國立成功大學 105 學年度碩士班招生考試試題

系　　所：分子醫學研究所

考試科目：分子生物學

考試日期：0228，節次：3

※ 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。

This test contains 3 sections: Section I (20%), Section II (40%), and Section III (40%)

Section I. Single Choice Questions（單選題---每題 2 分，20%):

Each of the questions is followed by 5 suggested answers or completions. Choose one that is best in each case. (2 points/question)

1. The position of a gene on chromosome is called

(A) Locus
(B) Gene
(C) Genotypes
(D) Phenotypes
(E) Alleles

2. In human the three alleles I^A, I^B, and *i* constitute a multiple allelic series that determine the ABO blood group system. A woman of blood group AB marries a man of blood group A whose father was group O. What is the probability that one son will be group B?

(A) 1/32
(B) 1/16
(C) 1/8
(D) 1/4
(E) 1/2

3. How many different types of gametes could be produced by an individual with the arbitrary genotype of AaBbCCDdEe ?

(A) 2
(B) 4
(C) 6
(D) 8
(E) 16

4. When mature mRNA produced by the insulin gene is hybridized with denatured chromosomal DNA, which of the following will most likely be observed?

(A) No hybridization would occur under any conditions.
(B) Hybridization of mRNA would occur with random sections of chromosomal DNA.

(C) Hybridization of mRNA with DNA would occur in a continuous stretch that is equal to the length of the mRNA.
(D) Hybridization of mRNA with DNA would occur but with many single-stranded loops of DNA.
(E) Hybridization of mRNA with DNA would occur but with many single-stranded loops of mRNA.

5. The addition of amanitin, a known inhibitor of DNA-dependent mRNA synthesis, to growing cells will most likely cause protein synthesis to
(A) stop immediately
(B) stop as mRNA becomes depleted
(C) stop as thymidine becomes depleted
(D) stop as the ribosomes become inactivated
(E) be unaffected

6. Which of the following <u>is LEAST likely</u> to cause a proto-oncogene to become an oncogene?
(A) A gene is incorporated into a retroviral genome.
(B) A gene is expressed at an inappropriate time.
(C) A gene is moved close to an enhancer, causing excess product to be made.
(D) A gene is truncated, yielding a protein with modified activity.
(E) A gene is moved into centromeric heterochromatin, silencing its transcription.

7. During cytokinesis in an animal cell, a constricting ring pinches the dividing cell into the two daughter cells. This contractile ring is formed by which of the following structures?
(A) Centrioles
(B) Microtubules
(C) Microfilaments
(D) Z discs
(E) The spindle apparatus

8. In the formation of the secondary structure of a protein, which of the following are most responsible for holding an alpha-helix region in its helical form?
(A) Hydrogen bonds
(B) Ionic bonds
(C) Disulfide bonds
(D) Hydrophobic interactions
(E) van der Waals interactions

9. Which of the following is the most truthful statement?

(A) Transfection is the term to describe the process of deliberately introducing nucleic acids into cells through the use of viruses.

(B) Episome is defined as a stable DNA molecule that persists in the nucleus without integrating into the cellular genome

(C) Xenotropic virus refers to a retrovirus that can reproduce only in the host of the species in which it originated.

(D) Hepatitis C viruses have a single-stranded negative-sense RNA genome.

(E) Influenza A viruses are DNA viruses.

10. Which of the following is a truthful statement?

(A) Histones are acidic proteins associated with eukaryotic nuclear DNA.

(B) Eukaryotes have 80S ribosomes, each consisting of a small (30S) and a large (60S) subunit.

(C) Both 5′ cap addition and 3′ polyadenylation of mRNAs are required for mRNA biogenesis.

(D) "Epistasis" describes a situation in which expression of one gene wipes out the phenotypic effects of another.

(E) "Y banding" is a technique for generating stained regions around centromeres.

Section II. Short-answer questions (簡答題---每題 4 分，40%):

1. **Restriction enzymes generate three types of termini after cleavage of a DNA molecule. What are them?**
2. **Analysis of a DNA sample indicates that 16% of the bases are A. What percentage of the bases are C?**
3. **Why most polymerases is inhibited by the addition of chelating agents such as EDTA?**
4. **A protein has a molecular weight of 7000 Da. How many amino acid residues the protein has? A double-strand DNA has a molecular weight of 132,000 Da. How long is the DNA molecule in basepairs?**
5. **What is CpG motif and its immune-associated activity?**
6. **What are the differences between siRNA and miRNA?**
7. **What are the differences between MHC class I and class II presentation pathways?**
8. **What characteristics should a typical mRNA have?**
9. **What are the differences between proto-oncogene, fetal-oncogene, and oncogene?**
10. **What are the major steps of transcriptional process?**

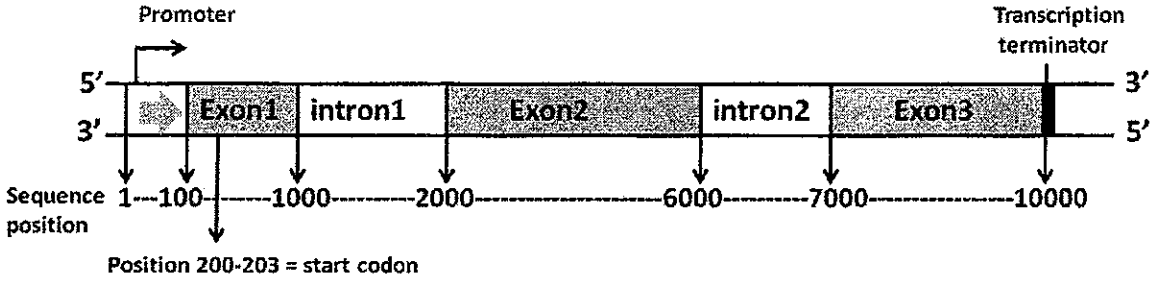
Section III. Assay questions (論述題---每題 10 分，40%):

1. **A scientist wants to use PCR to detect an invading viral sequence from a clinical specimen. The virus has a conserved DNA sequence shown below in 5' to 3'direction:**

5'Tacgggcgggacccgattagcatcgatgagtggattcgttatcg------cgattgccacgtctcgcatgtgcccgggtaatscggcactgcgccc3'

Question 1: What criteria he need to consider to design an ideal primer set for the detection?
Q2: What will be your ideal primer set?
Q3: If no specific PCR products can be amplified, what are the possible reasons?
Q4: What are the possible solutions you can use to detect the viral gene?

2. **Below is a schematic of a human gene X, which encodes protein X. The promoter region is indicated by an arrow. Transcription begins immediately following the promoter.**



Question 1: What do you know about Eukaryotic promoter? What kinds of regulatory elements can exist in the promoter region?
Q2: What kinds of regulatory elements can exist upstream and/or downstream of the gene?
Q3: The transcript first produced by this gene would be approximately how many nucleotides long? Another transcript approximately 3800 nucleotides long is produced from this gene. Explain how this is possible?
Q4: Assume gene X was mutated such that the base pair found at position 200 was changed from an A/T to a G/C. Would the transcription and translation of the altered gene X still occur? Would the first transcript be the same length, shorter or longer than the first transcript produced from the wild type gene X? Give all possible answers and explain your thinking.

