南京大学 2017 年攻读硕士学位研究生入学考试试题(三小时)

考试科目名称及代码 分子生物学 833

适 用 专 业：生物化学与分子生物学

注意：

1. 所有答案必须写在“南京大学研究生入学考试答题纸”上，写在试卷和其他纸上无效；

2. 本科目允许/不允许使用无字典存储和编程功能的计算器。

Part I: Please select **one** best answer to the following questions (1.5 point each)

1. Crick demonstrated that the genetic code involved three bases and suggested that the code was degenerate. What experimental technique did he use?
A). Gel electrophoresis
B). Density gradient centrifugation
C). Frameshift mutagenesis
D). Restriction digests of the rII gene

2. Each time a nucleotide is added as the transcription bubble passes down the DNA, the RNA-DNA complex
A) elongates
B) rotates
C) shrinks
D) disassembles

3. In order for a gene to be transcribed, RNA polymerase must have access to the DNA helix and be able to bind to the genes
A) activator
B) regulator
C) promoter
D) operator
E) repressor

4. The role of methylation of DNA is now viewed as
A) interfering with DNA transcription by blocking base pairing between cytosine and guanine
B) complexing with enhancers to prevent transcription
C) prevention of mutation
D) insuring that genes that are turned off. stay off
E) irrelevant to gene transcription

5. The RNA polymerases that transcribe bacterial DNA or eukaryotic nuclear DNA are
A). multisubunit enzymes and partially homologous.
B). monomeric and very large.
C). multimeric and interchangeable.
D). only active inside the cell.
E). highly glycosylated in their active forms.

6. RNA chain elongation can be inhibited by
A). Repressors.
B). Rifampicin (a Rifamycin derivative).
C). Actinomycin D.
D). RNases.
E). 0.5 M NaCl

7. A bacterial promoter is likely to contain:
A). a TATA box which is involved in the binding of RNA polymerase but is at -24 rather than -10;

Question 5. Nucleosomes are protein complexes formed by eight interacting subunits. These complexes aid in the orderly packing of DNA by acting as a spool around which the DNA double helix is wound.

a) How many polypeptides compose the nucleosome complex?(2pts)
b) What is quarternary structure? Does the nucleosome complex have quarternary structure?(2pts)
c) The following sequence of amino acids is found as part of the primary structure of the ucleosome complex: Val-Leu-Ile-Phe-Val-Val-Ile-Ile. In what general region of the nucleosome complex would you expect to find this stretch of amino acids?)2pts)
d) Why did you choose this region?(2pts)
e) Some regions of the nucleosome complex have high percentages of lysine and arginine. Given the function of the nucleosome, Where might these regions be found? What might be the role of these regions?(2pts)

B). an AATAAA sequence to ensure polyadenylation
C). a Shine-Dalgarno sequence:
D). a CCAAT box:
E). a region which will be recognised by sigma factors of RNA polymerase

8. The rapid appearance of HIV-1 strains that are resistant to AIDS drugs is due in part to this property of its reverse transcriptase:
A). the RNase H domain of p66 causes error prone synthesis.
B). it lacks a 5' --> 3' exonuclease.
C). AZT is too expensive to be taken in effective doses.
D). it has low affinity for the correct dNTP's.
E). it lacks a proofreading exonuclease.

9. Identify the polypeptide that would be produced as a result of transcribing and translating the following DNA sequence.
DNA: ...3' A C C A A G T C T 5'...
A) arg - phe - trp
B) arg - leu - gly
C) thr - lys - ser
D) trp - phe - arg
E) gly - leu – arg

10. The first experiment which suggested that protein was not the genetic material was performed by
A). Oswald Avery
B). Fred Griffith
C). Peter Mitchell
D). Rudolf Virchow

11. Which of the following conditions would cause the release of the Lac repressor protein from the lac operator site on DNA?
A). Presence of glucose in the growth media.
B). Presence of lactose in the growth media.
C). Presence of IPTG in the growth media.
D). Presence of mannose in the growth media.
E). Answers b and c.

