BIO3124 Midterm 2 – Section A

MULTIPLE CHOICE

Sets of genes in operons are coordinately regulated by which of the following?
a. activators
b. small RNAs
c. protein repressors
d. sigma factors
e. all apply

All of the following typically occur in the presence of high glucose and high lactose concentrations EXCEPT:
a. Adenylate cyclase is inhibited.
b. Enzyme II for glucose uptake is dephosphorylated.
c. cAMP concentration is low
d. Lactose is kept out of the cell.
e. CRP level in the cell is low.

The minimal bactericidal concentration is the:
a. the highest concentration of the drug that will kill an organism
b. the average concentration of the drug that will kill an organism
c. the lowest concentration of the drug that will prevent the growth of an organism
d. the lowest concentration of the drug that will kill an organism
e. the highest concentration of the drug that will prevent the growth of an organism

Which of the following is involved in unzipping the DNA strands during the replication process?
a. Primase
b. Beta calmp
c. DnaC
d. DnaB helicase

CGA —> TGA is a ---------- mutation.
a. transition, silent
b. transversion, missense
c. tansition, nonsense
d. transversion, silent

A MIC result of 10 μg/ml of penicillin for bacterial strain A, 15 μg/ml for stain B, 18 μg/ml for strain C, and 27 μg/ml for strain D can be interpreted as,

a. Bacterial strain C is more susceptible to penicillin than the others.
b. Bacterial strain D is more susceptible to penicillin than the others.
c. Bacterial strain B is more susceptible to penicillin than the others.
d. Bacterial strain A is more susceptible to penicillin than the others.
e. All strains are equally susceptible.

Initiation of DNA replication is controlled by DNA _____ and by the binding of a specific initiator protein to the origin sequence.

a. gyrase
b. methylation
c. restriction
d. helicase
e. ligase

Which does not apply to formaldehyde

a. it is sporicidal
b. it is a cross linking agent
c. it cannot inactivate viruses
d. it can inactivate DNA and proteins

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

A feature common to all control mechanisms is:

a. housekeeping enzymes
b. ability to sense that something inside or around the cell has changed
c. quorum sensing
d. phosphorylation cascades

which one of the following antibiotics is the least likely one to be used for treating a bacterial infection,

a. therapeutic dose of 10 ug/ml and toxic dose of 40 ug/ml
b. therapeutic dose of 20 ug/ml and toxic dose of 60 ug/ml
c. therapeutic dose of 100 ug/ml and toxic dose of 500 ug/ml
d. therapeutic dose of 50 ug/ml and toxic dose of 100 ug/ml
e. therapeutic dose of 10 ug/ml and toxic dose of 25 ug/ml

Ames used his reversion test with *Salmonella* to screen compounds for potential _____.

a. toxicity
b. pathogenicity
c. virulence
d. mutagenicity
e. antibiotics

When the chromosome replicates, how is the newly made strand related to its template strand?

a. The two strands have complementary sequences and are parallel to each other.
b. The two strands have identical sequences and are antiparallel to each other.
c. The two strands have complementary sequences and are antiparallel to each other.
d. The two strands have identical sequences and are antiparallel to each other, except that U replaces T.
e. The two strands have identical sequences and are parallel to each other.

RecA molecules are also called _____ because they are able to scan DNA molecules for homology and align the homologous regions, forming a triplex DNA molecule.

a. polymerses
b. transposases
c. integrases
d. synaptases

An example of an antibiotic that binds to the 30S ribosomal subunit would be:

a. aminoglycosides
b. sulfonamides
c. beta-lactams
d. fluoroquinolones

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

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

If a 10^{-3} dilution of a test compound kills a culture of *Staphylococcus aureus* in 10 minutes but not in 5 minutes while a 1:50 dilution of phenol kills the same culture in the same time, what is the phenol coefficient of the test compound?

a. 5
b. 40
c. 50
d. 0.05
e. 20

Which of the following mechanisms of acquiring a new piece of DNA by bacteria is sensitive to DNase treatment?

a. tranposition
b. generalized transduction
c. transformation
d. conjugation

A nucleoid gently released from *E. coli* appears as 30–100 tightly wound loops, each defined by anchoring proteins called:

a. supercoils
b. histone-like proteins
c. gyrase
d. topoisomerase
e. histones

Which of the following is directly affected by an antibiotic that prevents the synthesis of tetrahydrofolic acid?

a. DNA synthesis
b. Ribosome assembly
c. Cell wall synthesis
d. Membrane permeability

Which of the following explains the regulatory activity of sRNA?

a. It codes for a sigma factor.
b. It creates an attenuator stem loop.
c. It prevents CRP interaction with RNA polymerase, thereby blocking its access to the promoter.
d. It target mRNAs for degradation.

