DNA - PROTEIN

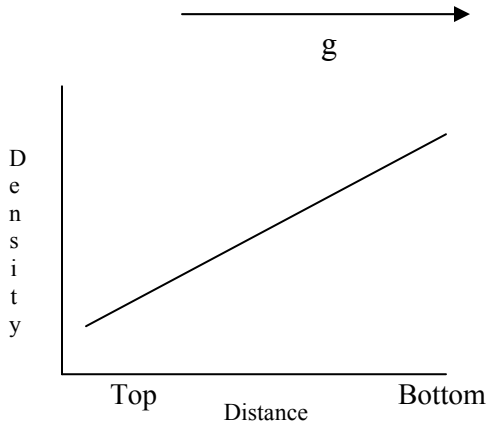
1. The replications of DNA by DNA polymerase require RNA because:

   a. Only RNA can hybridize to initiation sites for DNA replication
   b. DNA polymerase require a primer to initiate replication
   c. RNA is a regulatory molecule that controls the activity of the DNA polymerase complex

2. The fidelity of DNA replication depends on:

   a. DNA repair enzymes
   b. The proof reading function of DNA polymerase
   c. None of the above
   d. Both a and b apply

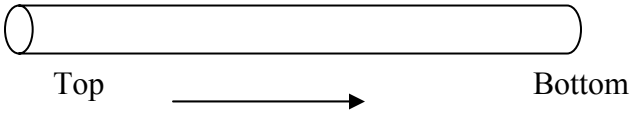
3. When a solution of $CsCl_2$ is subjected to high speed centrifugation. The $CsCl_2$ redistributes so that the density of the solution is higher at the bottom of the centrifuge tube thus at the top



DNA in which ^{15}N has been substituted for normal ^{14}N has a higher density.

In a classical experiment Messelson and Stahl grew E.coli cells which initially contained ^{14}N DNA in ^{15}N containing growth medium and under conditions where all cells divided at the same time. At various times they extracted the DNA and subjected it to centrifugation. In $CsCl_2$, under conditions where a density gradient was formed and the DNA localized to the position in the gradient where its density was the same as that of

the $CsCl_2$. Consider the following representation of where DNA would band (localize) after one generation and two generations.

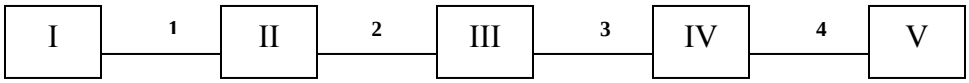


a) Initial
1 generation
2 generations

b) Initial
1 generation
2 generations

c) Initial
1 generation
2 generations

4. Differential splicing occurs in may genes. Imagine you have a gene of structure



Where I-V are Exons and 1-4 represent introns, you note that in muscle the mature mRNA has the structure I-V but in liver it has the structure I-II-IV-V you expect that in the initial transcript:

Select best answer:

a. Different proteins bind to Exon III in the in muscle
b. Liver contains a nuclease specific for Exon III
c. A small RNA molecule binds to Exon III resulting in cleavage the double stranded RNA
d. a and b apply
e. a and c apply

5. For the same gene showed in the last question a mutation results in a mRNA that lacks Exon IV in liver and muscle. The most likely site for such a mutation is:

   a. In Exon IV
   b. At the boundry between intron 3 and Exon 4
   c. Both are possible

6. The same gene above as a result of a deletion lacks Exon V. Yet the mature mRNA is functional i.e. codes for a protein. You expect that (pick best answer)

   a. The mRNA lacks a poly A tail
   b. Exon IV contains signal for addition of a poly A tail
   c. There is not enough information to answer the question

7. In an in vitro system you use the polymer (UGA)n as an artificial mRNA, select from the list below the polymer(s) you expect to find

   a. (Aspartic)n
   b. (Methionine)n
   c. (Valine)n
   d. a and b apply
   e. a, b and c apply

8. A bacterial mRNA coding for 3 proteins cannot be translated in a rat liver cell, because (pick the best answer)

   a. It does not have a methyl G cap
   b. Eucaryotic ribosomes do not recognize internal start sequences
   c. Only eucaryotic protein synthesis starts at an initiator AUG
   d. a, b and c apply
   e. a and b apply

9. You discover a segment of a chromosome with high concentration of methyl cytosine. You conclude

   a. This is an actively transcribed segment of DNA
   b. This is initiation site for RNA polymerase
   c. This is a “non transcribed” heterochromatic region of DNA

10. You compare the amino acid sequence and the sequence of the gene which codes for the enzyme glycogen phosphorylase in muscle of frogs, mice and humans. You expect to find

   a. Greater homology in introns compared to exons
   b. Greater homology in exons compared to introns

c. The amino acid sequence of all the proteins shows greater homology than the nucleotide sequence
d. a and c apply
e. b and c apply

11. Replication of DNA in bacteria proceeds at a much faster pace then in human cells is the most likely explanation:

a. Bacterial DNA polymerase does not have a proof reacting function
b. The structure of the bacterial "chromosome" is less complex
c. The need to generate Okazaki fragments in humans but not in bacteria

12. Telomerase is required for:

a. Each cycle of cell division
b. Cells may replicate for a number of cell divisions before suffering the consequences of lack of telomerase

13. Topoisomerases

a. Rewind DNA after the replication fork has passed by
b. Open the DNA helix so that replication can start
c. Remove the strain on the helix that results from DNA replication

14. When DNA fragments are separated by Gel electrophoresis, the separation of fragments depends primarily on

a. Size of fragment
b. The nucleotide sequence of fragment
c. Both a and b apply

15. Imagine that you have a DNA microarray that allows you to identify 20,000 different DNA sequences randomly distributed across the whole human genome. You use this array to measure the abundance of these DNA sequences in human cells growing synchronously i.e. the cells divide at approximately the same time. You expect

a. The concentration of all sequences to increase at the same rate
b. The concentration of some sequences to increase earlier and other later
c. You expect the early sequences to be closer to the origins of replication
d. b and c are correct

16. Ubiquitin is

a. A modified base in RNA
b. A protease

c. A small protein which when linked to other proteins targets them for degradation in lysosomes
d. A small protein that stabilizes other proteins
e. A small protein that when linked to cellular proteins targets them for degradation in protcosomes

17. Eucaryotic cells have three RNA polymerases, they each (Think carefully)

a. Can synthesize all RNA's
b. Polymerase II is the only polymerase that synthesizes mRNA's
c. Polymerase I synthesizes small RNA's
d. b and c apply

18. Procaryotic mRNA's start with a

a. Methyl G cap
b. A nucleoside triphosphate

19. For the DNA of each gene DNA

a. Both DNA strands in the gene are transcribed
b. Only one strand is transcribed

20. Introns are present in primary transcript of eucaryotic genes

a. The sequence of the introns can be totally random
b. The sequence at the splice site most be specified
c. The introns also has sequences that identify it as an introns
d. b and c apply

21. When you compare the exon sequences present in an initial gene transcript with the sequences in the mature message

a. All the exon sequences are present in the mature message
b. The mature message may only contain some of the exon sequences

22. In order for mRNA to exit from the nucleus it most have

a. A methyl G ap at the 3' end
b. A methyl G ap at the 5' end
c. A poly A tail
d. a and c apply
e. b and c apply

23. The genetic code is

a. An overlapping triplet code
b. A non overlapping triplet code

24. Aminoayl tRNA synthetase (think carefully)

a. Recognize the anticodone of the tRNA and this is sufficient for the reaction to proceed (i.e. link an amino acid to the tRNA)
b. The enzymes also recognize other sequences in the tRNA