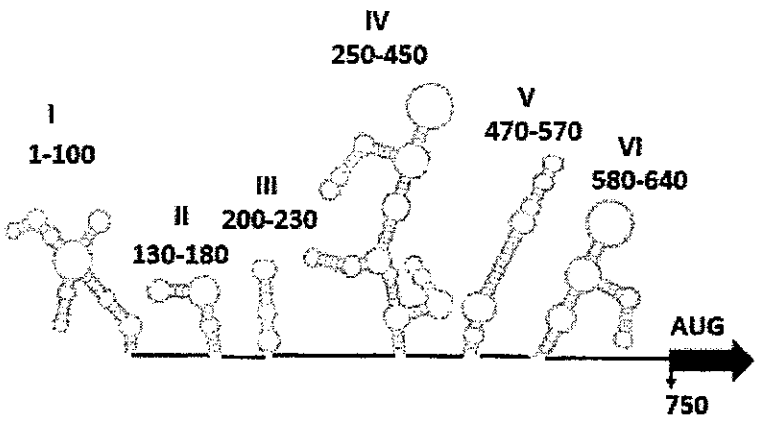
國立成功大學 105 學年度碩士班招生考試試題

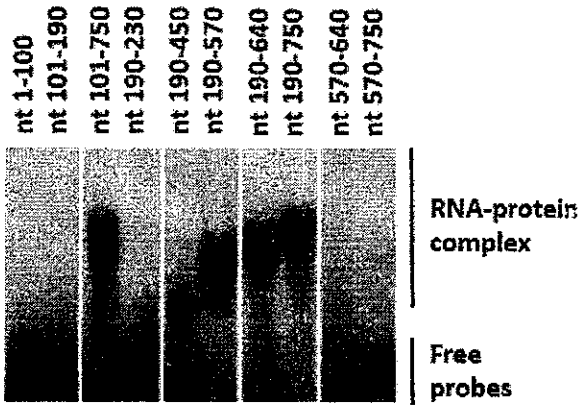
系　　所：分子醫學研究所

考試科目：分子生物學

考試日期：0228，節次：3

3. A scientist found that a cellular protein X can interact with the 5'UTR of a RNA virus. He wants to identify further the possible binding sites of the 5'UTR to the protein X. The possible interacting secondary structures of the 5'UTR are predicted by him using the Mfold software, which results in 6 highly structured stem loops (I-VI). The first and the last nucleotides in each secondary structure are numbered as indicated below. By using the so called EMSA technique, he is able to use different nucleotide probes to identify the binding sites of the 5'UTR to protein X. A figure depicting the result is shown below.





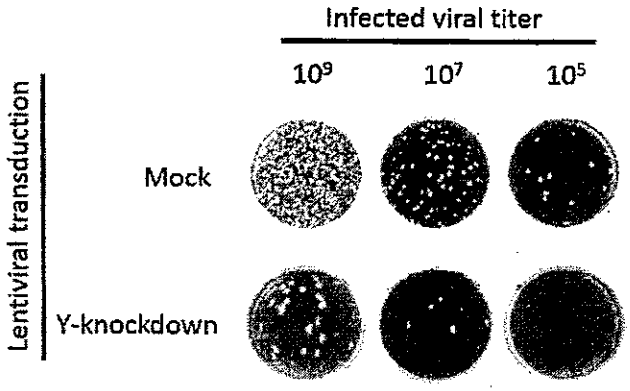
Question 1: What is EMSA? Describe the theory behind the technique.

Q2: What methods can he used to generate different nucleotide probes?

Q3: What is his finding? Explain the meaning of RNA-protein complex and free probes.

Q4: If the interaction region is located in the so called **IRES** region, what will be the functional relevance of X protein?

4. A scientist found that a cellular gene has a role to modulate the production of an invading RNA virus. Knockdown of the Y gene, in contrast to overexpression, significantly increased the viral production in an infected human cell line. Following is the result of his knockdown experiment.



國立成功大學 105 學年度碩士班招生考試試題

系　　所：分子醫學研究所

考試科目：分子生物學

考試日期：0228，節次：3

Question1: What approach the scientist used to knockdown cellular Y gene? Briefly describe how this is done.

Q2: What approach the scientist used to assay the knockdown effect of Y gene from the human cell line after exposing with the RNA virus? Briefly describe the name of the assay and the theory behind.

Q3: How do you explain the result? Is Y gene required or not required to fight against the virus?

Q4: The experiment is doubted by another scientist, saying that this data is only preliminary. What kinds of control experiments or other alternative assays you can used to strengthen the result?