BIO 226R
EXAM II (Sample)

_____ _____
PRINT YOUR NAME **SSN**

Please sign below if you wish to have your grades posted by the last five digits of your SSN

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BIO 226R Exam II has 6 pages, and 27 questions.
There are a total of 100 points. It will count as one third of your final grade.
Place your name at the top of each page and check that your exam is complete.

Be brief and precise in your answers. Do not ramble!

Copying and all other forms of cheating will be met with the appropriate disciplinary action.

YOU MUST HAND OVER YOUR COMPLETED EXAM TO A PROCTOR WHEN LEAVING THE ROOM
MAKE SURE THAT YOU SIGN YOUR NAME ON THE SIGN-OUT SHEET

Name _____ SSN _____

Circle the BEST answer for questions 1-6: (3 points each)

1. Oxidation of sugar by glycolysis
   a. occurs only in aerobic organisms
   b. produces a net gain of ATP
   c. uses NADH as a source of energy
   d. generates carbon dioxide

2. DNA exists in three forms, A, B, and Z. Which of these exists predominantly in the cell?
   a. A b. B
   c. Z d. All are present equally

3. Which of the following events does **not** occur in translation?
   a. Proteins are released when the ribosome reaches the "stop" codon.
   b. Codons are read in a sequence.
   c. GTP is hydrolysed.
   d. Amino acids are added to the t RNA after it is hydrogen - bonded to m RNA

4. Translation of an mRNA molecule on a polyribosome:
   a. occurs only in prokaryotes
   b. produces many copies of the same protein
   c. produces many copies of different proteins
   d. produces a single copy of one polypeptide

5. _____ inactivate repressor proteins thereby increasing the synthesis of certain enzymes.
   a. inducers b. corepressors
   c. effectors d. none of these

6. Attenuation is a regulatory process that can function in
   a. eubacteria ONLY b. eukaryotes ONLY
   c. ALL prokaryotes d. ALL living cells

Fill in the blanks/circle the best answer:

7. (4 points) A cell uses both respiration and fermentation to synthesize ATP. In fermentation the final acceptor of electrons is _____, and ATP is synthesized during glycolysis by _____ phosphorylation; where as in respiration the final acceptor of electrons is _____, and most of

the ATP is synthesized by _____ phosphorylation.

8. (2 points) Phosphofructokinase, a key enzyme in glucose metabolism, is inhibited by ADP / ATP, and stimulated by ADP / ATP.

_____ _____

Name SSN

9. (4 points) Photosynthetic fixation of CO_2 requires energy in the form of _____

and reducing power (H) in the form of _____.

Short answers:

10. (4 points) Fermentation is essentially glycolysis plus an extra step in which pyruvic acid is reduced to form lactic acid or alcohol and carbon dioxide. What is the MAIN purpose and significance of this last step? (Be complete and specific. Answer in less than 30 words)

ANSWER EITHER QUESTION 11A 0R 11B:
We will only grade the first one you answer.

11A. (4 points) What is the role of autolysins in a bacterial cell?

11B. (4 points) What is the chemical nature of bactoprenols and what is their role in the cell?

12. (4 Points) Both bacitracin and penicillin inhibit the synthesis of the peptidoglycan cell wall. Which of these 2 antibiotics will be rendered ineffective if there was no D-alanine residue in the "PG" subunit? Explain in less than 30 words.

13. (4 points) You have a mutant of *E. coli* that is defective in DNA ligase at 40°C (not at 30°C). What would be the effect of this mutation on DNA synthesis at 40°C as compared to that at 30°C? Explain your answer in less than 20 words.

_____ _____

Name SSN

ANSWER EITHER QUESTION 14A 0R 14B:
We will only grade the first one you answer.

14A. (6 points) Both DNA polymerase I and III participate in DNA replication. Which of these two enzymes is responsible for removing the primer and filling in the gaps. Which property(ies) (be specific, in terms of direction of synthesis and nuclease activity) of the enzyme allow it to do so?

DNA polymerase: _____

Synthesis: _____; Nuclease activity: _____

14B. (6 Points) Describe the major enzymatic reaction catalyzed by DNA polymerase III of *E. coli* . What makes this reaction irreversible?

15. (8 points) Identify the following structure. Label which of the phosphate bonds are linked by
the ester (low energy) linkage and which are linked by the anhydride (high energy) linkage.