25. The ribosome has a proof reaction function to assure that only the correct tRNA's interact with mRNA

a. True
b. False

26. Amino acids are linked to tRNA at

a. At its 5" end
b. At its 3" end
c. The terminal nucleotide which is Adenine
d. a and c apply
e. b and c apply

27. When the ribosome reaches the end of the coding region of a mRNA

a. It releases the polypeptide chain still linked to the last tRNA
b. It releases the free polypeptide
c. There is a specific tRNA that binds to the termination codon (s)
d. a and c apply
e. b and c apply

28. After completing protein synthesis the ribosomal subunits

a. Remain bound to each other
b. Are separated

29. For initiation of protein synthesis the following sequence applies

a. The ribosomal subunits bind to each other, following by binding to tRNA Met and finally to mRNA
b. The small ribosomal subunits bind mRNA. Following by tRNA-Met and the large ribosomal subunit
c. The sequence in b is reversed and the small ribosomal subunit binds last

30. Peptide bond synthesis is a function of Peptidyl synthetase

a. A ribosomal RNA
b. A ribosomal protein

31. The same tRNA Mel is used for initiation of protein synthesis and for methionine residues internal in the protein sequence

a. True
b. False

32. All mature proteins have methionine at their amino end. (Think carefully)

a. True
b. False

33. You have discovered a new gene coding for glaserase a protein required for survival in BIO 255. You obtain a DNA fragment with sequence

ATGCCTAAGGTA

While you contemplate what to do with this information, one of your "friends" steels the sequence and tells you that from this he can determine the amino acid sequence of Glaserase and prepare an antibody to it by synthesizing a small polypeptide coded by this sequence.

Which is the sequence of this polypepticle

a. Met - Pro - Lys - Val
b. Cys - Leu - Avg
c. Your friend has no clue and can not do this

34. In eukaryotes the ribosome identifies an mRNA by the presence of a methyl G cap. In prokaryotes

a. The same applies
b. Each coding sequence is preceded by a unique sequence in a polycistronic message

The next two questions are related

35. All proteins in a given cell type are degraded

a. Randomly
b. Different protein are degraded at different rates

36. Proteins are normally degraded in a pathway that require:

a. The nucleus
b. In proteosomes
c. Marked by ubiquitin
d. ATP
e. c and d apply

37. You identify a series of mutations in the gene for a protein, with the following changes in mRNA sequence in a small portion of the mRNA

Wild type	CAAU – GGA - UAC – ACA – AAG
Mutant 1	CAAC – GGA – UAC – ACA – AAG
Mutant 2	CAAU – GGG – UAG – ACA – AAG
Mutant 3	CAAU – GGA – UAG – ACA - AAG

You wish to know the amino acid sequence for which the DNA codes you find that Mutant 1 and 2 make protein of altered enzyme activity but of normal size. Mutant 3 results in a truncated (smaller) protein. Based on this information write the amino acid sequence corresponding to this sequence of nudeotides codes in the wild type and each of the mutants

Wild Type
Mutant 1
Mutant 2
Mutant 3

38. The Martian Rover after 10 years of explorations has identified life on Mars. The proteins are composed of different amino acid but only 12 amino acids (rather than 20 on earth) are used. The DNA bases (A, G, T, C) are however the same. Could the Martian cells use a 2 base rather than a 3 base genetic code (think carefully)

a. Yes
b. No

39. The amino acyl tRNA synthetases recognize all the tRNA for a particular amino acid. Is it possible that

a. They only recognize the anticodon present in the tRNA
b. They must recognize other common sequences in the tRNA's that code for the same amino acid

40. You chemically reduce cysteine (labeled with ^{14}C) linked to its tRNA, to generate (^{14}C) labeled alanine still linked to the tRNA. You use this as a substrate in an <u>in vitro</u> protein synthesis including all normal aminoacyl tRNA's ribosones etc. You use an artificial message of sequence

AUG GCA GGA AGC UGC ACA GCC

1 2 3 4 5 6 7

You expect to find (^{14}C) alanine in the resulting polypeptide in

a. Position 2
b. Position 7
c. Position 5
d. a and b apply

41. When you examine the DNA strand which is transcribed into mRNA in a chromosome

a. All transcription is from the same strand
b. Each gene is transcribed from one strand, but different genes are transcribed from different strands gene
c. Genes are not overlapping
d. a and c apply

42. Chemical alterations of DNA will inhibit the progression of the DNA synthesis complex i.e. DNA polymerase II. Cells can overcome this by

a. Removing the damaged DNA and replacing it with appropriate base paired DNA
b. In some cases a special DNA polymerase will "jump over" the damaged region
c. a and b apply but "a" will always result in cells with altered genome
d. a and b apply but "b" will always result in cells with an altered genome
e. Neither "a" nor "b" applies

43. The deamination of cytosine in DNA if not corrected before DNA replication will result in daughter cells

a. With DNA identical to the parental cells DNA
b. With one daughter cell in which a G-C pair has been changed to an A-T pair
c. With one daughter cell in which a A-T pair has been changed into a G-C pair

The next two questions are related

44. Ultraviolet light results in the formation of

a. A cross linked A-A base pair
b. A cross linked T-T base pair

45. For the answers to questions 3 the cross linked bases are

a. On opposite strands
b. On the same strand
c. Both can occur

The next two questions are related

46. Excision of damaged DNA and repair requires

    a. Removal of both strands of DNA
    b. Removal of one strand of DNA

47. The repairs requires (pick the best answer)

    a. The normal DNA replication complex
    b. A special DNA polymerase
    c. DNA ligase
    d. a applies plus ATP
    e. b and c apply plus ATP

48. Transposons (pick the best answer)

    a. Move by removing a section of DNA from one location to another in the genome
    b. Sometimes move by removing a section of DNA from one location to another in the genome but other transposons are first replicated and the replicated DNA is inserted at a new location in the genome
    c. Some transposon are first copied (transcribed) into RNA and used reverse transcriptase to make the DNA that will be inserted elsewhere in the genome
    d. a and b apply
    e. b and c apply

49. During Meiosis chromosomes exchange genetic information

    a. Randomly between different chromosomes
    b. By recombination between homologous chromosomes

50. Viruses and bacteriophages (bacterial viruses) can move genetic information between cells. This occurs because:

    a. They lyse cells and fragments of the cells DNA can be picked up by other cells
    b. Sometimes these viruses incorporate cellular DNA in their genome which they transfer to new cells which they infect

51. Bacterial conjugation results in the transfer of genetic information from one cell to another in a process that requires:

    a. DNA synthesis
    b. The formation of a channel (pillus) between cells
    c Occurs between cells of different mating types
    d. All apply

52. The classical experiment by Avery McLeod and McCarthy demonstrated that DNA was the molecule that (pick the best answer)

    a. Was the genetic material of all cells
    b. Could transform "rough pneumococci" to "smooth pneumococci"
    c. Coded for specific proteins

53. The results of the Hershey-Chase experiment conclusively proved that the <u>total</u> genetic information of bacteriophage T-2 was DNA

    a. True
    b. False

The next two questions are related

54. Histones are basic proteins that bind to DNA and form structures called

    a. Beads
    b. Chromatin
    c. Nucleosomes

55. The structure in questions 3 are

    a. Invariant
    b. Subject to modification

    If you picked a. answer question 5, if you picked b. answer question 6.

