PART A consists of 14 multiple choice questions. Answer questions 1 to 20 on the computer test scoring sheet in PENCIL ONLY. Only the test score sheet is graded for questions 1 to 20 inclusive.

1. Based on the experiments of Avery, MacLeod and McCarty, which combination will NOT produce type IIIS colonies of *Streptococcus pneumoniae* (hint: transforming principle)?

IIR cells plus heat-killed Type IIIS cells
IIR cells plus DNase treated heat-killed Type IIIS cells
IIR cells plus protease treated heat-killed Type IIIS cells
IIR cells plus RNase treated heat-killed Type IIIS cells
More than one of the above.

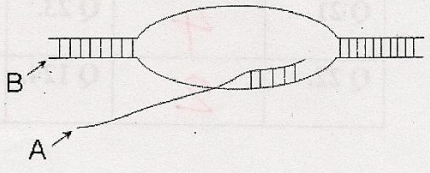
2. Each carbon of a deoxyribose sugar has a hydrogen atom attached. Besides the hydrogen, a deoxynucleoside triphosphate has a base attached to the 1' carbon, a H attached to the 2' carbon, a OH attached to the 3' carbon and a PO attached to the 5' carbon.

phosphate, OH, OH, base
base, OH, OH, phosphate
base, H, OH, phosphate
base, OH, H, phosphate
phosphate, OH, H, base

3. Which of the following statements regarding telomerase is correct?

Telomerase extends the parent strand using 5' to 3' polymerase activity.
The polymerase activity of telomerase does not require a 3'OH for nucleotide addition.
The polymerase activity of telomerase does not require a template.
Telomerase synthesizes RNA.
More than one of the above is correct.

4. The diagram to the right illustrates a transcription bubble. Two ends have been labeled "A" and "B". Are they 5' or 3' ends?



A	B
5'	3'
5'	5'

3' 5'
3' 3'
It is not possible to determine the ends using the information provided.

5. Which of the following statements regarding the *E. coli* RNA polymerase is correct?

The core enzyme includes the σ factor.
The σ factor is responsible for recognizing sequences within the promoter to initiate transcription.
The holoenzyme is responsible for transcription elongation.
The σ factor is responsible for unwinding the DNA strands during elongation.
More than one of the above is correct.

6. A poly(A) tail is

added to the 3' end of prokaryotic transcripts.
removed from the mRNA by the spliceosome before translation begins.
the result of the post-transcription addition of adenine residues by ribosomes.
the result of the post-transcription addition of adenine residues by poly(A) polymerase.
More than one of the above is correct.

7. Which of the following statements regarding spliceosome-mediated splicing of introns is **incorrect**?

Spliceosomes are composed of snRNAs and proteins.
snRNPs work in concert to excise introns and splice the exons.
The 3' end of exon 1 is covalently attached to the 5' end of exon 2.
The 5' end of exon 1 is covalently attached to the 3' end of exon 2.
More than one of the above.

8. Which of the following components is NOT involved in the translation of prokaryotic mRNA?

Shine-Dalgarno sequence
promoter
stop codon
ribosome
release factor

9. Which of the following would be a component of a polycistronic prokaryotic mRNA?

A single stop codon located near the 3' terminus of the mRNA.

A 7-methylguanosine cap at the 5' terminus of the mRNA.
A single promoter sequence.
Multiple Shine-Dalgarno sequences.
More than one of the above.

10. If the anticodon of a charged tRNA is 5'-AUG-3', with which amino acid will it normally be charged?

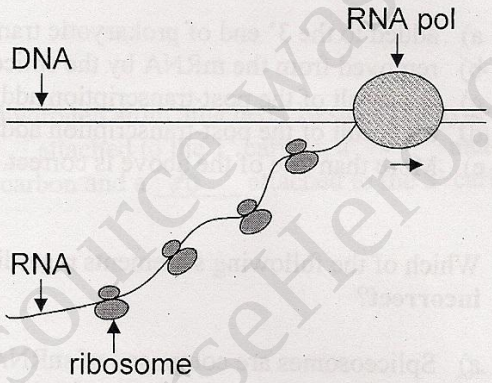
UAC

CAU

valine (val)
leucine (leu)
methionine (met)
tyrosine (tyr)
histidine (his)

11. The following diagram represents gene expression in a cell. What type of cell is it most likely to be?

a plant cell
a prokaryotic cell
an animal cell
a virus
More than one of the above.



12. During translation the carboxyl terminus of one amino acid is joined to the amino terminus of the next amino acid by

peptidyl elongase
aminoacyl-tRNA synthetase
peptidyl transferase
RNA polymerase
peptidyl polymerase

13. A mutation occurs in a gene resulting in a non-functional protein (protein A). A second mutation occurs in a different gene. The 2nd mutation restores the function of protein A. What type of mutation is the second mutation?

nonsense mutation
reversion
intragenic suppressor

extragenic suppressor
None of the above.

