BIO2134 Final exam 2011

Part 1: This part of the exam includes 40 multiple choice questions (1 pts/each).

----------showed that the pébrine disease of silkworms was caused by a protozoan Nosema bombycis

a. Robert Koch
b. Agostino Bassi
c. Louis Pasteur
d. Francesco Redi
e. Neither

You have isolated a bacterium that you believe to be the causative agent of a new disease in mice. How would you test the Koch's third postulate?

a. Determine the shape of the bacterial cells
b. Inject the bacteria into a healthy mouse
c. Isolate the bacterium from a sick mouse
d. Show that the bacterium is NOT present in healthy animals
e. Grow a pure culture of the bacterium

Increasing the refractive index of the medium between the object and the objective lens increases:

a. wavelength
b. reflection
c. magnification
d. resolution

Which of the following microscopic techniques is useful for resolving the image of molecules?

a. confocal scanning laser microscopy
b. Scanning electron microscopy
c. Atomic force microscopy
d. Transmission electron microscopy
e. Neither

Which of the bacterial functions is not directly dependent on proton motive force acrosss membrane

a. PTS dependet sugar uptake
b. flagellar rotation
c. ATP synthase
d. Na ion transport out of the cell

The bacterial protein that determines the rod shape of the bacterial cells,

a. MinCD
b. FtsK
c. ZipA
d. FTsI
e. MreB

Porin proteins are,

a. cytoplasmic membrane integral proteins that regulate the sodium uptake
b. not part of the bacterial outer membrane
c. part of cell wall in gram negative bacteria that bridges the outer membrane and the cell membrane
d. outer membrane integral proteins that regulate the uptake of water and organic compounds

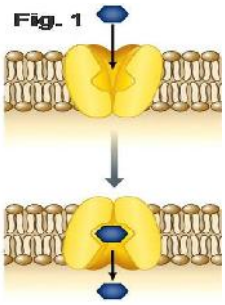
Which name refers to having flagella attached at both ends of the bacterial cell?

a. peritrichous
b. lophotrichous
c. monotrichous
d. bitrichous

Na/H+ antiporter coupled Na/glucose uptake is an example of

a. active transport that leads to net intracellular glucose gain
b. PMF mediated active transport that leads to net intracellular gain of Na and glucose
c. ABC transpoerter
d. facilitated diffusion

What kind of nutrient transport system is used in Fig. 1,



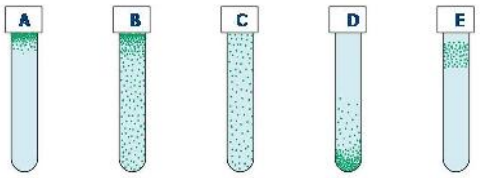
a. Facilitated diffusion
b. ABC transporter
c. PTS dependent active transport
d. Passive diffusion
e. Neither

Human pathogens are:

a. halophiles
b. psychrophiles
c. mesophiles
d. thermophiles
e. extreme thermophiles

Which of the cultures contain a facultative anearobic bacteria? test tubes are not airtight.

a. A
b. B
c. C
d. D
e. E



D value of a culture of *S. aureus* treated at 90 C for 18 minutes that resulted in cell number decrease from 10^8 cfu/mL to 10^2 cfu/mL, is

a. 0.6 min
b. 0.33 min
c. 3.3 min
d. 3.0 min
e. Neither

The temperature change that results in 10-fold acceleration of killing of 90% of a bacterial suspension defines the,

a. Thermal death time
b. D-value
c. Z-value
d. Thermal death point

Salvarsan is an arsenic derivative drug used to target which of the following pathogens?

a. *Treponema pallidum*
b. *Mycobacterium tuberculosis*
c. *Escherichia coli*
d. *Streptococcus mutans*
e. Neither

Which of the following would be the best target for a new antibiotic?

a. phospholipids in plasma membrane
b. glycolysis pathway
c. pyrimidine bases
d. nuclear envelope
e. ribosomes

Which of the following describes the selective toxicity of Azithromycin,

a. a dose of 30 mg/kg body weight twice a day will clear dysenteric *E.coli* infection but not a gram positive pneumococcal lung infection
b. patient's hepatic functions altered within normal ranges and the infection is cleared over the prescribed period
c. renal tissue damage observed in patients at the attainable serum drug concentration for effective clearance of a severe intestinal infection
d. long term delivery will equally remove pathogenic strains and the residing natural microflora

