Suffolk County Community College

Michael J. Grant Campus

Department of Mathematics

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MAT 106
Mathematics for Health Science

Final Exam

Instructor:

Name: Alexander Kasiukov
Office: Health, Science and Education Center, Room 109
Phone: (631) 851-6484
Email: kasiuka@sunysuffolk.edu
Web Site: `http://www.kasiukov.com`

Please print the requested information in the spaces provided:

Student:

Name:

Student Id:

Email: *include to receive the final grade via email* ONLY *if you are not getting email updates*

- *Notes and books are permitted on this exam.*
- *Graphing calculators, computers, cell phones and any communication-capable devices are prohibited. Their mere presence in the open (even without use) is a sufficient reason for an immediate dismissal from this exam with a failing grade.*
- *You will not receive full credit if there is no work shown, even if you have the right answer. Use back pages if necessary. Please don't attach additional pieces of paper: if you run out of space, please ask for another blank final.*

Problem 1. Vancomycin is an antibiotic recommended intravenously as a treatment of neonatal sepsis with the following dosages:

Gestational Age	Postnatal Age	Dose	Frequency
< 30 weeks	$0 - 7$ days	10 mg/kg	12 hourly
< 30 weeks	> 7 days	10 mg/kg	8 hourly
$30 - 37$ weeks	$0 - 7$ days	15 mg/kg	12 hourly
$30 - 37$ weeks	> 7 days	15 mg/kg	8 hourly
$37 - 44$ weeks	All ages	25 mg/kg	12 hourly

(Gestational age is computed as 40 weeks minus the number of weeks before due date at birth. For example, if a baby is born 2 weeks prematurely, its gestational age is 38 weeks.)

(1). The drug is available in the form of a 500 mg vial with powder that needs to be diluted into solution.

The solution is prepared according to the following protocol.

1. add 10 mL of sterile water for injections into the 500 vial;
2. withdraw 1 mL of the resulting solution;
3. further dilute this 1 mL to 10 mL with 0.9% Sodium Cloride;
4. discard any remaining solution from the vial immediately.

What is the concentration of the resulting solution?

Space for your solution:

(2). What is the gestational age of a baby born 1 month prematurely?

Space for your solution:

(3). The baby considered in the previous problem developed sepsis by the 5 day since birth. It weighs 2 kg. What is the single dose of pure Vancomycin to be administered?

Space for your solution:

(4). What is the single dose of the Vancomycin solution to be administered?

Space for your solution:

Problem 2. Sickle cell anaemia is an autosomal recessive disorder. It affects erythrocytes (the red blood cells that transport oxygen). Individuals with two normal alleles have normal erythrocytes, but are easily infected with the malaria.

Those who have two defective alleles suffer from the anaemia. Their erythrocytes develop abnormally and may collapse when deoxygenated. However, malaria parasite cannot grow in those abnormal erythrocytes. Therefore people with anaemia are protected from malaria, but suffer from the effects of the erythrocyte defect.

Those who are heterozygous (i.e. are carriers: have one normal and one defective allele) have some sickling of erythrocytes, but do not suffer any ill effects from it, except when severely dehydrated or deprived of oxygen. In addition, malaria parasite cannot reproduce well within these their partially defective erythrocytes. Thus, heterozygous individuals tend to reproduce at a higher rate than those who have one of the two homozygous genotypes.

Compute all probabilities with at least four digits after the decimal.

(1). In a particular family, one parent is healthy and another one has sickle cell anaemia. They had a child who also suffers from the anaemia. What is the probability that their next child will have sickle cell anaemia?

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(2). Sickle cell anaemia is estimated to occur in 1 in 500 African Americans. What are the frequencies of the normal and defective sickle cell anaemia alleles in the African American population?

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(3). Using the information from the previous subproblem, determine the probability of an African American to be a carrier of sickle cell anaemia.

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(4). In a particular family, one parent is a healthy African American and another one has sickle cell anaemia. Determine the probability of their child having sickle cell anaemia.

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Problem 3. Mammogram is an X-ray imaging of human breast, used for diagnosis or screening of breast cancer. Approximately 1 in 8 U.S. women (about 12.4%) will develop invasive breast cancer over the course of her lifetime: $P\begin{pmatrix}\text{breast}\\ \text{cancer}\end{pmatrix} = 12.4\%$. The following parameters can be defined for any diagnostic procedure. They are listed below with their estimated values for mammogram, based on *Saving Women's Lives: Strategies for Improving Breast Cancer Detection and Diagnosis.*

- sensitivity of the test (also called the "true positive" rate)

$$P\left(\begin{matrix}\text{positive}\\ \text{mammogram}\end{matrix}\middle|\begin{matrix}\text{breast}\\ \text{cancer}\end{matrix}\right) = 90\%$$

  (estimates range from 83 to 95 percent);

- specificity of the test (also called the "true negative" rate)

$$P\left(\begin{matrix}\text{negative}\\ \text{mammogram}\end{matrix}\middle|\begin{matrix}\text{no breast}\\ \text{cancer}\end{matrix}\right) = 95\%$$

  (estimates range from 90 to 98 percent);

- type I error probability (also called the "false positive" rate)

$$P\left(\begin{matrix}\text{positive}\\ \text{mammogram}\end{matrix}\middle|\begin{matrix}\text{no breast}\\ \text{cancer}\end{matrix}\right) = 1 - (\text{specificity}) = 5\%,$$

- type II error probability (also called the "false negative" rate)

$$P\left(\begin{matrix}\text{negative}\\ \text{mammogram}\end{matrix}\middle|\begin{matrix}\text{breast}\\ \text{cancer}\end{matrix}\right) = 1 - (\text{sensitivity}) = 10\%,$$

Sensitivity and specificity of a mammogram depends on age and type of breast tissue. The above are the overall rates that should be adjusted in any specific case to take into account the particulars of the patient being tested.

(1). Find the probability that a random U. S. woman having a mammogram will get a positive mammogram result.

Space for your solution:

(2). Positive predictive value of the mammogram test is defined as

$$P\left(\begin{matrix}\text{breast}\\ \text{cancer}\end{matrix}\,\middle|\,\begin{matrix}\text{positive}\\ \text{mammogram}\end{matrix}\right).$$

Use the Bayes theorem and the previously mentioned data to find positive predictive value of a mammogram test for U.S. women.

Space for your solution: