

# 國立中央大學九十學年度碩士班研究生入學試題卷

所別: 生命科學系 不分組 科目: 分子生物學 共 2 頁 第 1 頁

1. (15 points) Beside the large scale DNA sequencing technology, physical mapping offers rather precise way to reveal the genetic information on many ongoing genome projects. There are three major physical techniques have been used, namely, restriction mapping, fluorescent *in situ* hybridization (FISH), and sequence tagged site (STS) mapping. Please describe the principles of these techniques and also compare the advantage and disadvantage with one another.
2. (10 points) Bacterial operons are typical genomic units that respond to various stimuli or nutritional supply. Using *lac* operon in *E. coli* as a model to explain the molecular mechanism that leads to the bacterial survival in an environment that fills with lactose but lacks of glucose for the energy source. What would happen to the gene expression status of *lac* operon if only maltose provided as carbon source? Please explain using molecular terms.
3. (15 points) Before cells are subjected to proliferation, chromosomes must be duplicated before cell division occurs. Bacteria such as *E. coli* have been good objects for studying DNA replication. Using prokaryotic models, please describe the process of DNA replication in the aspects of topology and enzymology.
4. (15 points) What is so called "coupled translation and transcription"? Using this term to distinguish the major differences between prokaryotic and eukaryotic gene expression systems. You should be aware to include every possible and detailed difference around this question cited above.
5. (45 points) Heavily polluted environment such as dense areas of chemical and electronic factories always provide the threat to public health and also to the ecological surrounding. In developed or under-developed countries, the condition worsens for the presence of unregulated activities and poorly conditioned mechanical devices. The following is a fictitious episode (虛構情節); however, you should take it seriously and offer your scientific knowledge as well as the common senses to solve the problems to be considered as an excellent molecular biologist who has skills and passion for protecting our environment. Yet, You understand that you only make conclusion when the evidences are solid. Here is the episode:

" You are a molecular biologist and the leader of an international research team consisting of a dozen of biologists and chemists who are investigating the health and ecological impact caused by a long-termed leakage of an identified cancer inducing chemical, compound XX, released by a notorious (惡名昭彰) factory. In the first trip to survey the pollution, every member was shocked by seeing a species of nematode (a kind of tiny worm-like animal) along with several species of plants filled with a pond that is just thirty meters away from the factory. As a well-trained scientist and also a team leader, you instantly order your members to collect every possible sample and bring them back to laboratories for further analyses.

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Three weeks later, the preliminary data showed the water indeed contains 1000 folds higher than legal concentration of the compound XX. The collected water sample then caused obvious cancerous symptoms within three weeks after the mouse were fed with the sample. Surprisingly, the collected nematode was then identified as *Caenorhabditis elegans*. *C. elegans* is a kind of very tiny worm that each consists of only few hundreds of cells and it has been frequently used in the laboratory for many genetic and molecular biological studies. Many more experiments are also being carried out in order to gather enough scientific evidence. One of the experiments showed the polluted water killed the wild type *C. elegans* in six hours while all collected biological samples had been able to grow and reproduce in fresh water so far.

As the experiments are going on in the labs, in a public conference urgently demanded by local residents, scientific community, government agencies, private foundations, the irresponsible manufactory, pharmaceutical industry and journalists, you are to answer critical questions.

(1) Here is the first question raised by Prof. LK Knoof, "“ Could you propose three hypotheses to explain why these nematodes collected from the polluted site that seem to live so well? What are the hypotheses? ”" (2) The second question is asked by Prof. PM Reinhart, "“ How are you going to design and carry out the required experiments to prove every hypothesis? ”" (3) The third question is asked by the representative of the company making pollution, Mr. DW Sinn, "“ Since you have found organisms that live well in the pond filled with the chemical that you think is toxic, you cannot prove that it is harmful to every thing, can you? ”" (4) The fourth question is asked by the director of an environmental protection foundation, Ms. Y Doolittle, "“ I think the public need to know more about the fact that the chemical indeed is toxic and has negative impact on health and the environment. I think scientist like you should own a heart with love and care. What are your proposals to pursue the scientific evidence and prove the wrong-doing of Mr. Sinn and his company? ”" (5) The fifth question is asked by a researcher from the R&D section of a pharmaceutical company, Dr. L Weil, "“ What are the potentials (潛力) you see in this case that it may apply to drug-making or other biotech business? Could you explain using the sentences with your expertise (專業知識) on molecular biology? ”" ” Please share your answers with us.

Thanks and Good Luck!

Note: (1)(2)(4)(5): 10 points each; (3): 5 points