Which one of the following antibiotics is a cell wall synthesis inhibitor,

a. Tetracyclin
b. Gentamicin
c. Chloramphnicol
d. Vancomycin
e. Neither

Pathogen driven enzymatic inactivation of antibiotics apply to all except for,

a. Chloramphenicol
b. Ampicillin
c. Kanamicin
d. Trimethoprim

***dnaQ* codes for the epsilon subunit of replisome and is responsible for removal of RNA primer from the 5'-end of Okazaki fragments**

a. True
b. False

Which is correct?

a. copying the information from template strands starts when helicase at each open fork facilitates laying down an RNA primer by recruiting the primase to the fork.
b. By semiconservative replication of DNA, cells ensure accurate passage of information in both strands by providing each of two progeny cells with full copies of newly synthesized strands of the double stranded chromosome.
c. DnaA-ATP is only recruited to the OriC when DNA is fully methylated by Dcm methylases
d. SeqA protein binds tightly to the fully methyated DNA at OriC and inhibits premature inititation of the chromosome replication

Which of the following forms of DNA repair is error-prone?

a. SOS repair
b. methyl mismatch
c. base excision
d. nucleotide excision
e. photoreactivation

Which of the following is the activator of the SOS response?

a. *RecA*
b. *LexA*
c. *FtsZ*
d. *sulA*
e. *uvrA*

Sets of genes in operons are coordinately regulated transcriptionally or translationally by which of the following?

a. protein repressors
b. activators
c. sigma factors
d. small RNAs
e. all of the choices

What occurs when an inducer is added to a medium containing an organism with a metabolic pathway controlled by a repressor?

a. The inducer combines with the repressor and activates the repressor
b. The inducer combines with the repressor and inactivates the repressor
c. The inducer combines with the substrate and blocks induction
d. The inducer combines with the substrate and activates induction
e. The inducer does not combine with but functions as a chaperone molecule for the enzyme-substrate complex

Which one of the following <u>is not</u> correct,

a. Vaccinia virus is an example of a virus with complex capsid symmetry
b. Influenza virus is an example of an enveloped virus
c. T4 is an example of a temperate phages
d. TMV is an example of a virus with helical capsid symmetry

Assembly and release of M13 phage virions is achieved by,

a. Coat proteins are secreted to the cell membrane outer surface while genome is loaded into the assembled capsids
b. Coat proteins are assembled around the genome units in the cytoplasm and complete virions leave the cells by lysing the host cell
c. Coat proteins integrate into membrane where the virion is assembled and bud out of the cell while covered with a layer of membranous envelop
d. Complete virion particles form in cytoplasm and leave the cells through holes formed in the membrane by holins
e. Neither

Which of the following applies to hemagglutination assay?

a. a quantitative method for titering only naked viruses
b. can distinguish between infectious and non infectious virions
c. results are expressed as Hemagglutination units that is the inverse of the highest dilution that caused visible agglutination
d. is a direct method for measuring the titre of all viral preparations

Which of the following viruses acquire its envelop from nuclear-ER membranes

a. HSV-2
b. HIV-1
c. Influenza A virus
d. Poliovirus type I

Which of the following best describes the genome of influenza virus?

a. negative strand segmented RNA
b. positive strand segmented RNA
c. negative strand single-piece RNA
d. positive strand single-piece RNA
e. double-stranded RNA

The term phagovar refers to

a. A number of phages that can infect one type of bacterium
b. A collection of bacteria that show similar sensitivities to a known group of bacteriophages
c. a classification method to group different bacteriophages
d. the serological differences between different bacteriophages

Real-time polymerase chain reaction on a clinical sample from a suspected hantavirus patient can determine both:

a. antibodies to hantavirus and viral resistance
b. viral resistance and viral load
c. presence of hantavirus and viral load
d. antibodies to hantavirus and strength of immune response
e. hanta serotype and strength of immune response

Toxic shock syndrome is associated with which of the following:

a. *E. coli* O157:H7
b. enterotoxin of *Staphylococcus aureus*
c. superantigens of some Gram-positive cocci
d. meningococcal capsular antigen
e. pertactin of whooping cough

MRSA infections are typically treated with _____.

a. penicillin G
b. tetracycline
c. vancomycin
d. ciproflaxacin
e. amoxicillins

The major challenge with treating flesh-eating disease caused by *Streptococcus pyogenes* is that:

a. rapid necrosis of infected tissue limits access
b. no antibiotic is useful because it's a mixed infection
c. toxin encoding phage also encode antibiotic degrading enzymes
d. the causative agent is a MRSA

Which of the following is NOT a symptom of influenza?

a. fever
b. runny nose
c. muscle aches
d. sore throat
e. headache

Strains of *E. coli* that cause about 75% of all urinary tract infections use _____ to latch onto proteins coating the urinary tract epithelium.

a. sex pili
b. P pili
c. fimbrae
d. adhesins
e. glycocalyx

Which of the following is not part of the inflammatory response?