12. Enhancers are
A) proteins located adjacent to promoters
B) distant sites where regulatory proteins bind
C) expediters of RNA polymerase capture
D) proteins that bind with repressors, deactivating them
E) a bacterial form of promoters

13. When a homeodomain binds to DNA, the actual binding portion of the homeodomain is
A) a leucine zipper
B) the operon
C) zinc fingers
D) the histine
E) a helix-turn-helix motif

14. In prokaryotes. translation is said to be coupled to transcription. This means that:
A) transcribed genes are both transcribed and translated by ribosomes;
B) one mRNA can be bound by several ribosomes:
C) both transcription and translation take place in the same part of the nucleus:
D) in this respect prokaryotes are the same as eukaryotes:
E) genes are often translated as they are being transcribed.

15. Nucleosomes inhibit
A) activators
B) RNA polymerase
C) translation
D) assembly of transcription factors

16. A form of binding motif containing a nearly identical sequence of 60 amino acids in many eukaryotes is the
A). homeodomain motif
B). zinc finger motif
C). leucine zipper motif
D). universal motif

17. The operon that controls tryptophan producing genes in E. coli consists of _____
A) only one gene
B) two genes
C) three genes
D) four genes
E) five genes

18. Transcription factors appear to be unable to bind to a nucleosome because
A) activators are inhibited by the configuration
B) of inhibition of RNA polymerase
C) of histones positioned over promoters
D) nucleosomes are especially vulnerable to repressors
E) operators are placed in an inaccessible position

19. The "closed complex" at bacterial promoters
A). is in equilibrium with free RNA polymerase and the promoter.
B). is not affected by promoter mutations.
C). is bound more tightly when repressors are present.
D). is not affected by activator proteins.
E). Choices a) and b) are both correct.

20. Translation repressor proteins may shut down translation of processed mRNA transcripts by
A) binding with the poly-A tail
B) resetting the reading frame
C) reinserting introns into the transcript
D) excising a short sequence of nucleotides
E) excising a short sequence of nucleotides

21. In many animals, the genes that regulate the development of stem cells are activated
A) once
B) only twice
C) up to 10 times
D) over a hundred times
E) not at all

22. Regulatory domains of most activators interact with
A) the transcription factor complex
B) RNA polymerase
C) repressors
D) the regulatory factor complex
E) the DNA binding domain

23. In order for the helix-turn-helix motif to bind to DNA, the _____ must fit into the major groove of the DNA.
A) homeotic switches
B) zinc fingers
C) operator
D) recognition helix
E) protein link

24. The most common form of gene expression regulation in both bacteria and eukaryotes is
A) translational control
B) transcriptional control
C) post-transcriptional control
D) post-translational control
E) control of passage from the nucleus

25. In eukaryotes, many genes may have to interact with each other, requiring more interacting elements than can fit

around a single promoter. This physical limitation is overcome by
A) alternating promoters and operators
B) placing promoters on both sides of each gene
C) the use of very long promoters
D) distant sites in a chromosome controlling transcription of a gene
E) having factors on one chromosome control genes on another gene

26. Proteins that block the passage of RNA polymerase are called:
A) operons
B) activators
C) repressors
D) enhancers
E) promoters

27. Which factor or enzyme is required in the iniation stage of protein synthesis in prokaryotes?
A). Formylethionine-transfer RNAf (tRNAf)
B). EF-Tu
C). Cap-binding protein
D). tRNA synthetase
E). RF-2

28. The order in which nucleotides are moved along the ribosomes binding sites is
A) APE
B) PEA
C) EPA
D) EAP

29. In eukaryotes, there are _____ codons that specify amino acids.
A) 21
B) 24
C) 61
D) 64
E) 60

30. In eukaryotes, the "start" codon also specifies the amino acid,
A) phenylalanine
B) valine
C) aspartate
D) methionine
E) methionine

31. In mitochondrial genomes, _____ is a "stop" codon.
A) UGA
B) UUU
C) AUA
D) UAA
E) AGA

32. Together with proteins, rRNA
A) provides a site for polypeptide synthesis
B) transports amino acids to the ribosome
C) travels to the ribosome to direct the assembly of polypeptides
D) transcribes DNA
E) translates DNA

