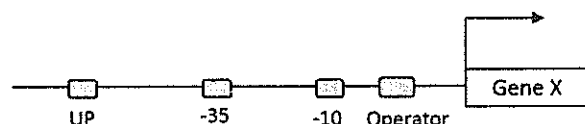


- 說明下列各組有關核酸複製、核酸修復的酵素或蛋白質，在生物體的功能及作用機制：
 - DNA polymerase I, DNA polymerase III (5 分)
 - DNA topoisomerase I, DNA topoisomerase II (5 分)
 - UvrA, UvrB, UvrC, UvrD (5 分)
 - MutS, MutL, MutH (5 分)
 - Ku70, Ku80 (5 分)
- IPTG-induction of β -galactosidase activity is the result of (2 分)
 - stimulation of lac repressor function
 - IPTG binding to the *lac* operon and inducing transcription
 - IPTG binding to the *lacI* gene product and inhibiting its activity
 - inhibition of β -galactosidase degradation
 - IPTG stimulates enzymatic function of β -galactosidase
- Which of the following is not a structural motif found in a DNA-binding domain? (2 分)
 - Random-coil acidic domain
 - Zinc finger
 - Helix-loop-helix
 - Homeodomain
- What is the function of RNA-dependent RNA polymerase in RNAi? (2 分)
 - They prevent the spread of the RNAi pathway by replicating the target RNAs.
 - They help amplify the RNAi response by replicating the target RNAs.
 - They produce additional copies of siRNAs to ensure that the RNAi response is sustained and spread.
 - They are viral proteins that prevent the spread of RNAi by preferentially replicating siRNA sponges.
- After lambda (λ) phage initially enters a bacterial cell, activation of the early promoters (2 分)
 - directs synthesis of an antiterminator protein.
 - prevents accumulation of the cII/cIII complex.
 - is controlled by levels of nutrients in the cell.
 - leads directly to lysis of the cell.
- CRISPR/Cas9 has become one of the most popular ways to perform genome editing. Which of the following statement about CRISPR/Cas9 is incorrect? (2 分)
 - An RNA molecule guides Cas9 to the target.
 - Cas9 is an endonuclease that cut double-stranded RNA.
 - The system has been shown to work in many organisms including fish, yeast and plants.
 - The system was originally discovered as part of adaptive immunity in bacteria.
- Here shows the regulatory region of the prokaryotic *Gene X*. Please describe what protein factors may be involved and to which regulatory elements they may bind when *Gene X* is actively transcribed. (5 分)

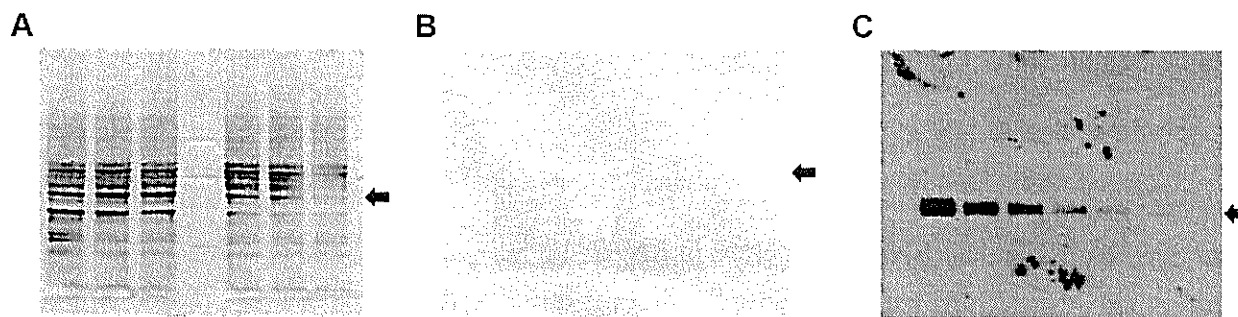


- Please describe how a gene can be turned “off”. Please provide two examples. (5 分)
- Please explain what alternative splicing is, using the gene structure (*Gene X*) provided. (5 分)