All of the following apply to CRISPRS except for,

a. a prokaryotic equivalent of siRNA response
b. a nucleic acid based mechanism for immunity against bacteriophages
c. is sensitive to a single nucleotide difference between spacer and target sequence
d. spacer sequences are chronologically ordered from 5' to 3'-end
e. is active only on mRNA targets

SHORT ANSWER

23. **If a *Staphylococcus aureas* bacterium was to become resistant to a newly discovered antibiotic, what could be the four basic forms of resistance this bacterium could have acquired?** (1.25 marks each)

1) Alteration of drug target
2) enzymatic modification of abtibiotic by pathogens
3) Drug exclusion from cell by reducing membrane permeability to antibiotic
4) Efflux pumps: pump the antibiotic out using specific or nonspecific transport proteins

24. **How do bacteria sense and respond to their environment.**

1) Two-component signal transduction systems allow organisms to sense and respond to their environment. (1.5 marks)
2) Binding of a ligand to a membrane integral sensor kinase protein results in a conformational change and self-phosphorylation. (2 marks)
3) The phosphate is then passed to a response regulator in the cytoplasm that controls gene expression. (1.5 marks)

25. **What are the differences between replicative and nonreplicative transposition?**

1) In nonreplicative transposition, the transposable element excises itself from one DNA molecule and integrates into another. (2.5 marks)
2) In replicative transposition, the transposable element copies itself so a new DNA molecule has a copy and the original host also retains its copy. (2.5 marks)

26. **Glucose transport into the cell indirectly inhibits an enzyme closely associated with the phosphotransferase system. What is this enzyme and what is its role in the metabolism of lactose?**

1. Glucose indirectly inhibits adenylate cyclase (1 mark).
2. Adenylate cyclase makes cyclic AMP (cAMP) from ATP (1 mark)
3. cAMP binds to the cAMP receptor protein (CRP) to form the cAMP-CRP complex (1.5 marks)
4. This complex acts as an activator and allows transcription of the *lac* operon to occur (1.5 marks)

BIO3124 Midterm 2 – Section B

MULTIPLE CHOICE

_____ prevent transcription, whereas _____ stimulate transcription.
a. Corepressors; inducers
b. Repressors; activators
c. Activators; repressors
d. Regulators; repressors
e. Inducers; corepressors

When _____ interacts with RNA polymerase, it increases the rate of transcription initiation of the *lac* operon.
a. glucose
b. cAMP-CRP complex
c. lactose
d. LacI protein
e. allolactose

Which of the following is NOT true of sRNA genes?
a. They share homology between related species.
b. They occur between genes.
c. They can act as antisense RNAs.
d. They have a ribosomal binding site.

A derivative F plasmid that contains host DNA is called an:
a. F^+ plasmid
b. F plasmid
c. F' plasmid
d. Hfr plasmid
e. F^- plasmid

The lagging strand is synthesized _____ , while the leading strand can be synthesized_____.
a. 5'-to-3'; 3'-to-5'
b. quickly; slowly
c. continuously; discontinuously
d. 3'-to-5'; 5'-to-3'
e. discontinuously; continuously

Which of the following is NOT true of eubacterial plasmids?
a. They are found in archaea.
b. They are usually circular.
c. They are positively supercoiled.
d. They are found in eukaryotes.
e. They are found in bacteria.

Which molecule is responsible for removing torsional stress during DNA replication?

a. single-stranded binding protein
b. DNA ligase
c. RNase H
d. DNA gyrase
e. DNA primase

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

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

The primer in DNA replication is:

a. an RNA starter sequence with a free 5' OH group
b. a DNA starter sequence with a free 3' OH group
c. a DNA starter sequence with a free 5' OH group
d. an RNA starter sequence with a free 3' OH group
e. a telomere with a free 5' phosphate

A quorum-sensing gene system requires the accumulation of a secreted small molecule called a/an _____.

a. repressor
b. autoinducer
c. inducer
d. corepressor
e. activator

Which of the following proteins is involved in nucleotide excision repair pathway?

a. RecBCD and UvrD
b. LexA, SulA and RecA
c. UvrABC and UvrD
d. MutHLS and UvrD
e. RuvABC and RecBCD

A bacterial strain exhibiting a DNA gyrase mutation would most likely resist the activity of what class of antibiotics?

a. metronidazoles
b. quinolones
c. sulfa-drugs
d. cephalosporins
e. tetracyclines

A missense mutation may generate:
a. no phenotypic change
b. a loss-of-function mutation
c. a gain-of-function mutation
d. B and C
e. all choices apply