33. The genetic code consists of groups of three nucleotides called
A) codons
B) introns
C) anticodons
D) reading frames
E) triplets

34. The function of tRNA is to
A) provide a site for polypeptide synthesis
B) transport amino acids to the ribosome
C) travel to the ribosome to direct the assembly of polypeptides
D) transcribe DNA
E) translate DNA

35. In the formation of an initiation complex, a _____ is positioned first.
A) met-tRNA
B) ser-tRNA
C) tyr-rRNA
D) mval-tRNA
E) cyst-tRNA

36. Enzymes called amino acyl-tRNA synthetases
A) synthesizes tRNA
B) attaches amino acids to tRNA
C) strips tRNA from its amino acid in the process of translation
D) destroys excess tRNA molecules
E) helps tRNA synthesize amino acids

37. In a process called _____, the initial tRNA is ejected from the ribosome.
A) elongation
B) translocation
C) initiation
D) transcription
E) elimination

38. The function of mRNA is to
A) provide a site for polypeptide synthesis
B) transport amino acids to the ribosome
C) travel to the ribosome to direct the assembly of polypeptides
D) transcribe DNA
E) translate DNA

39. The process of _____ cuts introns from the primary transcript and the final "processed" mRNA is produced.
A) RNA cleaving
B) RNA translocation
C) RNA elongation
D) RNA splicing
E) RNA releasing

40. As polypeptides are formed at the ribosome, elongation continues until _____ is exposed.
A) a release factor
B) an intron
C) a nonsense codon
D) an exon
E) polypeptidase

41. In messenger RNA. the nucleotide series UAG specifies
A) arginine
B) serine
C) stop
D) proline
E) aspartate

42. Which enzyme is incorrectly matched to its function?
A) RNA polymerase -- transcription
B) aminoacyl-tRNA synthetase -- attaches an amino acid to a tRNA
C) peptidyl transferase -- translation
D) DNA ligase -- joins Okazaki fragments
E) All of the above are paired correctly.

43. Identify the polypeptide that would be produced as a result of transcribing and translating the following DNA sequence. DNA: ...3' A C C A A G T C T 5'...
A) arg - phe - trp
B) arg - leu - gly
C) thr - lys - ser
D) trp - phe - arg
E) gly - leu - arg

44. Which one of the following is not a kind of RNA?
A) tRNA (transfer RNA)
B) mRNA (messenger RNA)
C) rRNA (ribosomal RNA)
D) nRNA (nuclear RNA)
E) All of the above are kinds of RNA.

45. Which of the following are not matched correctly?
A) exon splicing-occurs in nucleus
B) post-translational modifications-phosphorylation
C) snRNA-splice out exons from transcript
D) activated enhancers-trigger transcription
E) all are matched correctly

46. In eukaryotes. the "start" codoń also specifies the amino acid.
A) phenylalanine
B) valine
C) aspartate
D) methionine
E) methionine

47. Together with proteins. rRNA
A) provides a site for polypeptide synthesis
B) transports amino acids to the ribosome
C) travels to the ribosome to direct the assembly of polypeptides
D) transcribes DNA
E) translates DNA

48. A molecule of tRNA with the anticodon AAA will transport the amino acid
A) phenylalanine
B) lysine
C) proline
D) glycine
E) arginine

49.Which one of the following statements best describes eukaryotic transcriptional promoters?
A). They are all same for RNA polymerase II genes
B). They direct initiation to a diversity of startpoints
C). They require sigma factor to be recognized by RNA polymerase II
D). They are al upstream of the startpoint of transcription
E). They are different for each type of RNA polymerase

50. Which of the following is a component of the splicing reactions necessary to convert heterogeneous nuclear RNA to messenger RNA in eukaryotes?
A). Ribonuclease P
B). The sequence G-U and A-T spanning the intron/exon borders
C). The sequence AAUAAA within the intron
D). Small nuclear ribonucleic acid (snRNA) U1
E). A 7-methylguanylate cap

51. Eukaryotic mRNA differs from prokaryotic mRNA in that
A). They do not have a 5' untranslated region (UTR)
B). Their coding regions are separated by spacers
C). They do not have a 3' (UTR)
D). They have only A sequences on their 3' ends that are coded for by the genes foe each mRNA
E). They have a free 3' hydroxyl (-OH) group on each of their ends.