56. The structures are invariant because they provide a scaffold for DNA folding

    a. True
    b. False

57. The structures are variable and change due to chemical modification of histones

    a. True
    b. False

58. Human females have two X chromosomes while males have one, therefore they

    a. Synthesize twice as many gene products coded by the X chromosome
    b. They randomly inactivate half the genes on each X chromosome
    c. They inactivate a specific set of genes in each X chromosome, so that each chromosome only expresses a different half of the X chromosome genes
    d. None of the above is correct

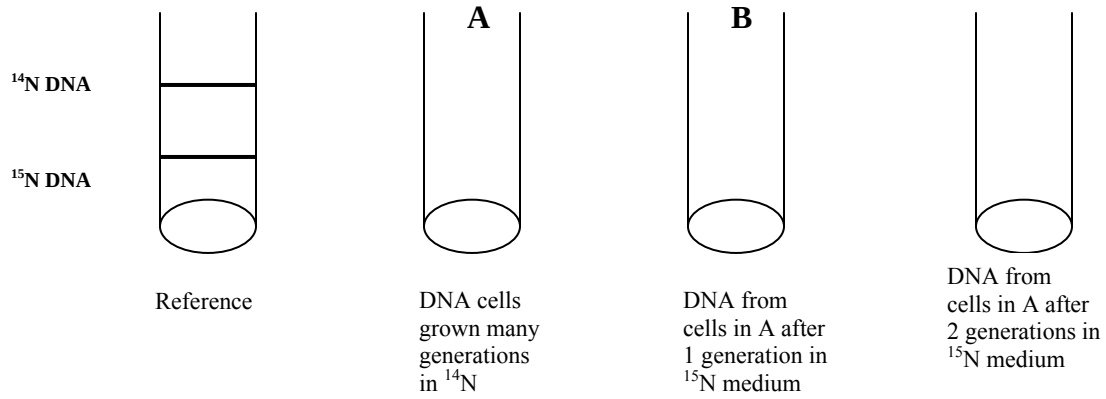
59. The minimal DNA sequences required for a functional chromosome in eukaryotic cells is

    a. Two centromeres, one telomere, one origin of replication
    b. Two telomeres, one centrosome and one origin of replication
    c. Two telomeres, multiple origins of replication and one centromere

60. E.coli cells lack telomerase yet, they survive because

    a. They reproduce rapidly in large numbers and can tolerate multiple mutations
    b. Their DNA has no end

61. DNA can be obtained from Ecoli cells grown in "normal" medium with nutrients that contain ^{14}N or in medium with nutrients that contain ^{15}N. The DNA from the latter has higher density and ^{14}N and ^{15}N DNA can be separated by an ultracentrifugation in a C_sCl_2 density gradiant. Examine the enclosed diagram and fill in the expected results



If you show more than one band write the relative % on the side of the figure.

62. Starting at the origin of replication, the replication fork(s) move(s) in

    a. One direction
    b. Two directions

63. Imagine that you have a DNA microarray that allows you to identify 20,000 different DNA sequences randomly distributed across the whole human genome. You use this array to measure the abundance of these DNA sequences in human cells growing synchronously i.e. the cells divide at approximately the same time. You expect

    a. The concentration of all sequences to increase at the same rate
    b. The concentration of some sequences to increase earlier and other later
    c. You expect the early sequences to be closer to the origins of replication
    d. b and c are correct

64. Before DNA synthesis can start DNA polymerase(s) require (think very carefully)

a. A preexisting oligonucleotide that is RNA
b. A preexisting oligonucleotide that is DNA
c. a or b may apply if we are looking at DNA replication or at DNA repair

65. DNA polymerase proof reading

a. Results in its dissociation from the DNA if a mistake has been made
b. Removal of the mismatched base and its replacement by the correct base
c. Cleavage of the template strand

The next two question are related

66. Telomerase is an enzyme that

a. Adds random set of bases (nucleotides) to the ends of DNA
b. Adds repeated sequences to the end of DNA
c. The repeated sequences are complementary to an RNA sequence which is part of telomerase

67. After telomerase adds a nucleotide sequence to the end of DNA (think very carefully)

a. A complementary strand must be synthesized at the leading strand as an Okazaki fragment
b. A complimentary strand must be synthesized at the lagging strand as an Okazaki

68. When DNA synthesis is initiated at origin of replication, the two parental strands are replicated (think carefully)

a. In opposite directions
b. In same direction
c. One continuously and one discontinuously
d. a and c apply
e. b and c apply

69. DNA synthesis is always initiated by

a. An RNA primer
b. A guanosine cap
c. A deoxyribonucleotide triphosphate

70. RNA molecules have

a. No secondary structure
b. Fold at random
c. Can fold using base pairing rules into unique structures

71. Synthesis of RNA requires

    a. Four ribonucleoside triphosphate and RNA polymerase
    b. Promoter and an initiation of transcription site
    c. Regulatory proteins that control transcription
    d. a and b apply
    e. a, b and c apply

72. Messenger RNAs differ in procaryotes and eukaryotes

    a. Procaryotic messages are polycistronic (code for more than one protein) and eucaryotic messages only code for one protein
    b. Procaryotic messages code for one protein, eucaryotic messages code for multiple proteins

73. Amino acids are covalently attached to tRNA to form aminoacyl tRNAs

    a. The amino acid is attached to the anticodon on tRNA
    b. The amino acid is attached to 3' hydroxyl at terminal adenine on tRNA
    c. Neither statement applies

74. The initiation of protein synthesis involves initially

    a. The large subunit of ribosomes
    b. Small subunit of ribosomes
    c. Both

75. In eucaryotes mRNAs at their 5' end are identified by ribosomes because

    a. They contain a TATA box
    b. Have a methylguanine cap
    c. Have a poy A tail

76. Proteins and mRNAs once made in a cell

    a. Remain for the life time of the cell
    b. Are continuously degraded at rates specific for each molecule

77. A given messenger at any time will have attached to it

    a. One ribosome at the end
    b. One ribosome at each end
    c. Multiple ribosomes in the process of synthesizing protein

78. Regulators of transcription in procaryotes and eucaryotes are

a. Always positive regulators, i.e., activate transcription
b. Are always negative regulators
c. Both types are functional in cells

79. When E. coli is grown in the presence of streptomycin (an antibiotic) approximately 5 colonies grow from 10^8 cells. A strain of E. coli defective in the proofreading mechanism of DNA polymerase grows poorly under normal conditions. When tested for its ability to grow in the presence of streptomycin you expect per 10^8 cells

a. 5 colonies
b. > 5 colonies
c. < 5 colonies

80. The RNA primer of each Okazaki fragment is

a. Released and reused
b. Degraded to individual nucleotides

81. The original evidence that DNA is the genetic material of cells is based on

a. Chemical analysis of DNA
b. Analysis of chromosomes
c. Transformation of bacteria by DNA
d. a and b apply

82. When DNA is chemically damaged, DNA repair requires: (think carefully)

a. Excision of both strands of damaged DNA
b. Excision of damaged nucleotides
c. Filing in gaps with DNA polymerase and sealing with DNA ligase
d. a and c apply
e. b and c apply

83. Synthesis of RNA requires

a. Four ribonucleoside triphosphate and RNA polymerase
b. Promoter and an initiation of transcription site
c. Regulatory proteins that control transcription
d. a and b apply
e. a, b and c apply

84. When a ribosome reaches the end of a mRNA it releases the completed protein

a. Attached to tRNA
b. As a free polypeptide

85. Phosphorylation of proteins (enzymes) by ATP catalyzed by specific protein kinases is used to

a. Modify the charge of protein
b. Change the enzymatic activity of the protein (an on/off switch)

86. When DNA synthesis is initiated at origin of replication, the two parental strands are replicated (think carefully)

a. In opposite directions
b. In same direction
c. One continuously and one discontinuously
d. a and c apply
e. b and c apply