Hyperthermophilic archaea possess an unusual gyrase called _____, which introduces positive supercoils into the chromosome.
a. reverse transcriptase
b. DNA helicase
c. topoisomerase
d. reverse DNA gyrase
e. DNA ligase

Transcriptional attenuation is a common regulatory strategy used to control many operons that code for what?
a. amino acid degradation
b. carbohydrate biosynthesis
c. carbohydrate degradation
d. amino acid biosynthesis
e. none of the above

The minimal inhibitory concentration is the:
a. the midline concentration of the drug that will prevent the growth of an organism
b. the average concentration of the drug that will prevent the growth of an organism
c. the lowest concentration of the drug that will prevent the growth of an organism
d. any concentration of the drug that will prevent the growth of an organism
e. the highest concentration of the drug that will prevent the growth of an organism

Which of the following is NOT true of a pyrimidine dimer?
a. It blocks transcription.
b. It blocks DNA replication.
c. It is produced by ultraviolet light.
d. It can be repaired by photoreactivation.
e. The pyrimidines are base paired one to another.

Benzalkonium chloride is a,
a. Quaternary ammonium disinfectant that is less active if prepared in hard water
b. halogenated compound that oxidizes the macromolecules
c. disinfectant gas the is used for sterilization of heat sensitive plastic packages
d. heavy metal containing organic salt that inactivates the microbes by binding to proteins and precipitating them

The process in which bacteriophages carry host DNA from one cell to another is known as _____.

a. transduction
b. transposition
c. transformation
d. conjugation
e. recombination

If a 1:5000 dilution of a test compound kills a *Staphylococcus aureus* in 10 minutes but not 5 minutes while a 10^{-2} dilution of phenol kills the population in the same time, what is the phenol coefficient of the test compound?

a. 500
b. 0.02
c. 5
d. 40
e. 50

Drugs such as Cycloserine and cephalosporins work when the bacterial culture is in:

a. lag phase
b. stationary phase
c. death phase
d. log phase
e. any or all of the growth phases

Antiviral therapy for the human immunodeficiency virus (HIV) usually consists of a protease inhibitor that inhibits what function?

a. viral exit of the newly formed virions by vial budding
b. insertion of viral DNA into the host cell DNA
c. viral fusion of the viral envelope with the host cell membrane
d. binding to the CD4 receptor on human immune cells
e. cleavage of polypeptide chains to make functional HIV viral proteins

SHORT ANSWER

23. **Both Penicillin and Vancomycin interfere with bacterial cell wall synthesis. Explain in two sentences how their mode of actions are different.**

Vancomycin: binds the terminal D-alanine residue of peptidoglycan units (1.25 marks) and prevents the transpeptidation reaction catalysed by PBPs (1.25 marks)
Penicillin: competitive irreversible binding to the active site of PBPs (1.25 marks) that inactivates the PBPs transpeptidation function (1.25 marks)

24. **What is diauxic growth and why does this occur?** (1.25 marks each)

1) This type of growth occurs when an organism has a choice of two carbon sources such as glucose and lactose.
2) Catabolite repression causes the organism to first use the glucose since the enzymes for

metabolizing glucose are constitutively produced and it is the preferred carbon source.
3) The lactose operon will be repressed until the glucose has been consumed.
4) After the glucose is consumed the lactose operon will no longer be repressed and the lactose can be metabolized.

25. **Compare and contrast the mechanism of action of topoisomerase I and topoisomerase II.**

Topo I: Is a single subunit enzyme (0.5 pts) that unwinds the supercoils by nicking one strand and allowing the other strand to pass through the nicked strand (1 pts). This relieves the accumulated positive supercoils ahead of the replication fork (0.5 pts).
Topo II: Unlike TopoI the TopoII is composed of two subunits GyrA and GyrB (0.5pts). GyrB binds DNA and allows the GyrA to introduce a double strand break (DSB) using ATP (1 pts). While remaining attached to the double break ends the GyrA allows the DNA to pass through the break and reseals the DSB (1 pts). This introduces a negative supercoil to DNA (0.5 pts).

26. **How is the Ames reversion test performed and what is it used to determine?** (1 mark each)

1) The Ames test can be used as a rapid initial screen to determine whether a substance is a possible mutagen.
2) This test uses a mutant of *Salmonella enterica* that is deficient in histidine biosynthesis, so it can't grow on minimal media that does not contain histidine.
3) Sterile disks containing the test compound is put on a minimal media plate that is covered with salmonella tester strain. test compound is diffused out of disk to form a concentraion gradient.
4) If a reversion mutation occurs in the *his* gene and restores the gene's function, the bacteria will be able to grow around the disk
5) **Interpretation:** if a chemical is able to mutate the *his* gene and cause a reversion mutation, then that chemical has the potential to affect any gene and cause mutations.