系所組別：分子醫學研究所

考試科目：分子生物學

※ 考生請注意：本試題不可使用計算機。 請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

第一部分、選擇題（共 20 分，每題 1 分，單選）

1. Which of the following statements is false regarding eukaryotic replication origins?

A. More origins are licensed and initiated within embryonic cells than in adult cells.
B. Replication is committed to initiate from an origin once it is bound by the pre-replication complex.
C. During each cell cycle only a subset of potential replication origins are licensed.
D. A eukaryotic replication origin is defined by several factors including DNA sequence, DNA topology and chromatin structure.

2. Replication origins are prevented from deactivating, but are re-initiated when which of the following cell cycles is employed?

A. G1-S-G2-M
B. G1-S
C. S-M
D. G1-S-M

3. Which of the following replication enzymes functions to relieve tangling ahead of the replication fork that is caused by the activity of DNA helicase?

A. DNA helicase
B. Topoisomerase
C. Telomerase
D. DNA ligase

4. Which of the following replication enzymes contains proofreading activity and corrects mistakes that are made during the S phase?

A. DNA primase
B. DNA polymerase
C. DNA Telomerase
D. DNA ligase

5. Which of the following best describes the reason why DNA ligase is required to complete the replication of internal chromosomal segments?

A. DNA ligase is able to remove the last nucleotide of the oligonucleotide that is left by RNaseH.
B. DNA ligase is able to incorporate nucleotides into the gap that is left by RNaseH and the exonuclease.
C. DNA ligase is able to generate the final phosphodiester bond thereby fixing single stranded nicks that are left by DNA polymerase.
D. DNA ligase is able to relieve the tangles that occur ahead of the replication fork.

6. Which of the following types of ends (that are generated by restriction enzymes) cannot be joined together by DNA ligase?

A. 5' overhang – 3' overhang
B. Blunt – Blunt
C. 3' overhang – 3' overhang
D. 5' overhang – 5' overhang

7. Which of the following enzymes is used during replication to separate the two DNA strands, thereby alleviating the need to raise the temperature to such high levels?

A. DNA polymerase
B. Topoisomerase I
C. DNA helicase
D. Single Stranded Binding Protein (SSBP)

（背面仍有題目，請繼續作答）

※ 考生請注意：本試題不可使用計算機。 請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

8. Which of the following cell cycles allows for the maximum number of replication origins to be used during DNA synthesis?

A. G1-S-G2-M
B. G1-S
C. S-M
D. G1-S-M

9. If a single DNA duplex is amplified using 35 rounds of PCR which of the following would represent the total number of molecules that are generated?

A. $2 \times 35 = 70$
B. $35^2 = 1225$
C. $2 + 35 = 37$
D. $2^{35} = 3.4 \times 10^{12}$

10. Which of the following pairs represents a transition mutation?

A. T:G
B. G:A
C. T:C
D. T:T

11. Which of the following types of mistakes/damage are corrected by the Mismatch Repair System?

A. Thymine nucleotides base pairing with cytosine nucleotides (T:C)
B. Addition of large chemical adducts (organic compounds) to bases.
C. Base oxidation (i.e. oxidative guanine)
D. Formation of thymine dimers by exposure of DNA to ultraviolet light.

12. During which phase of the cell cycle does the Mismatch Repair System function to remove incorrectly paired nucleotides?

A. G1
B. S
C. G2
D. M

13. The Mismatch Repair System serves as a back-up system for which of the following repair pathways and/or enzymes?

A. Base Excision Repair
B. Nucleotide Excision Repair
C. RNA polymerase
D. DNA polymerase

14. Which of the following is corrected by the Base Excision Repair System?

A. Conversion of cytosine to uracil by deamination.
B. Creation of a G:A base pair by DNA polymerase
C. Expansion of CAG triplet repeats during cellular replication by slippage.
D. Thymine dimer formation resulting from exposure to ultraviolet (UV) light

15. In what phases of the cell cycle is the Base Excision Repair System functional?

A. S
B. G1-S-G2-M
C. G1-S
D. S-M

※ 考生請注意：本試題不可使用計算機。 請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

16. Which of the following serves as a backup for the Base Excision Repair System?
A. RNA polymerase
B. Mismatch Repair
C. Fail Safe DNA Glycosylases
D. DNA polymerase