87. Mistakes in DNA synthesis are to a large extent avoided because DNA polymerase has

a. Proofreading function
b. Mismatch repair enzymes correct DNA after synthesis
c. Both a and b apply

88. Some mutations (base changes in DNA) are phenotypically silent (i.e., have no biological effect). Their most likely location is in

a. Exons
b. Introns

89. RNA is synthesized by copying DNA

a. Both strands of DNA are transcribed to yield double stranded RNA
b. At any position in genome only one strand of DNA is transcribed

90. RNA molecules have

a. No secondary structure
b. Fold at random
c. Can fold using base pairing rules into unique structures

91. Messenger RNA

a. Codes for proteins
b. Is the only RNA transcribed from DNA
c. a and b apply

92. Messenger RNAs differ in procaryotes and eucaryotes

a. Procaryotic messages are polycistronic (code for more than one protein) and eucaryotic messages only code for one protein
b. Procaryotic messages code for one protein, eucaryotic messages code for multiple proteins

93. Eucaryotic messengers RNAs has

a. A poy A tail at 5' end and a methyl G cap at 3' end
b. A poy A tail at 3' end and a methyl G cap at 5' end

94. The nucleotide sequence of a small fragment of messenger RNA is AUGCUCAGCGUU. The genetic code is attached to the last page of the exam. You conclude that the amino acid sequence of the protein coded by this message contains the sequence

a. Cys-Ser-Ala
b. Met-Leu-Ser
c. There is not enough information to decide

95. The function of tRNAs is to translate mRNA sequence

a. There is only one tRNA for each amino acid
b. There are multiple tRNAs for some amino acids
c. There are multiple tRNAs for all amino acids

96. Amino acids are covalently attached to tRNA to form aminoacyl tRNAs

a. The amino acid is attached to the anticodon on tRNA
b. The amino acid is attached to 3' hydroxyl at terminal adenine on tRNA
c. Neither statement applies

97. Proteins and mRNAs once made in a cell

a. Remain for the life time of the cell
b. Are continuously degraded at rates specific for each molecule

98. The minimal components required for function of a eucaryotic chromosome are

a. Centromere
b. Replication origin
c. Telomere and telomerase

d. All apply

99. In general the DNA in each cell of the body of a eucaryotic organism, for example man

a. Is different in each cell type
b. Is the same in each cell type

100. Proteins that control gene expression, i.e., frequency of transcription, bind to

a. Single bases in DNA
b. Multiple bases in DNA
c. Bind to DNA in either the major or minor groove
d. a and c apply
e. b and c apply

101. In procaryotes the synthesis of enzymes required to make essential amino acids/vitamins/sugars depends on the availability of these in the fluid in which cells grow. Repressors are best described as

a. Proteins that control nutrient uptake by cells
b. Proteins that bind to DNA at promoter regions, dependent on concentration of specific ligands in cells, for example, an amino acid
c. Are a component of RNA polymerase

102. In eucaryotic cells all RNA molecules are

a. Made by the same RNA polymerase
b. Made by different RNA polymerases

103. A given regulatory protein may

a. Control expression of a single gene
b. Can control expression of multiple genes

104. A strain of E. coli containing an integrated Fplasmid in the genomic DNA is also resistant to rifampicin, and able to grown in the absence of tryptophan. You observe that rifampicin resistance is transferred at high frequency while the ability of the recipient cells to grown in the absence of tryptophan is observed with low frequency. You conclude (pick best answer)

a. The two genes are on different chromosomes
b. The location of rifampicin resistance gene is close to the site of integration of Fplasmid and the tryptophane gene is distal
c. The location of rifampicin resistance gene is close to the beginning site for DNA transfer and the tryptophan gene is remote from this site

105. You chemically link the amino acid alanine (Ala) labeled with ^{14}C to tRNA for leucine. You use this molecule in an *in vitro* system to synthesize a protein using appropriate mRNA, ribosomes, etc. The initial coding sequence for this protein is

AUG-UUU-GCU-CUU-GCG

You expect to find radioactive alanine (think carefully)

a. In position 1 and 3
b. In position 3
c. In position 4
d. In position 5

106. Retroviruses contribute to genetic diversity because (think carefully, pick the best answer)

a. They contain RNA instead of DNA
b. They contain reverse transcriptase
c. Their genome is inserted as DNA into chromosomes
d. During transcription and packaging of virus they sometimes (rarely) incorporate a host gene into viral particle as RNA

107. Homologous recombination cell occur between DNA molecules which at the site of recombination

a. Have highly different nucleotide sequences
b. Identical or nearly identical nucleotide sequences

108. Restriction enzymes cleave DNA

a. At random sites
b. At unique sequences
c. The sequence at the site is often a palindrome
d. a and c apply
e. b and c apply

The next two questions are related

109. You clone the portion of mouse DNA that codes for the enzyme hexokinase (involved in glycolysis) as well as a small portion of adjacent DNA. You sequence a portion of this DNA and you use it to identify clones for the same DNA region (coding for hexokinase) from pig/human/horses/baboons using hybridization and a radioactive oligonucleotide with the mouse sequence as a probe. In order to accomplish this you hybridize the protein to your clones at

a. High stringency

b. Low stringency
c. It does not matter, either will work

110. Having obtained clones for the gene for hexokinase from mouse/pig/horse/ baboon/human, you examine their pattern of cleavage by restriction enzymes. You expect

a. The pattern to be totally different
b. The pattern of cleavage of baboon and human genes to be more similar than mouse and human
c. The pattern of cleavage of baboon and human genes to be as different from each other as mouse and human

111. You completely sequence the hexokinase genes from all species and you compare the sequence not only at nucleotide level but also of the protein (i.e., hexokinase) for which they code. You expect

a. More divergence in introns than in exons
b. Less divergence in introns than in exons
c. The amino acid sequence of protein to be more related than nucleotide sequence
d. a and c apply
e. b and c apply

112. You wish to code the gene for red hair, so everyone can look like Luis Glaser. You determine a partial amino acid sequence of a protein that determines hair color as

Ala-Phy-Gly-Gly-Leu

and after looking up the genetic code (attached), you synthesize an oligonucleotide probe to identify the gene from a genome library. The oligonucleotide that you synthesize has the sequence

GCC-UUC-GGU-GGG-UUA

and you fail to find after five years of work any sign of the gene. You should have

a. Come to class more often
b. Synthesized a series of random oligonucleotides
c. Synthesized all possible oligonucleotides that can code for the amino acid sequence above

113. The effect of cholesterol on a lipid bilayer is to

a. Make it more fluid
b. Restrict mobility

114. The region of a membrane protein that traverses the lipid bilayer is usually arranged on

a. An extended chain of amino acids
b. An α helix
c. A pleated sheet

115. Tight junctions

a. Promote movement of proteins in membranes
b. Restrict movement of proteins in membranes

116. For all cells is

a. Na^+ inside > Na^+ outside
b. Na^+ outside > Na^+ inside

117. Glucose and mannose are monosaccharides of identical size (Mol wt. 180) yet glucose readily enters muscle cells and mannose does not. The concentration of glucose in the intracellular fluid (cytoplasm) is never higher than in extracellular fluid and often lower. Based on these observations, you expect glucose entry into muscles to be

a. Via a pore
b. By a glucose specific carrier
c. by a Na^+/glucose cotransporter (symport)

118. Which of the following statements is correct regarding ATP driven pumps?

a. The only ATP driven pump is the Na^+/K^+ ATPase
b. Eucaryotic cells contain a variety of ATP driven pumps including Na^+/K^+ ATPase, Ca^{++} ATPase and H^+ ATPase
c. All ATP driven pumps are in the cytoplasmic membrane
d. b and c are correct

