and the prevalence is particularly high in sub-Saharan Africa and southern Asia among women and infants. A gold standard test for iron anemia exists and has a sensitivity of 95% and a specificity of 98%. You are leading a team of researchers with the goal of investigating the possible association between low household income and iron-deficiency anemia in women in rural Nepal. It is predicted that adult women who live in households with low income have reduced access to iron-rich foods. Through previous research, you know that the true prevalence of this disease in Nepal among women is 60%. You take a random sample of villages in rural Nepal, and from that random sample, you select a fixed proportion of households within each village from which you will draw your adult women to be included in your study. Given the rural nature of your study, you are not able to use the gold standard test, but instead use a point of care rapid test. The haemoglobin level of women with a relatively high household income is approximately 7.5 mmol/L and you predict a haemoglobin level of 6.8 mmol/L for women who live in low-income households. From a previous literature search, you know the variance in haemoglobin levels in the Nepali population is about 1.1 mmol/L.

16.a.) In this example, who or what is your source population? (be specific) (1 mark)

16.b.) In this example, what sampling technique was used? (be specific) (1 mark)

_____
3.5

16.c.) Your research funder asks you to implement probability cluster sampling to select potential research participants. Explain how you would implement this sampling approach using the example outlined above. (1 mark)

16.d.) Your research funder is concerned with how well your rapid test performs compared with the gold standard test. In a separate study of 200 participants, you demonstrate that when compared with the gold standard test, your rapid test also diagnoses iron-deficiency anemia for 65% of individuals, and also diagnoses sufficient levels of iron for 30% of individuals. In 4% of individuals, the gold standard test indicates iron-deficiency anemia that was not picked up using the rapid test. The remaining participants were labeled as iron-deficiency anemic using the rapid test only. With what level of certainty do you inform the research funder that your decision to use the rapid test is rationale? (3 marks)

4.0

16.e.) If you wanted to show a significant difference in hemoglobin levels between the two groups identified in this study, what is the minimum sample size that would be required (assuming α=0.05 and β=0.2)? (3.5 marks)

3.5

Provided Formulae

(you may remove and keep this sheet)

$$\text{Agreement}_{\text{Expected}} = [(a+b)*(a+c)/n + (c+d)*(b+d)/n] / n$$

$$\text{Kappa} = (\text{Agreement}_{\text{Obs}} - \text{Agreement}_{\text{Exp}}) / (1 - \text{Agreement}_{\text{Exp}})$$

Kappa values:

< 0.2	slight agreement
0.2 - 0.4	fair agreement
0.4 - 0.6	moderate agreement
0.6 - 0.8	substantial agreement
> 0.8	excellent agreement

$$n = \frac{{Z_\alpha}^2 * \sigma^2}{L^2}$$

$$n = \frac{{Z_\alpha}^2 * p * q}{L^2}$$

$$n = \frac{\left(Z_\alpha\sqrt{2pq} - Z_\beta\sqrt{p_1q_1 + p_2q_2}\right)^2}{(p_1 - p_2)^2}$$

$$n = 2 * \left[\frac{\left(Z_\alpha - Z_\beta\right)^2 * \sigma^2}{(\mu_1 - \mu_2)^2}\right]$$