14. Which of the following repair mechanisms requires DNA photolyase activity?

photoreactivation
base excision repair
nucleotide excision repair
mismatch repair
More than one of the above.

15. The Ames test uses rat liver enzymes to

mutate *his*$^-$ bacteria to *his*$^+$, restoring the wild-type phenotype.
metabolize histidine present in the growth medium.
provide nutrients for the *Salmonella* bacteria.
test the mutagenicity of metabolic derivatives of chemicals.
digest the *Salmonella* bacterial proteins, providing a supply of histidine.

16. Tautomeric shifts in the bases of DNA generate mutations by:

facilitating the action of intercalating agents such as proflavin.
producing nicks in the sugar backbone of the strands.
producing apurinic sites prior to the passing of replication forks.
directing the incorporation of "wrong" mismatching bases during replication.
producing thymine dimers.

17. Which of the following *lac* operons would express active β-galactosidase (Z) consititutively, but would not express active permease (Y) either constitutively or by induction (assume no glucose present).

cap$^-$I$^-$O^{c}Z$^+$Y$^-$
cap$^+$I$^-$O$^+$Z$^-$Y$^+$
cap$^-$I$^+$O^{c}Z$^+$Y$^-$
cap$^+$I$^+$O^{c}Z$^+$Y$^-$
More than one of the above.

18. Which of the following is an effector molecule involved in regulation of the *trp* operon?

the product of the *trpR* gene
the leader peptide

cAMP
an inducer molecule
tryptophan

19. The following categories of genes are found in prokaryotes:

Constitutive genes, which are expressed all the time.
Inducible genes, which are expressed only when the product is required.
Repressible genes, which are turned-off when the product is no longer needed.
Genes, which are epigenetically regulated by chromatin structure.
More than one of the above is correct.

20. Which of the following statements regarding attenuation of the *trp* operon is correct?

Low levels of tryptophan results in the formation of a hairpin structure between regions 2 and 3 of the attenuator region.
The hairpin structure which forms between regions 2 and 3 of the attenuator region functions as a rho-independent terminator.
The attenuator region is located at the 3' end of the structural genes of the *trp* operon.
High levels of tryptophan results in the formation of a hairpin structure between regions 2 and 3 of the attenuator region.
More than one of the above is correct.

PART B – Answer the following questions in the space provided. Marks for each question are indicated at the beginning of each question. Part B is worth a total of 20 marks. Questions answered in pencil cannot be re-graded.

21. [5 marks]

i) [2 marks] Describe the function or enzymatic activity of each of the following proteins.

a) Helicase

0.5 b) DNA primase

0.5 c) Topoisomerase

0.5 d) DNA polymerase III

1 ii) [1 mark] What is the function of the 5'→3' exonuclease activity of DNA polymerase I?

iii) [1 mark] Imagine that you have purified all cellular components needed for DNA replication. But when mix them and add template DNA, although replication occurs, half of the newly synthesized DNA strands consists of numerous segments of a few hundred nucleotides long. What are you observing? Which enzyme in the mixture is not working?

0.5

iv) [1 mark] In prokaryotes (*E.coli*) a protein called DnaA binds several 9 bp repeats next to the origin called *oriC*. What does DnaA do to force the unwinding of the double helix at *oriC*. Why does *oriC* unwind easier as compared to the surrounding DNA?

0.5

22. [3 marks] Using a diagram(s), describe the process of rho-independent termination. Your answer should include an example of the type of sequence you would expect to find on both the DNA and RNA.

23. [4 marks]

The following DNA sequence contains the complete open reading frame for a six amino acid polypeptide.

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Strand A  5′ TCTACTTATGGCATAGAAGAATCCATAACCG 3′
Strand B  3′ AGATGAATACCGTATCTTCTTAGGTATTGGC 5′
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i) [2 marks] What are the nucleotide sequences of the two possible RNA molecules that could be transcribed from this DNA? Specify the strands.

ii) [1 mark] Which strand (A or B) is the template strand? Why is it not possible for the other strand to be the template strand?

iii) [1 mark] What is the amino acid sequence of the protein (write from amino to carboxyl terminus)?

24. [4 marks] Describe the steps involved in the prokaryotic base excision repair pathway.

25. [4 marks]

i) [4 marks] A wild type culture of *E. coli* is grown in medium without lactose or glucose (other sugars are present). Describe how the positive and negative regulatory mechanisms of the *lac* operon will respond in this environment. What is the overall effect on the expression of the structural genes?