119. Ribozymes are

a. Enzymes that cleave ribonucleotide
b. RNAs with catalytic activity
c. Enzymes that cleave RNA at specific sequences
d. a and b apply
e. b and c apply

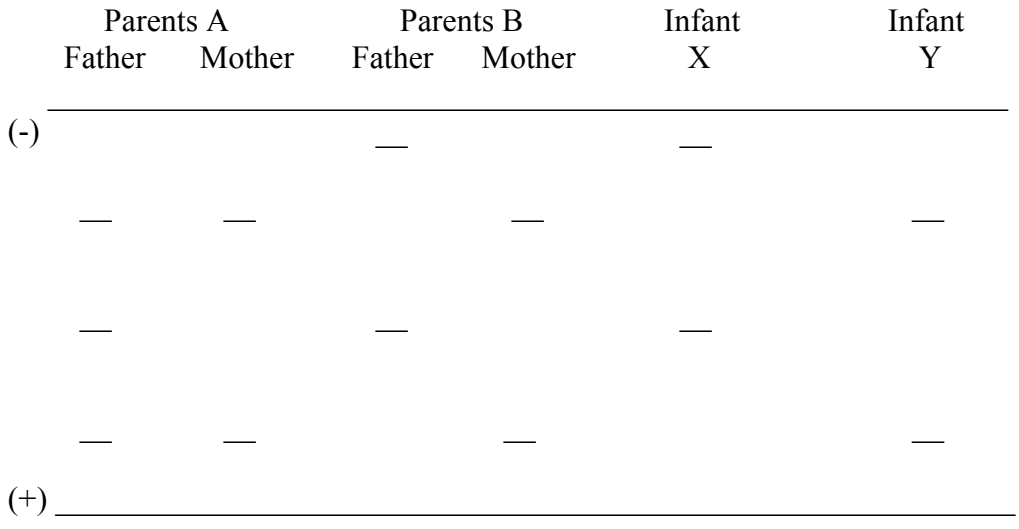
120. Na^+/H^+ antiport is one of the primary regulators of intracellular pH. When the fluid surrounding a cell contains no Na^+ would you expect the cells cytoplasm

a. To become more acid
b. To become more alkaline

121. A particular cell type can potentially utilize 3 different regulatory proteins that control gene expression to generate different phenotypes by utilizing any possible combination of these proteins from 0 to 3. How many potential phenotypes can arise?

a. 3
b. 6
c. 8
d. None of the above

122. Consult the following restriction fragment length polymorphism detailed by hybridization to a DNA probe after digestion of human DNA with restriction enzyme



123. To create a transgenic cow that would sunthesize a human protein in milk, you would

a. Inject total human DNA into the mammary gland
b. Select embryonal stem cells (ES) transfected with human gene under control of a promoter expressed in all somatic cells
c. Select ES cells transfected with a human gene under control of a DNA sequence specific for proteins secreted in milk such as lactalbumin and transfer these cells to early blastulas
d. None of the above

124. A cDNA library is prepared from muscle cells and liver cells. You expect the genes found in these two libraries to be

a. The same
b. Partially overlapping
c. Totally different

The next two questions are related.

125. The following is the nucleotide sequence, starting with AUG for a normal cellular protein, and three mutant forms (a genetic code is attached at the end of the exam).

		start
Normal	___	φAUGκUUAAGAUUCAAA - - — —
Mutant 1	__	AUGUGAAGAUUCAAA - — —
Mutant 2	—	AUGUUAAGGUUCAAA - — —
Mutant 3	—	AUGUUAAGGUUCCAN - — —

You examine the cells containing each of these mutations for presence of normal or mutant proteins and you find one of them has no measurable protein. This cell is

a. Mutant 1
b. Mutant 2
c. Mutant 3

126. You examine these same cells to determine which has a fully functional protein. The choices are

a. Mutant 1
b. Mutant 2
c. Mutant 3

127. Hershey showed that when a bacteriophage was labeled with ^{32}P (to label DNA) and ^{35}S (to label protein) the production of new phase by E. coli resulted from

a. The injection of ^{32}P and ^{35}S labeled material into E. coli
b. The injection of ^{35}S labeled material
c. The injection of ^{32}P labeled material

128. Single strand DNA binding protein is required to:

a. Identify the origin of replication
b. Prevent base paving in lagging strand

129. In a classical experiment Avery McLeod and McCarthy showed that extracts of smooth strains Streptococcus Pneumonia could transform rough strains to smooth strains. The difference between the two is the ability of smooth strains to synthesize a capsular polysaccharide. They further should:

a. That the transforming principle was the capsular polysaccharide

b. Was DNA
c. Required specific proteins as well as DNA

130. Helicase is required for DNA replication. It:

a. Unwinds the DNA helix
b. Unwinds the DNA helix in an ATP dependent manner
c. Neither statement is correct

131. Many amino acids are specified by multiple code words often differing from each other at the third base, but in many cases differing in all three positions. The aminoacyl tRNA synthetase for the amino acid recognizes all of the tRNA's that code for that amino acid. Would you conclude from this statement that:

a. This enzyme functions exclusively by recognizing the anticodon in the tRNA
b. That this enzyme at a minimum must recognize another feature of the tRNA in addition to the anticodon sequence.

132. You will need to consult the genetic code supplied with the examination. The genetic code was deciphered in part by allowing ribosomes to translate synthetic oligonucleotides, which ribosomes translated by random initiation. Consider two such oligonucleotides.

I. UGAUGAUGA_ _ _ _ _
II. GCAGCAGCA_ _ _ _ _

How many homopolymers of amino acids do these two oligonucleotides code for:

a. Two
b. Four
c. Five
d. Six

Which homopolymers are coded by oligonucleotides I?

Which by oligonucleotides II?

Note: a homopolymer is a polymer of a single amino acid.

Indicate below the probe sequence the mutation in this mouse.

The next two questions are related

133. E. coli cells divide under optimal conditions every 30 minutes. You label DNA in rapidly growing E. coli with ^{32}P for 3 minutes by adding ^{32}P inorganic phosphate and

then allow cells to grow 5 generations in the absence of ^{32}P. You extract DNA from a sample of cells immediately after the labeling period and at the end of the experiment. You determine the amount of ^{32}P label that is retained in cells DNA after 5 generations. You expect to find:

a. Most of the ^{32}P DNA is lost
b. Most of the ^{32}P DNA is retained

134. You examine the cells from question 1 after 5 generations individually by exposure to x-ray film and autoradiography; you expect to find the radioactivity: (think very carefully)

a. Uniformly distributed among all cells
b. Localized exclusively in a few cells
c. Distributed among most cells but some are more radioactive than others.

135. The following schematic diagram illustrates the structure of a hypothetical gene (introns and exons), which is expressed in a variety of tissues. The arrows indicate sites where poly A addition may take place. The gene is expressed in a variety of cells and results in different spliced RNA which of these in RNA is functional.