Can this structure be used by "primase" to synthesize the primer? Yes / No

16. (6 points) In the figure shown below, label the following:
a. Origin of replication. (Write O)
b. Okazaki fragments on one of the strands as 1, 2, and 3 in the order in which they were synthesized, with 1, being the first one to be synthesized.
c. The site of MOST recent DNA synthesis on the leading strand. (Write S)

_____ _____

Name SSN

17. (6 points) The RNA polymerase (holoenzyme) of *E. coli* consists of several different polypeptide subunits.

Which of these subunits is responsible for recognizing the promoter sequence?

_____

Which of these subunits has the catalytic activity?

_____

Rifampicin inhibits transcription by binding to _____ subunit.

18. (6 points) Transcribe (using the holoenzyme RNA polymerase) the following double stranded
DNA to give an RNA transcript. **Show only 6 nucleotides**.
[Hint: In prokaryotes the consensus promoter sequence is -35 : TTGACA, and -10 : TATAAT]

a. Indicate the -35, -10 and the +1 region on the double stranded DNA.
Specify whether these are on the top or the bottom strand.

b. Sequence of the transcript: 5'_____

5′-AATAGTGTA**TTGACA**TGATAGAAGCACTCTAC**TATATT**CTCAAT**A**GACGTCAAG-3′
3′-TTATCACAT**AACTGT**ACTATCTTCGTGAGATG**ATATAA**GAGTTA**T**CTGCAGTTC-5′

19. (3 points) What is the role of amino-acyl tRNA synthetases?

20. (4 points) Why (chemically) can N-Formyl methionine only be used for initiation of protein synthesis? On which of the three sites (A, E, or P) on the ribosome does the tRNA carrying N-formyl methionine sit? Explain your answer in less than 30 words.

21. (4 points) Describe both the structural and functional role of 16S rRNA in protein synthesis?

Name _____ SSN _____

22. (4 points) What is the **main** difference between **Negative** and **Positive** regulation of mRNA synthesis?

23. (3 points) Regulatory proteins, e. g. repressor molecules for the *trp* and *lac* operon, are specific DNA binding proteins which have characteristic "motifs" which allow them to recognize both strands of the DNA at the regulatory site. Which of the following motifs is most likely to represent a bacterial repressor?

Helix turn helix / Leucine zipper / Zinc finger

24. (6 points) *E. coli* grown in the presence of both glucose and lactose uses glucose / lactose before using glucose / lactose, because the enzymes required for the break down of glucose / lactose are constitutive / inducible, where as those for glucose / lactose are constitutive / inducible.

Bonus:

25. (2 points) Which of the 3 forms of DNA has a left-handed helix? Does this form have any biological significance?

26. (2 points) Describe the role of Dna A **OR** of topoisomerase II in replication?

27. (2 points) Tetracyclin inhibits replication / transcription / translation by binding to

Additional sample questions:

1. The pentose phosphate pathway provides
    a. ATP
    b. NADPH
    c. four- and five-carbon sugars for amino acid and nucleic acid synthesis
    d. All of these

2. Which of the following is **NOT** a phase of the Photosynthetic carbon reduction cycle?
    a. carboxylation phase
    b. regeneration phase
    c. reduction phase
    d. oxidation phase

13. (4 points) Both NAD^+ and $NADP^+$ participate in biochemical reactions in the cell as electron carriers. Which one of these predominantly functions in catabolic reactions, and which one in anabolic reactions?

Anabolic reactions: _____, Catabolic reactions: _____

16. (5 points) Would a cell containing valine instead of D-alanine as the terminal residue in its peptidoglycan subunits (NAM-amino acids 1-5, linked to NAG) be sensitive to bacitracin (an antibiotic)? Explain in less than 20 words.

16. (4 points) At which step of peptidoglycan synthesis does penicillin act?

Which of the following structures (A or B) is used by primase to synthesize the primer for DNA replication? Explain why?

3. Replication of DNA requires a primer to initiate DNA synthesis because:
    a. DNA polymerase can only add its first nucleotide to a ribonucleotide
    b. DNA polymerase requires a base paired nucleotide with a free 3' hydroxyl group before it can add a new nucleotide
    c. DNA polymerase can only polymerize nucleotides in the 5' to 3' direction
    d. DNA polymerase can only synthesize short fragments

4. What do DNA replication and transcription have in common?
    a. Synthesis proceeds in 5'to 3' direction
    b. Synthesis proceeds in 3'to 5' direction
    c. Use the same enzymes

d. Use the same nucleotides

19. (3 points) DNA polymerases are incapable of initiating DNA synthesis in the cell. They require a free _____ group to which incoming nucleotides are covalently linked.