17. Which of the following is removed by the Nucleotide Excision Repair System?
A. G:T nucleotide pair
B. A:G nucleotide pair
C. double strand breaks (DSB)
D. Thymine dimers

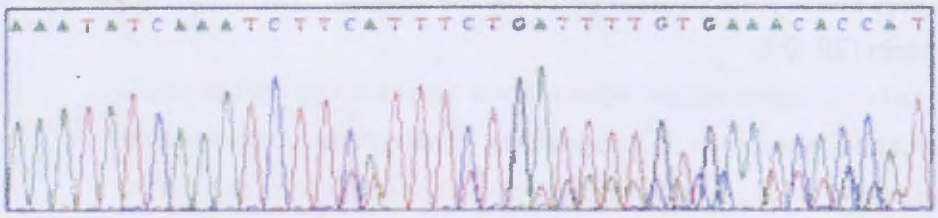
18. Which of the following serves as a backup for the Nucleotide Excision Repair System?
A. DNA polymerase
B. RNA polymerase
C. Fail Safe DNA Glycosylase
D. Mismatch Repair System

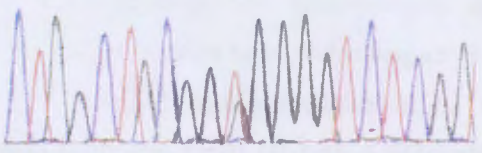
19. During which phase of the cell cycle does the Nucleotide Excision Repair System function to remove damaged nucleotides?
A. G1-S
B. S
C. S-M
D. G1-S-G2-M

20. Which of the following enzymes is used in the Mismatch Repair, Base Excision and Nucleotide Excision Systems?
A. UvrD
B. exonuclease
C. MutS
D. DNA ligase

第二部分、選擇與簡答題（共 20 分）

一、選擇題（10 分，共 3 題，單選）

Panel A 

Panel B 

1. The above DNA sequences were obtained by: (3 分)
A. Sanger sequencing (with chain termination)
B. Pyrosequencing (with chemiluminescence)
C. Sequencing by synthesis (with reversible dye-terminator)
D. Single-molecule real-time sequencing (with fluorescence)

（背面仍有題目，請繼續作答）

※ 考生請注意：本試題不可使用計算機。 請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

2. What kind of mutation is shown in panel A? (5 分)

A. Point mutation
B. Frameshift mutation
C. Deletion mutation
D. Truncation mutation

3. What kind of mutation is shown in panel B? (2 分)

A. Point mutation
B. Frameshift mutation
C. Deletion mutation
D. Truncation mutation

二、簡答題 （共 2 題，10 分）

1. What is a short tandem repeat (STR)? (4 分)

2. Please describe briefly the 2 most common testing using the STR analysis. (6 分)

第三部分、問答題（共 5 大題，60 分）

1. Describe the roles of the cap structure and the roles of the poly (A) tail in regulating eukaryotic mRNAs (8 分).

2. Describe how RNA polymerase II-catalyzed transcription starts in a eukaryotic cell (12 分).

3. Please describe how the sigma factors of a bacterial RNA polymerase are involved in transcription initiation and how these factors regulate bacterial gene expression in response to changes in the environment? (10 分)

4. Please describe the mechanisms of transcription termination in bacteria (10 分).

5. Sarcolipin is the smallest eukaryotic protein (> 10 amino acids). The following is the full-length cDNA sequence for this protein (20 分).

```
  1 ggtgtgtctt tgcttctctt caggacgtga agacgagcca gtgtccttgg tgtgcactca
 61 gaagtcctcc tggagttctc acccagacct tctgaagatg gagcggtcta cccaggagct
121 gtttatcaac ttcacagttg tcctgatcac tgtgctcctc atgtggctcc tcgtgaggtc
181 ctaccaatac tgaggggcca tgccacactc ccgggagtga ctgctgtgtg ccctgagctt
241 ccactgctct gttgacatgg gatgctgctc ttggctcctc cagcacctct gattcaca
```

1) Please briefly define "central dogma for genetic flow" in molecular biology (5 分).

2) Please A) name the process of converting mRNA into cDNA and B) list 3 essential components required for synthesizing an eukaryotic RNA molecule in vitro (8 分).

3) Please list the conventional nucleotide sequence for the initiation and termination codons in eukaryotes (4 分)

4) Based on the given cDNA sequence and your answers to the question (3), please calculate the exact number of amino acids encoded by Sacrolipin (3 分)