	Functional	Non Functional
m RNA Liver	_____	_____
m RNA Muscle	_____	_____
m RNA in Kidney	_____	_____
m RNA in Skin	_____	_____

136. DNA synthesis is best described as

a. Addition of nucleotides at 3' end of growing chain
b. Addition of nucleotides at 5' end of growing chain
c. Both a and b apply

137. During DNA replication the original DNA strands are

a. Destroyed
b. Conserved

138. The following proteins are required for DNA synthesis

a. DNA polymerase, primase, sliding clamp
b. Helicase, DNA ligase
c. RNA polymerase
d. a and b apply
e. b and c apply

139. Uracil is a base unique to RNA; it pairs with

a. Guanosine
b. Cytosine
c. Adenine

140. Messenger RNA

a. Codes for proteins
b. Is the only RNA transcribed from DNA
c. a and b apply

141. Introns are DNA sequences that

a. Code for proteins
b. Code for tRNAs
c. Serve as spacers between exons

142. Exons are assembled into mature mRNA

a. Same sequence in every cell
b. Alternative splicing of primary transcripts occurs in different cell types

143. The boundary between exons and introns is

a. Precisely defined so that splicing always occurs at the same site
b. The boundary is variable and splicing can occur in many regions for the same exon/intron boundary

144. The genetic code is best described as

a. A binary code
b. A non-overlapping code
c. A triplet code
d. a and b apply
e. b and c apply

145. The genetic code has only

a. One code word for each amino acid
b. Multiple code words for many but not all amino acids

146. The nucleotide sequence of a small fragment of messenger RNA is AUGCUCAGCGUU. The genetic code is attached to the last page of the exam. You conclude that the amino acid sequence of the protein coded by this message contains the sequence

a. Cys-Ser-Ala
b. Met-Leu-Ser
c. There is not enough information to decide

147. The function of tRNAs is to translate mRNA sequence

a. There is only one tRNA for each amino acid
b. There are multiple tRNAs for some amino acids
c. There are multiple tRNAs for all amino acids

148. Protein synthesis is always initiated by the amino acid

a. Leucine
b. Methionine
c. Glycine

149. Ribosomes are best described as

a. A large set of proteins and DNA
b. Two particles the large and small ribosomal subunit each containing RNA and protein
c. Particles containing an RNA which can function as an enzyme (catalyst)
d. a and c apply
e. b and c apply

150. The ribosome contains

a. One binding site for tRNA
b. Three binding sites for tRNAs
c. Two binding sites for tRNAs

151. Proteins are synthesized by ribosomes

a. Starting at their amino end
b. Starting at their carboxyl end

152. As proteins are made by ribosomes

a. They fold into three dimensional structures as the polypeptide emerges from ribosomes
b. They remain unfolded until synthesis is complete

153. A given messenger at any time will have attached to it

a. One ribosome at the end
b. One ribosome at each end
c. Multiple ribosomes in the process of synthesizing protein

154. The minimal components required for function of a eucaryotic chromosome are

a. Centromere
b. Replication origin
c. Telomere and telomerase
d. All apply

155. In general the DNA in each cell of the body of a eucaryotic organism, for example man

a. Is different in each cell type
b. Is the same in each cell type

156. When a ribosome reaches the end of a mRNA it releases the completed protein

a. Attached to tRNA
b. As a free polypeptide

157. Phosphorylation of proteins (enzymes) by ATP catalyzed by specific protein kinases is used to

a. Modify the charge of protein
b. Change the enzymatic activity of the protein (an on/off switch)

158. Proteins that control gene expression, i.e., frequency of transcription, bind to

a. Single bases in DNA
b. Multiple bases in DNA
c. Bind to DNA in either the major or minor groove
d. a and c apply
e. b and c apply

159. In eucaryotic cells all RNA molecules are

a. Made by the same RNA polymerase
b. Made by different RNA polymerases

160. The initiation of transcription of a gene coding for protein in eucaryotic cell requires

a. RNA polymerase and nucleoside triphosphates
b. General transcription factors, and phosphorylation of RNA polymerase
c. Primase, and TATA box
d. a and b plus TATA box
e. b and c plus nucleotide triphosphates

161. Think about the following statement, "The genetic information present in gametes (eggs or sperm) is absolutely identical to the genetic information present in somatic cells of the individual that generated these cells." Is this statement

a. True
b. False

162. You have cloned and sequenced all of human chromosome 10. You expect

a. All the coding sequences are on one strand (the same strand of DNA)
b. Both strands of DNA contain coding sequences
c. The exons on both strands of DNA base pair with each other

163. DNA Ligase requires

a. An RNA primer
b. ATP

164. Ribozymes are

a. Enzymes that cleave ribonucleotide
b. RNAs with catalytic activity
c. Enzymes that cleave RNA at specific sequences
d. a and b apply
e. b and c apply

165. Ribosomes are

a. Assembled in cytoplasm
b. Assembled in nucleus
c. The large and small subunits are assembled separately and only come together in the presence of mRNA
d. a and c apply
e. b and c apply

166. Transposones are

a. Enzymes that cleave DNA

b. DNA sequences that move to different locations on genome
c. Viruses

167. Ribosomes can

a. Translate any messenger RNA
b. Are specific for a particular messenger RNA
c. At any given point in time only one ribosome can be bound to a given mRNA
d. a and c apply
e. b and c apply

168. Which of the following statements is correct for eucaryotic cells?

a. All cellular proteins are degraded at the same rate
b. Each cellular protein is degraded at a different rate
c. All proteins are degraded in lysosomes
d. Some proteins are degraded in lysosomes, others in proteosomes
e. b and d are correct

169. DNA binding proteins (for example, transcription regulators) bind to DNA without opening the double helix. They bind with specificity because

a. They recognize a portion of the bases in the nucleotides (A,T,G,C) which are exposed in the major or minor groove
b. They recognize the net charge on the helix

170. Which of the following statements is correct?

a. All proteins have alanine at their amino end
b. All proteins initially have methionine at their amino end but this may be removed from the mature protein
c. The code for the first amino acid at the amino end of protein can be any coding triplet

171. When the ribosome reaches a code word UGA, it

a. Releases the nascent protein still linked to tRNA
b. Releases the nascent protein without tRNA
c. Binds a release factor which allows peptidyltransferase to release the protein
d. a and c apply
e. b and c apply

172. An individual ribosome can make only one type of protein.

173. Because the two strands of DNA are complementary, the mRNA of a given gene can be synthesized using either strand as a template.

174. The amount of an enzyme (protein) present in cells of steady state, depends on its rate of synthesis, its catalytic activity, and its rate of degradation.

175. When RNA polymerase II reaches a signal for poly adenylation, it and the RNA transcript are released. You compare the state of phosphorylation of the RNA polymerase in the process of transcription and the released protein, and you expect to find as the most likely result

a. The released protein is not phosphorylated
b. The released protein is highly phosphorylated

CONTROL GENETIC ENZYMES

1. You isolate an E.coli mutant that <u>cannot</u> synthesize 3', 5' cAMP. You measure the synthesis β galactosidase under the following conditions. All cells use sucrine acid as an energy source

I no additions
II In the presence of thiomethyl βD-galactoside (TMG)
III TMG + glucose

You expect synthesis of β-galactosidase to occur (think carefully)

a. None of these bacterial cultures
b. Culture II
c. Culture III
d. Culture I and II
e. Culture II and III

2. A gene contains 6 exons, a mutation results in a deletion of the last exon. You expect

a. The synthesis of a shorter protein
b. No protein is made
c. Synthesis of a shorter protein if exon five has a polyadenylation signal
d. Synthesis of a shorter protein if exon five has a signal for the synthesis of a methyl G Cap

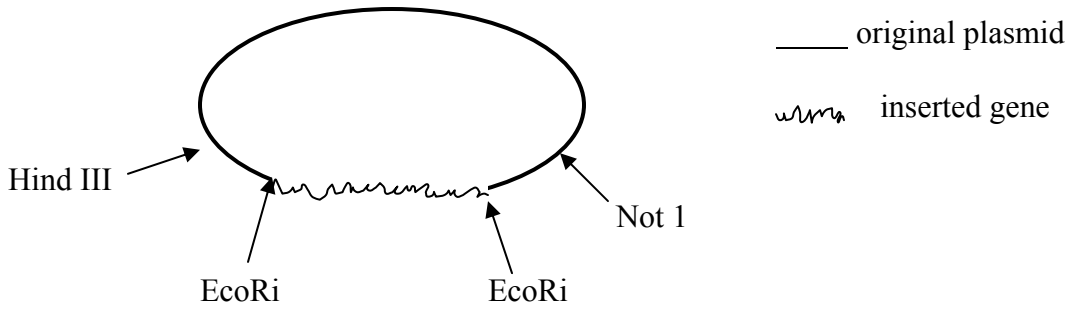
3. Which of the following statements are correct?