52. A protein whose expression is needed in very large amounts for very short periods of time only. such as the oncogene product c-Fos, might be expected:
A).to have a very unstable mRNA;
B). to have a highly stable mRNA;
C). to be encoded in multiple copies;
D). to be present on a plasmid;
E). to be composed of multiple subunits.

53. Which factor or enzyme is required in the elongation stage of protein

synthesis in prokaryotes?
A). Formylethionine-transfer RNAf (tRNAf)
B). Cap-binding protein
C). tRNA synthetase
D). EF-Tu
E). RF-2

54. Which of the following statements describing general factors in transcription initiation in false?
A). TATA binding protein (TBP) binds first to the promoter and bends DNA.
B). TFIIF always goes with RNA polymerase II and is recruited to the promoter after TFIIB.
C). TFIIH has protein kinase activity and phosphorylates the carboxyl-terminal tail, also referred to as CTD of RNA polymerase II.
D). TBP can associate with other factors called TAFs and make the TFIID complex.
E). TFIIH binds promoter after TBP and recruits RNA polymerase II.

55. The melting of 40-45 bp at the oriC site of *E. coli* requires
A). DnaA + Primase.
B). DnaA.
C). DnaA + DnaB.
D). DnaA + DnaB + DnaC.
E). DnaA + DnaB + DnaC + Pol III holoenzyme.

56. Which of the following statements concerning gene expression in human is correct?
A). Gene expression is just another way to describe transcription;
B). The control of gene expression takes place only in the nucleus;
C). Control of protein activity is not part of the regulatory mechanism of gene expression;
D). Control of RNA synthesis is the primary means to have differential gene expression in different cells.
E). Different cells have different gene expression because they have different RNA polymerases.

57. Which of the following does not occur in the function of the catabolite activator protein (CAP) of E. coli?
A) Cyclic-AMP binds to the CAP protein.
B) The protein changes shape.
C) Space is increased by the binding of tryptophan.
D) Helix-turn-helix motifs are enabled to bind to the DNA.

58. Are non-functional repressor alleles dominant or recessive?
A). Non-functional repressor alleles are recessive, because the repressor made by the functional lacI can act on any copy of the operon.
B). Non-functional lacI is dominant because it prevents binding of functional lacI.
C). Non-functional lacI is recessive because non-functional alleles are always recessive.
D). Non-functional lacI is dominant because it eliminates the entire function of the lac operon.

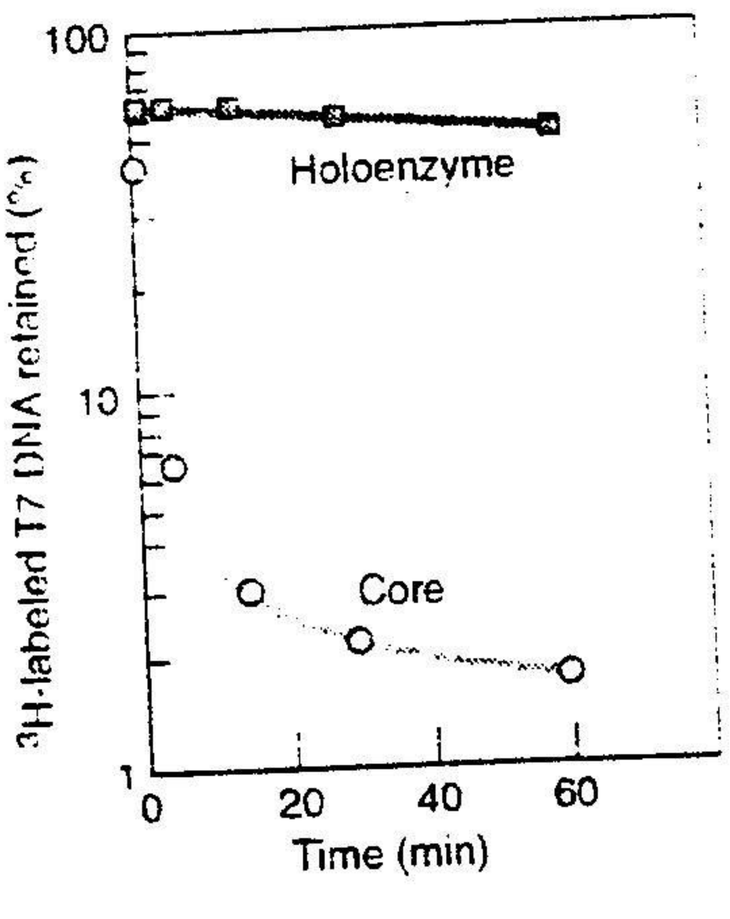
59. There is a certain degeneracy in our three letter code. This degeneracy:
A). means that occasionally more than one amino acid is coded for by the same codon;
B). means that 'spare' codon are available for emergencies;
C). is a consequence of the fact that there are more codons than biologically utilised amino acids;
D). means that suppressor tRNAs only correct a fraction of mutations;
E). is only present in primitive