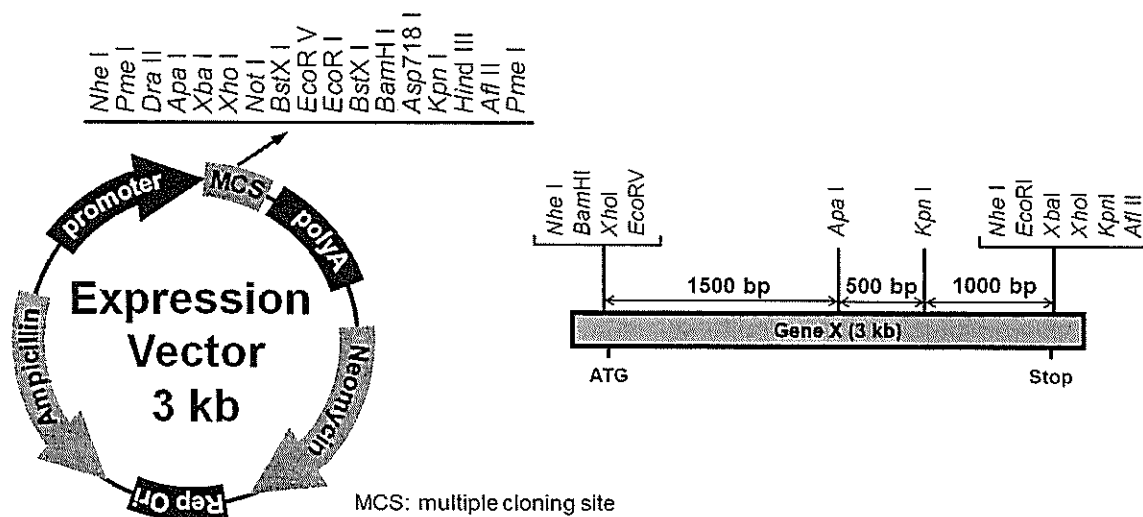


Short answer questions

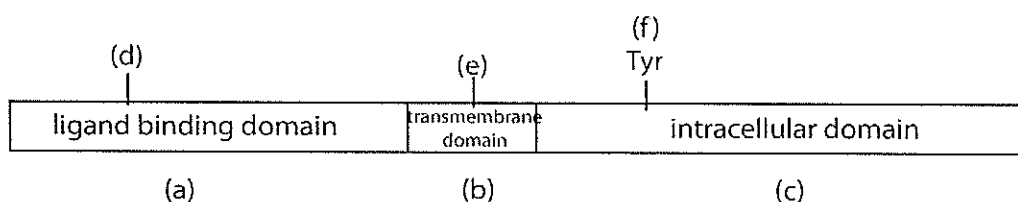
- 10. Chromosomal translocation caused overexpression of fusion proteins may contribute to carcinogenesis. Please propose TWO methods (including its principle) to identify this alteration. (5 分)
- 11. Quantitative Polymerase Chain Reaction (QPCR) is a common molecular technique for analyzing nucleic acid. Please describe TWO principles that how QPCR works. In addition, please briefly describe the application of QPCR. (5 分)
- 12. Next-generation sequencing (NGS) is a powerful tool in molecular biology especially in precision medicine area. Please describe the principle of NGS and its applications. (5 分)
- 13. Western blot is a very common technique for protein analysis. In below, there are three results of Western blot (A, B and C). Please try to interpret each result and propose your troubleshooting. (The arrow indicates the anticipated signal of target protein.) (5 分)



- 14. Suppose you would like to clone a gene X into a vector for constitutive expression in cells. In below is the information of cloning vector and gene X with restriction enzyme mapping. Please describe your cloning proposal with strategies and steps (be sure to include "how to confirm the final construct is correct?"). (5 分)

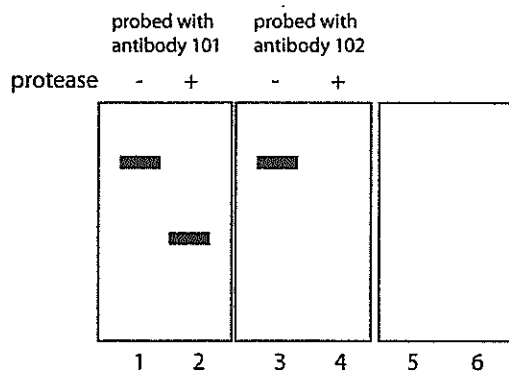


- 15. Mutations on growth factor receptors often cause unregulated receptor activation and therefore unregulated cell growth, eventually lead to cancerous development. Illustrated is a hypothetical tyrosine kinase growth factor receptor called YYR, which is activated when bind to growth factor YY. Please answer the following question.



- (1) How does binding to growth factors activate such receptor? (4 分)

- (2) When activated, SH2 domain-containing proteins often are recruited to the receptor. How is SH2 domain recruited?(3 分)
- (3) Often the transmembrane domain (b) is folded into which of the following secondary structures? (2 分)
- (A) β -sheet
 - (B) Z-form helix
 - (C) α -helix
 - (D) Coiled-coil
- (4) Which of the following mutations on this receptor is most likely to cause cancerous development? (2 分)
- (A) missense mutation
 - (B) large deletion
 - (C) nonsense mutation
 - (D) insertion
- (5) The amino acid residue at site (e) is least likely to be (2 分)
- (A) Ile
 - (B) Glu
 - (C) Gly
 - (D) Val
 - (E) Ala
- (6) predict the distribution of this receptor in a cell with and without growth factors. (2 分)
- (7) Continued from above, if site (f) is mutated into serine, predict the localization and function when the growth factor is present(3 分)
- (8) In an experiment, you treated the cells with protease before harvesting for Western blot analysis. You acquired two different batches of antibodies for probing XXR. The results are shown here. (2 分)



Compare Lane 1~4, which domain(s) do you think each antibody is targeting? (use the symbols listed in the Figure above)

- (9) continued from above, the protein band detected in Lane 2 should consist of which domains of XXR? (2 分)
- (10) continued from above, how would the results in Lane 1 and 2 be different if the XXR is truncated with domain (b)? (1 分)
- (11) Continued from above. In Lane 5 and 6 please draw a predicted result of:
- Lane 5: cell lack of signal peptidase
 - Lane 6: cell lack of signal peptidase, treated with protease (2 分)