a. Each gene has a regulatory protein(s) unique to that gene, i.e. they do not affect any other gene
b. Each gene's expression is regulated by one or more regulatory proteins which also influence the expression of other genes
c. Each regulatory protein recognizes a specific sequence in DNA
d. a and c are correct
e. b and c are correct

4. Transgenic animals have one or more of their genes replaced by altered forms of the gene and carry this altered form in their germ line. Transgenic mice can be generated from embryonal stem (ES) cells carrying an altered gene because

a. ES cells when introduced into pseudopregnant mothers give rise to a complete embryo that can grow to an adult form
b. ES cells injected into blastula become part of embryonal cells, thus first generation descendants are mosaics of normal and mutant cells

5. You clone a DNA fragment in a plasmid using EcoRi cleavage of the plasmid. This DNA is expressed in E.coli. It codes for an enzyme in amino acid metabolism. You have no amino acid sequence or DNA sequence for this gene but you wish to obtain the DNA sequence. You have a full DNA sequence of the original plasmid. The restriction map for plasmid with this gene inserted is:



In order to sequence this DNA you would release gene from the plasmid with (think carefully)

a. EcoRi
b. Not 1
c. Hind III
d. Not 1 and Hind III

The next two questions are related

6. You want to develop a "genetic cure" for a decease that is the result of a mutation in one specific gene. You clone the gene and insert it into a retrovirus which has also been engineered to not reproduce in human cells but can infect these cells. The inserted sequence should minimally include

a. The full sequence of the gene including introns and exons
b. A binding site for transcription factors and RNA polymerase
c. The full set of regulatory sequences for tissue specific expression of the gene
d. a and c apply
e. a, b and c apply

7. You did the experiment in the previous question in cells in tissue culture and it seems to work. You want to proceed to human trials, and a young and inexperienced officer at the FDA gives you permission to do so. Five individuals are infected with your virus; all show clear indications of function of normal gene. You are happy and excited unfortunately within first year, two individuals develop tumors each in a different organ. Further, the FDA officer is fired; you are embarrassed and think back to BIO 255. This sad result is most likely due to

a. The oncogenic effect of any viral infection
b. The accidental insertion of your virus into a region of the genome where it could initiate formation by altering expressive of other genes
c. Random events unrelated to your virus

8. A specific small RNA when expressed in a cell can alter splicing pattern of a gene. For this to occur the small RNA binds to a

a. Sequence in a specific exon
b. Sequence in a specific intron
c. Subunit of the RNA polymerase

9. You wish to use E.coli to synthesize human growth hormone. You use a plasmid that contains the cDNA sequence of human growth hormone and a gene for penicillin resistance. You select E.coli cells that are resistant to penicillin and none of them make human growth hormone or it's mRNA. This is because

a. E.coli RNA polymerase cannot transcribe a human DNA sequence
b. You forgot to insert a eukaryotic control sequence
c. You forgot to insert a prokaryotic control sequence

10. Proteins that control gene transcription bind to DNA

a. By unwinding a portion of the helix and binding to the bases in DNA
b. By hydrogen bonding to the deoxyribose residues and the bases linked to them
c. By hydrogen bonding to atoms in the bases exposed in the major groove
d. The binding to DNA is sequence specific
e. c and d apply

11. A particular set of "leucine zipper" regulatory proteins is composed of three different chains A, B, C. Each can form homodimers or heterodimers with other chains in the set. How many <u>different</u> DNA sequences can this family of regulatory proteins recognize?

a. 3
b. 5
c. 6

12. In bacteria for a pathway involved in the synthesis of a molecule, for example an amino acid, or the degradation (metabolism) of a molecule for example a sugar, you expect all the enzymes <u>unique</u> to that function (i.e. not shared by other metabolic sequences to be

a. Coded by a separate mRNA
b. Coded by a polycistronic mRNA

13. Before the eukaryotic RNA polymerase II initiates transcription the enzymes is phosphorylated by transcription factors at specific serine residues. The role of this phosphorylation is

a. To alter the charge of the RNA polymerase II
b. To bind to the small ribosomal subunit
c. To bind enzymes that processes the initial RNA transcripts to mature mRNA

14. The acetylation of histones in the nucleosome generally

a. Promotes (facilitates) gene transcription
b. Blocks gene transcription

15. The presence of multiple methyl cytosine residues in a DNA sequence indicates that it is
a. Transcriptionally silent
b. Transcriptionally active

16. Genetic innovation most frequently is the result of

a. Mutation
b. Gene duplication
c. Exon shuffling
d. All apply

17. The origin of the different hemoglobin chain most likely is the result of

a. Horizontal gene transfer
b. Mutation followed by gene duplication
c. Gene duplication followed by independent evolution (mutation) of the duplicated genes

18. Exon shuffling can be the result of

a. Transposon
b. Unequal crossing over
c. Both can apply

The next two questions are related

19. You compare the genomic sequence and the protein sequence for the enzyme glucokinase in mice, gorillas and humans you expect

a. The greatest divergence in the protein sequence
b. The greatest divergence in the exons
c. the greatest divergence in the introns

20. You expect for the system in the previous question the divergence in the exon sequence to

a. Always result in an amino change in the protein
b. Rarely result in an amino acid change in protein

21. Differential splicing is controlled by tissue specific proteins that bind to sequences in introns and/or exons

a. True
b. False

22. When a cell converts a mRNA to a double stranded RNA/RNA its most likely fate is

a. Cleavage by DICER
b. Insertion into genome by reverse transcriptase
c. None of the above

23. Small interfering RNA's can

a. In some case prevent mRNA translation
b. In other case target the mRNA to destruction
c. Both apply

The next two questions are related

24. The diagram shown below indicates a set of potential sites for the regulations of the concentration of a specific protein in cells. Which of the following best identifies the sites in prokaryotes?

Using the same diagram and descriptions, which applies in eukaryotes

The next two questions are related

25. You link a 100 nucleotide DNA sequence that precedes the beginning of transcriptions of the β-gal operon in E.coli to the gene for serum albumen and introduce the construct into E.coli. You measure the presence of an RNA transcript of the albumen gene under a variety of conditions and expect (think carefully and pick the best answer)

a. You find the RNA under all conditions i.e. transcription is constitutive
b. You only find the RNA in cells exposed to lactose
c. You only find the RNA in cells exposed to lactose in the absence of glucose
d. The cells never make the RNA

26. In the same experiment you, examine the cells for their ability to make serum albumen. Using the selection described in question 4 and which would apply
a, b, c or d

27. Histones (pick the best answer)

a. Simply provide a scaffold to package DNA
b. Histones can control the availability of DNA for transcription
c. Modified histones can enhance or inhibit the transcription of specific genes
d. Histones can be modified by acetylation and methylation
e. c and d apply

The next two questions are related

28. You travel to Iceland and you test the comelulion of the presence of a particular RFLP (restriction fragment length polymerphism) with the development of prostate cancer, and find such a correlation in their population. You conclude from these

    a. The RFLP identifies the gene responsible for prostate cancer
    b. The RFLP may be closely linked on the same chromosome with a gene that increases the probability to develop prostate cancer