organisms such as bacteria.

60. Sickle cell anaemia is caused by the mutation of a single codon, GAG to GTG in the B-globin gene, resulting in a substitution of glutamic acid by valine. If the single anti codon of the Glu tRNA were altered from CTC to CAC:
A). this mutation might well suppress the sickle cell mutation and the person would be normal;
B). this mutation might correct the specific change in the B-globin gene but all other Val codons might be similarly misread and the phenotype would be far from normal;
C). this tRNA would now be non-functional;
D). this tRNA would now be charged with valine rather than glutamine;
E). this tRNA would now encode a non-functional protein.

Part II: Please give your answers to the following questions:

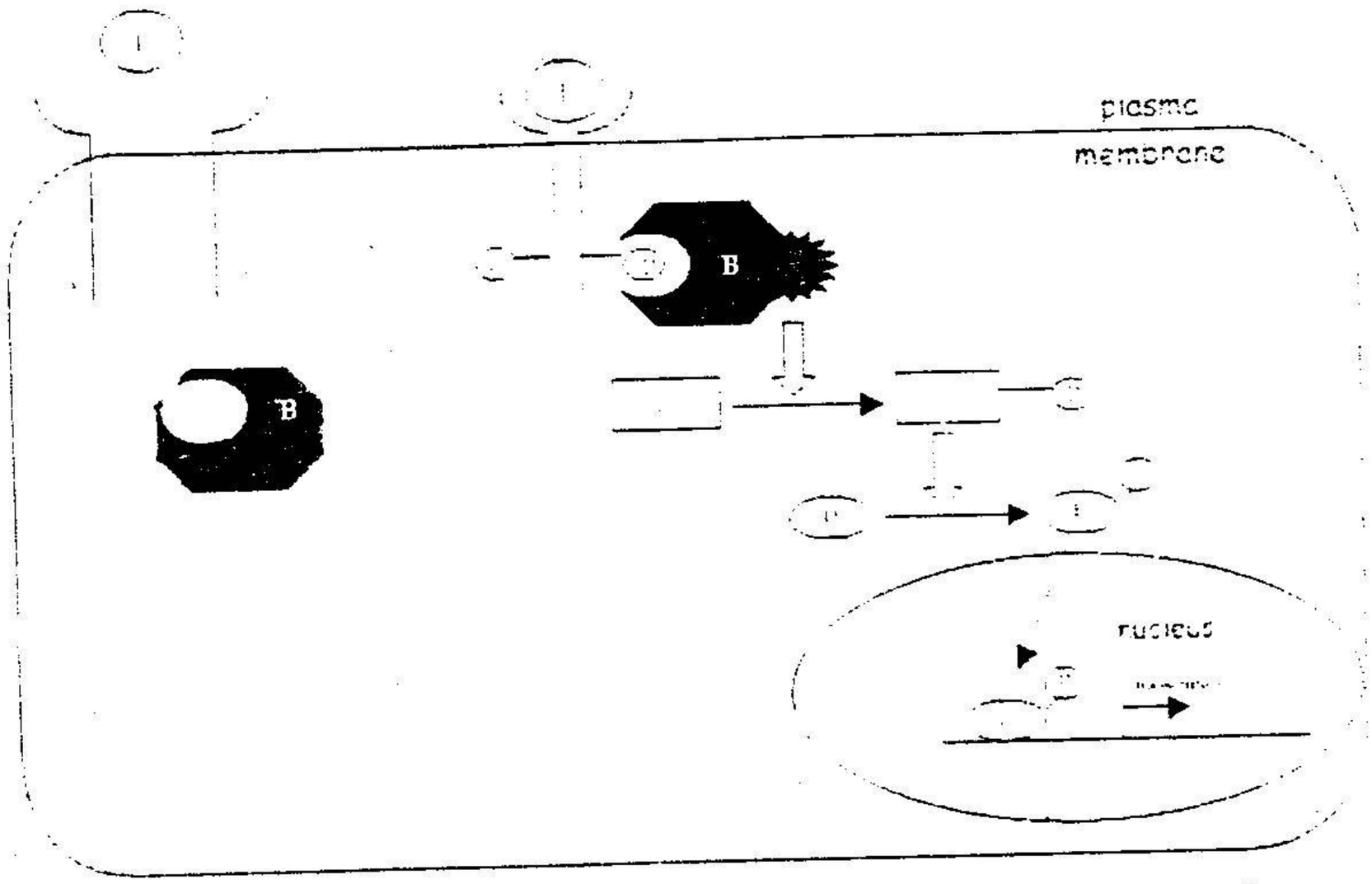
Question1. In the experiment shown below, ^{3}H-labeled T7 phage DNA was allowed to bind *E. coli* core polymerase (○) or to holoenzyme (□). Next, an excess of unlabeled T7 DNA was added, so that any polymerase that dissociated from the labeled DNA would be likely to rebind to unlabeled DNA. The mixtures were filtered through nitrocellulose at various times (X axis) to monitor the dissociation of the labeled T7 DNA-polymerase complexes. What important conclusion about *E. coli* RNA polymerase can be drawn from this experiment? Explain. (15pts)



Question 2. Why is it generally not possible to cut a gene directly out of the human genome, clone it into a bacterial expression vector, and have bacteria produce the protein product of the human gene? (15pts)

Question 3. List of the 7 differences between eukaryotic and prokayotic gene regulation. (10pts)

