

國立成功大學

111學年度碩士班招生考試試題

編 號： 266

系 所： 生理學研究所

科 目： 分子生物學

日 期： 0220

節 次： 第 2 節

備 註： 不可使用計算機

※ 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。

1. Please describe how to link individual nucleotides into a trinucleotide (15%).
2. Please describe the process of general transcription in eukaryotes. (15%)
3. Please describe how the chromatin structures modify the gene activity. (15%)
4. Please describe methods for post-transcriptional control of gene expression as much as you can. (10%)
5. Here is the sequence of a portion of a bacterial gene:  
5'GTATCGTATGCATGCATCGTAGA3'  
3'CATAGCATAACGTACGTAGCATCT5'  
The template strand is on the bottom. (Reference from Robert F. Weaver, Molecular Biology, fifth edition)
  - (a) Assuming that transcription starts with the first T in the template strand, and continues to the end, what would be the sequence of the mRNA derived from this fragment (5%)?
  - (b) Find the initiation codon in this mRNA (5%).
  - (c) Would there be an effect on translation of changing the first G in the template strand to a C? If so, what effect (5%)?
  - (d) Would there be an effect on translation of changing the second T in the template strand to a G? If so, what effect (5%)?
6. Please read the following paragraphs and answer the questions:  
On March 11, 2020, the World Health Organization declared coronavirus disease 2019 (COVID-19) a pandemic; from that date, the vaccine race has begun, and many technology platforms to develop a specific and effective COVID-19 vaccine have been launched in several clinical trials (protein subunit, RNA-based, DNA-based, replicating viral vector, nonreplicating viral vector, inactivated virus, live attenuated virus, and virus-like particle). Among the next-generation strategies, nucleoside-modified messenger RNA vaccines appear the most attractive, not only to counteract emerging pathogens but also for the possible applications in regenerative medicine and cancer therapy. However, exactly as all innovative drugs, they deserve careful pharmacovigilance in the short and long term. (Modified from references of <https://pubmed.ncbi.nlm.nih.gov/33675239/> & [https://en.wikipedia.org/wiki/Nucleoside-modified\\_messenger\\_RNA](https://en.wikipedia.org/wiki/Nucleoside-modified_messenger_RNA))  
Questions:
  - (a) What is nucleoside-modified mRNA? (5%)
  - (b) How did nucleoside-modified mRNA used in the development of RNA vaccine? (5%)
7. Please read the following paragraphs and answer the questions:  
The 2021 Nobel Prize in Physiology or Medicine is awarded to David Julius and Ardem Patapoutian for their discoveries of thermal and mechanical transducers.

**David Julius** wished to identify the cellular target of capsaicin, the pungent ingredient of chili peppers, as he believed this could provide fundamental insights into mechanisms of pain. He used a cDNA library from sensory neurons in a functional screen to look for a gene that could confer capsaicin sensitivity to cells that were normally unresponsive. The screen identified a cDNA encoding a novel ion channel (now called TRPV1) belonging to the family of transient receptor potential ion channels. Importantly, TRPV1 was shown to be activated by temperatures perceived as painful.

Following the discovery of TRPV1, David Julius and Ardem Patapoutian independently made another important advance with the discovery of TRPM8, a related cold-sensitive receptor. Several additional TRP-receptors were subsequently identified and shown to transduce thermal information in the somatosensory system. Thus, the seminal discovery of TRPV1 by David Julius opened the door to a molecular understanding of thermosensation.

**Ardem Patapoutian** used a functional screen of candidate genes expressed in a mechanosensitive cell line to identify ion channels activated by mechanical stimuli. Two mechanically-activated ion channels, named PIEZO1 and PIEZO2, were identified and shown to represent an entirely novel class of ion channels functioning as mechanical sensors. Importantly, Patapoutian also demonstrated that PIEZO2 is the major mechanical transducer in somatic nerves and is required for our perception of touch and proprioception. In further work, he uncovered central roles of PIEZO1 and PIEZO2 for many additional physiological functions. The work by the two laureates has unlocked one of the secrets of nature by explaining the molecular basis for sensing heat, cold and mechanical force, which is fundamental for our ability to feel, interpret and interact with our internal and external environment. (Modified from the reference of <https://www.nobelprize.org/prizes/medicine/2021/press-release/>)

Questions:

According to above description,

- (a) Please name at least two genes responsible for temperature and mechanical sensation, respectively? (5%)
- (b) Please compare methods and findings how these genes were cloned and identified? (10%)