a. dilation of blood vessels
b. release of histamines
c. chemotaxis of PMN
d. extravasation
e. antibody synthesis

Which of the following are the major phagocytic cells in the body?

a. T and B lymphocytes
b. basophils and eosinophils
c. erythrocytes
d. neutrophils and macrophages
e. epithelial cells with cilia

What is the correct order of the events in phagocytosis? (1) discharge of waste material, (2) fusion of the phagosome with a lysosome, (3) adherence of the microbe to phagocytes, (4) digestion of ingested microbe, (5) formation of a phagosome, (6) ingestion of microbe by phagocyte

a. 3, 6, 5, 2, 4, 1
b. 3, 4, 6, 5, 2, 1
c. 6, 5, 2, 4, 3, 1
d. 5, 2, 3. 6, 4, 1
e. Neither

Part 2: A clinical case study. Please read the following passage carefully and provide answers to the questions (6 pts).

Sheryl is a 28 year old graduate student who presented at her local hospital mid September 2010. Her body temperature was 38.5 C, and appeared tired with tender joints. She had headache, a stiff neck and backache. Upon examination the physician noted an irregular heart beat. She seemed unfocused and had difficulty remembering some details of the past 2-3 months. She provided the following history: She was studying mammalian wildlife at the university of Victoria and had to visit the Wisconsin university during the months of June and July. Together with a research partner they were tracking small mammals population in the field. This would require them to camp in the woods when she got several bites of mosquitoes, flies and ticks. She also remembered developing a large rash with a reddened edge and a pale center that did not last for more than a few weeks. Upon returning home she felt having flu for a week that she recovered after a week. Since then her symptoms had worsened that finally she decided to get seen by a specialist.

1. What is your diagnosis for this case and what would be the full name of etiologic agent? (2 pts)
Lyme disease (1 mark).
Etiologic agent is
genus name: *Borrelia* (0.5 pts)
species name: *burgdorfery or any of afzalii or garinii* (0.5 pts)

2. What features are critical to your diagnosis? (2 pts)
a) the bull's eye circular rash (1 pts)
any **two** of the following (0.5 pts each)
b) Working in the Wisconsin woods,
c) flu like symptoms
c) fever,
d) cardiac changes,
e) joint pain
f) unfocused/forgetfulness

3. What other methods do you apply to consolidate your diagnosis? (1 pts)
for any of two shown below (each **0.5** pts)
a) Isolation of bacteria
b) PCR
c) immunological tests

4. What is your treatment strategy? (1 pts)
Either of Amoxicillin or Ampicillin (anyone **0.5 pts**)
and Ceftriaxone (**0.5 pts**) (might mention for neurological disorders and to pass through BBB)

Part 3: this part includes **12** short answer questions. You will provide answers for **ONLY six** of them. The first **6** answered questions will be considered for marking. **(4 points each).**

1. **The bacterial membrane ATP synthase has two subunits, referred to as F_0 and F_1. What is the location and the function of each?**

The F_0 subunit is located within the cell membrane (1 pts) and serves as a proton channel (1 pts)
The F_1 subunit is within the cytoplasm (1 pts) and is the portion responsible for ATP synthesis (1 pts)

2. **What type of medium and conditions would you need to have in order to select for photoautotrophs?**

Phototrophs can generate **energy from absorption of light** (1 pts) and autotrophs use **CO_2** (1 pts) as **their sole carbon source** so the medium would **not need to contain** an energy source or an **organic carbon** source. Medium must also include minimal **salts** needed for growth (1 pts).
Selection: The lack of **organic substances** would inhibit the growth of other types of organisms, resulting in a selection for photoautotrophs (1 pts).

3. **Explain in point form the mode of action of chloramphenicol and how bacterial resistance is developed against this antibiotic.**

Mode of action: binds to 23S rRNA in 50S ribosomal subunit and inhibits peptidyl transferase reaction during protein synthesis resulting in halting translation (1 pts)
Resistance: enzymatic acetylation of chloramphenicol by acetyltransferases on –OH groups on the antibiotic (1 pts)

4. **What determines when DNA replication begins in *E.coli*?**

DNA methylation controls the timing of replication (1 pts).
SeqA **binds hemimethylated** (newly replicated) origins and **prevents another initiation immediately following replication** (1 pts).
Once the new **strand is methylated, SeqA dissociates** from the origin, which allows DnaA to bind (1 pts).
Initiation of replication is activated by DnaA protein binds origin. This increases **melting of DNA** at origin followed by assembly of replisome (1 pts).