Question 4. Consider the following hypothetical signal transduction pathway by which an extracellular growth factor induces a cell to grow and divide:



a) Upon binding of the growth factor (ligand L) to the receptor kinase A. receptor A dimerizes and autophosphorylates.
b) The kinase B is then able to bind the phosphorylated cytoplasmic domain of receptor A. leading to a change in the conformation of kinase B that makes it active.
c) The kinase B phosphorylates the kinase C. making it active
d) Kinase C then phosphorylates the transcription factor D
e) The phosphorylated D then enters the nucleus where it binds the promoters of genes involved in promoting the transition from G1 to S phase of the cell cycle.
f) These gene become actively transcribed. leading to cell proliferation

Given the previous information. which of the following gene mutations. if homozygous. would you expect to contribute to the development of cancer? Briefly explain why.

1) A missense mutation in the gene coding for kinase B that generates a protein whose three-dimensional structure is identical to kinase B in its activated form. (2pts)

2) In the cells that normally produce the ligand L. a gene rearrangement occurs such that a constitutively active promoter is placed upstream of the gene encoding L.(2pts)

3) A deletion in part of the extracellular domain of A that allows it to dimerize in the absence of ligand.(2pts)

4) A missense mutation in C that changes the serine that is normally phosphorylated by B to alanine. which cannot be phosphorylated.(2pts)
5) A nonsense mutation in the gene encoding transcription factor D, causing the loss of the factor's nuclear signal sequence.(2pts)