Replication, thus begins with a short sequence of _____, which is synthsized by the enzyme _____

28C. (4 points) As a general rule, eukaryotic organisms have _____ chromosomes, with _____ origin(s) of replication, whereas prokaryotic chromosomes are _____, with _____ origin(s) of replication.

4. Promoter regions are nucleotide sequences that are:
   a. involved in initiation of transcription
   b. important for translation
   c. contain code for one m RNA
   d. involved in termination

ANSWER EITHER QUESTION 25A 0R 25B:
We will only grade the first one you answer.

25A. (4 points) What is the mode of action of Rifampicin?

25B. (4 points) How does Tetracycline inhibit translation?

8. Which of the following steps in protein synthesis require ATP hydrolysis?
   a. Attaching an amino acid to a tRNA
   b. Base-pairing of codon to anticodon
   c. Binding of mRNA to the ribosome
   d. Binding of tRNA to the ribosome

9. Which of the following is **not** a regulatory mechanism used to control the lactose operon in *Escherichia coli*?
   a. repression b. catabolite repression

c. attenuation

d. negative regulation

Metabolosim:

Q: What are the 3 mechanisms by which ATP can be synthesized?
A: SLP, oxidative P, photo P

Q: What is the role of ETC in ATP formation?
A: Uses the flow of electrons to generate ATP

Q: In ATP, the alpha phosphate is linked to the ribose by ester*/anhydride bond.

PG synthesis:

Q: What is the role of autolysins?
A: To make controlled nicks in the PG cell wall.

DNA:

Q: T*/F: DNA is the genetic material for all cellular organisms.

Q: What type of bond do you find between complementary N-bases in the DNA?
A: H-bond

Q: Which of the following bond has higher energy? Ester/ Anhydride
A: Anhydride

Q: Where would you find the phosphodiester bond in the DNA and where would you find the H-bond?
A: Phosphodiester bonds links the adjacent nt on the same strand and H-bond is between the complementary N-bases in the 2 strands.

Q: Name 3 differences between Prokaryotic and Eukaryotic chromosomal DNA.
A: Pro: basic proteins, 1 replicon, circular
Euk: histones, multiple replicons, linear

Q: What does DNA polymerase need on a primer?
A: Free 3'-OH, to which an incoming dNTP can attach.

Q: Which of the 3 forms of DNA exists predominantly in cellular organisms?
A: B form

Q: Name the 3 forms of DNA and which kind of helix to they have.
A: A: right; B: right; Z: left

Q: What is the site of new DNA synthesis?
A: Replication fork

Q: Name enzymes, components involved in DNA initiation.

A: OriC, DnaA, Dna B(helicase), Primase, DnaC

Q: Which of the following enzymes is responsible for DNA unwinding?
A: DNA polymerase, helicase*, SSB, Dna A

Q: What do Topoisomerases I and II do in a bacterial cell?
A: Topo I relaxes DNA, makes a single nick. Topo II makes double stranded nicks and introduces supercoiling.

Q: What is the role of Topoisomerase II in DNA replication?
A: Resolves the two daughter molecules and is involved in unwinding/supercoiling.

Q: What is the role of DNA helicase?

Q: What is the role of Pol I? Which catalytic activity of Pol I allows it do so?
A: removes RNA primer (5'→3' exonuclease activity), and fills in gap (5'→3' polymerase activity)

Q: What are the components of the lagging strand synthesis?

Q: What are Okazaki fragments?
A: Short fragments of DNA synthesized on the lagging strand.

Q: What is the role of DNA ligase?
A: Links the Okazaki fragments in the lagging strand.

Q: What does the term "hemi-methylation" mean, w.r.t. DNA?
Q: How can the cell tell the difference between the parent and the "newly" replicated strand?
A: One (template) strand of DNA is methylated and not the newly synthesized one.

Q: What are the different factors that contribute to the accuracy of DNA replication?

Q: What is the role of telomeres?
A: To maintain genetic information at the ends of the lagging strands in a linear DNA.

Protein:

Q: What are the 3 sites on the ribosome? What is each one used for?
A: A: acceptor site, where the charged aminoacyl tRNA comes, in response to the codon on the mRNA.

P: peptidyl site, Initiator tRNA comes to this site and the chain elongates when the peptide is transferred to the A site from the P site.

E: exit site, to which the empty tRNA moves from the P site, after transferring the peptide