5. **Explain in point form how DNA base excision repair functions.**

- Special glycosylases cut base off sugar (1 pts)
- AP sites formed (1 pts)
- AP endonuclease cut phosphodiester bond 5' to AP site (1 pts)
- PolI fills in the gap and removes AP by its 5'->3' exonuclease activity (1 pts)

6. **How the lac operon is turned on? how presence of glucose intervenes with induction?**

Induction: tetrameric **LacI repressor binds to *lac* operator** and blocks the access of sigma factor and initiation of transcription. when **allolactose inducer** is available it **binds to the LacI** and causes it to **dissociate from *lac* operator** sequence leading to transcriptional activation of the operon. (2 pts)
Effect of glucose: glucose is preferentially taken up by the cells via PTS that indirectly leads to

inhibition of adenylate cyclase. (1 pts)
Inhibition of adenylate cyclase results in lower intracellular cAMP and therefore **unavailability of the activator cAMP-CRP complex**. This leads **transcriptional downregulation of the *lac* operon** by **prevention of operon induction**. (1 pts)

7. **Other than the lack of proper genes explain in one sentence why T4 phage does not have lysogenic life cycle.**

T4 destroys the host chromosome within short time after infection, therefore there is no chromosome taget to integrate to.

8. **Describe in point form how the influenza virus genome is delivered from the surface to the cytoplasm of the host cells.**

Receptor binding and entry: (0.5 points each)
a) virion binds through its trimeric viral HN protein to the host cell surface receptors containing terminal sialic
b) lung epithelial enzyme cleaves the HN to free its otherwise cryptic hydrophobic fusion peptide
c) cell takes up the virion by endocytosis
d) the endocytic vesicles fuse with lysosomes to form the endosomes
e) acidification of the endosomal environment triggers a conformational change in HN that releases the receptor binding domain from the sialic acids and also extends the fusion peptide to contact the endosomal membrane
f) multiple contacts between the viral envelope and endosomal membrane via trimeric fusion peptides bring two membranes close to each other
g) This facilitates the fusion of the endosomal membrane and the viral envelope
h) the viral nucleocapsid is released to the cytoplasm through the opening generated by membrane fusion that can start the replication cycle of virus

9. **Explain stepwise in short sentences how direct ELISA is used in clinic?**

Directly detects the presence of an antigen in bodily fluids
The following 4 steps summarizes the direct ELISA (1 pts each)
- A known antigen-specific antibody is immobilized (adsorbed) inside a well
- Patient serum is added to the well. If antigen is present, it will attach to the immobilized antibody
- An enzyme linked second antibody is added to detect a second epitop on the captured antigen
- The chromogenic colorless substrate of the linked enzyme is added and enzyme is assayed for the presence of the captured antigen

10. **Explain how infection with *Clostridium tetani* and *Clostridium botulinum* can produce completely opposite manifestations knowing that their toxins act in a similar ways.**

The following should be considered (1 pts each)
- *C. tetani* and *C. botulinum* produce structurally similar exotoxins that interfere with the membrane fusion between axonal cell membrane and the cholinergic vesicles that carry acetylcholine to the axonal plate at the neuromuscular junction.
- This results in inability of the neurons to release the neurotransmitter to the pre-synaptic space. In the case of botulinum toxin lack of Ach at the neuromuscular junction leads to flaccid paralysis.

• In the case of tetanus toxin (also called tetanospasim) delivery of toxin to the inhibitory neurons, along the path of stretch of neurons that transmit signal to skeletal muscles, results in inability of these neurons to release GABA, the inhibitory neurotransmistter.
• Therefore, the excitatory signals are overwhelmingly amplified and transmitted onto the skeletal muscles causing them exceedingly enter to a lasting painful contracted state that eventually leads to spastic paralysis of the patient.

11. **What is staphylococcal toxic shock syndrom? explain the cause, mechanism and clinical manifestation of this syndrom**

(1.25 pts each)

• caused by infection by ***S. aureus*** strains that release toxic shock syndrome toxin (**TSST-1**)
• TSST-1 acts as a **superantigen that activate T-cells nonspecifically to produce cytokines** uncontrollably
• massive cytokine production leads to **circulatory collapse , shock and multi-organ failure**
• **clinical manifestations:** low blood pressure, fever, diarrhea, extensive skin rash, and shedding off the skin

12. **Describe opsonization, the process in which innate and adaptive immunity work together to engulf an invader.**

Note: C3b dependent opsonization should be excluded from discussion since this form does not involve elements of adaptive immunity.
This process involves binding of antibodies to the epitopes on invading bacterial cell surface (2 pts), leaving the Fc regions facing outward to be recognized and bound by the Fc receptors on phagocytic cell surfaces This initiates phagocytosis (2 pts).