29. You pursue this further and using DNA arrays representing 15,000 human genes, find that a mutation in a particular gene is present in all members of several families who develop prostate cancer, but may individuals develop prostate cancer in other families without any mutation in these genes. Your likely conclusion is

    a. The correlation between the mutation and prostate cancer is fortuitous
    b. Prostate cancer can arise in different ways and the probability of developing this cancer is increased by the mutation your identified

The next two questions are related

30. You want to develop a "genetic cure" for a decease that is the result of a mutation in one specific gene. You clone the gene and insert it into a retrovirus which has also been engineered to not reproduce in human cells but can infect these cells. The inserted sequence should minimally include

    a. The full sequence of the gene including introns and exons
    b. A binding site for transcription factors and RNA polymerase
    c. The full set of regulatory sequences for tissue specific expression of the gene
    d. a and c apply
    e. a, b and c apply

31. You did the experiment in the previous question in cells in tissue culture and it seems to work. You want to proceed to human trials, and a young and inexperienced officer at the FDA gives you permission to do so. Five individuals are infected with your virus; all show clear indications of function of normal gene. You are happy and excited unfortunately within first year, two individuals develop tumors each in a different organ. Further, the FDA officer is fired; you are embarrassed and think back to BIO 255. This sad result is most likely due to

    a. The oncogenic effect of any viral infection
    b. The accidental insertion of your virus into a region of the genome where it could initiate formation by altering expressive of other genes
    c. Random events unrelated to your virus

32. The transcription of specific genes in a number of tissues is responsive to the addition of progesterone a steroid homone you expect

    a. The same genes are affected in each tissue
    b. Different genes are affected in each tissue
    c. Both could apply

33. You are concerned about the multiplicity of regulatory proteins that affect gene transcription and the possibility that cellular function may require a number of regulatory proteins that is impossible to achieve. What is the minimum number of regulatory proteins (that affect gene transcription) that could differentially regulate 8 different genes?

    a. 2 regulatory proteins
    b. 3 regulatory proteins
    c. 4 regulatory proteins
    d. 5 regulatory proteins

34. What would your answer be to question 12 if you tried to differentially regulate 15 genes?

    a. 2 regulatory proteins
    b. 3 regulatory proteins
    c. 4 regulatory proteins
    d. 5 regulatory proteins

35. Different proteins contain domains of similar sequence and three dimensional structures they most likely arise over evolutionary time by

    a. Mutation in specific bases
    b. Gene duplication
    c. Exon shuffling

36. When DNA fragments are separated by Gel electrophoresis, the separation of fragments depends primarily on

    a. Size of fragment
    b. The nucleotide sequence of fragment
    c. Both a and b apply

37. A cDNA library from liver compared to muscle will

    a. Consist of totally different DNA sequences
    b. Some common sequences and some different sequences

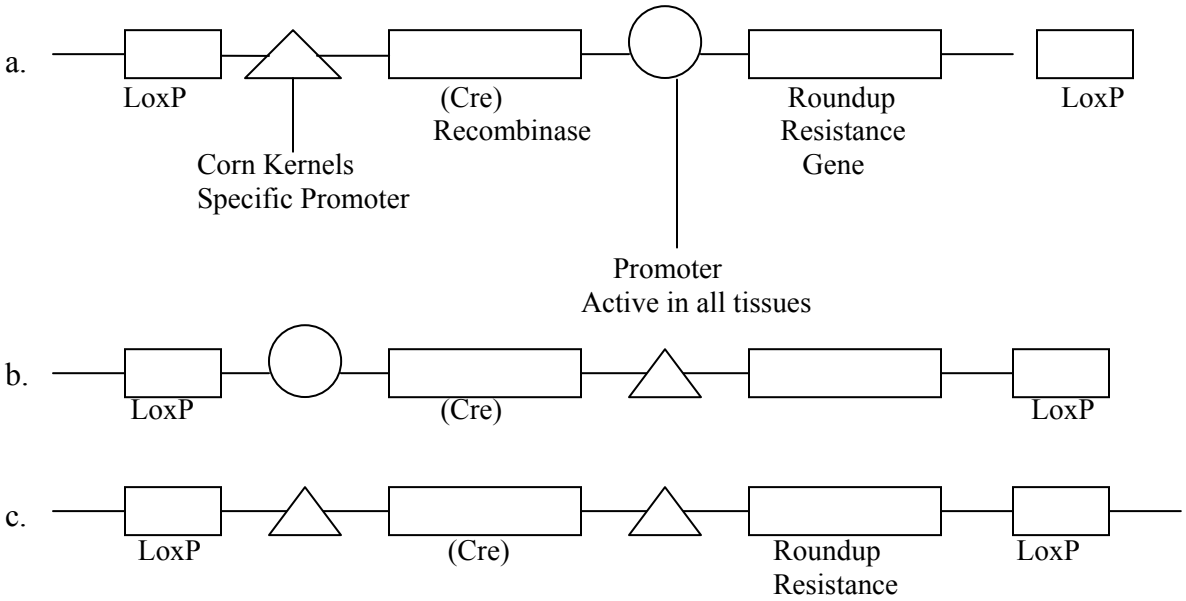
38. The structure in questions 3 are

c. Invariant
d. Subject to modification

39. Imagine that you have a DNA microarray that allows you to identify 20,000 different DNA sequences randomly distributed across the whole human genome. You use this array to measure the abundance of these DNA sequences in human cells growing synchronously i.e. the cells divide at approximately the same time. You expect

a. The concentration of all sequences to increase at the same rate
b. The concentration of some sequences to increase earlier and other later
c. You expect the early sequences to be closer to the origins of replication
d. b and c are correct

40. You wish to create a transgenic plant (corn), resistant to the weed killer Roundup, but do not want to risk the new genes being present in the edible portion of the plant, so that when Glaser eats tortillas he is not exposed to new proteins or genes. Which of the following genes insertions would complete this task? Symbols are the same in all cases.



41. Regulators of transcription in procaryotes and eucaryotes are

a. Always positive regulators, i.e., activate transcription
b. Are always negative regulators
c. Both types are functional in cells

42. Enhancer sequences are

a. DNA sequences that control DNA replication

b. DNA sequences distant from gene that binds regulatory proteins that control gene expression

43. Higher organisms often contain multiple proteins which have apparently evolved from a common ancestral gene. The most likely origin of these is (for example, hemoglobin)

a. Unequal crossing over
b. Bacterial infections
c. Insertion of enhancer molecules close to the initiation site of gene transcription

44. You have cloned and sequenced all of human chromosome 10. You expect

a. All the coding sequences are on one strand (the same strand of DNA)
b. Both strands of DNA contain coding sequences
c. The exons on both strands of DNA base pair with each other

45. The dideoxy nucleotide method for sequencing DNA is based on

a. The chain termination of DNA polymerase action after a dideoxy nucleotide is incorporated into DNA
b. The separation of DNA molecules that differ in length by one nucleotide
c. The knowledge of the beginning sequence of the DNA to synthesize a primer
d. a and b apply
e. a, b and c apply

The following two questions are related:

46. Two children are born in a hospital at the University of Florida. Since Gators are not careful, the blood samples taken from the two mothers may have been mislabeled and there is a possibility that the parents took home the wrong child. Before alarming anybody, a bright UM graduate suggests a RFLP analysis to see whether she can solve the problem. The results with a probe are

Parents A		Child X	Parents B		Child Y
Mother	Father	They took home	Mother	Father	They took them
_____		_____		_____	_____
	_____			_____	_____
_____	_____	_____	_____		

a. Child X does not belong to Parents A
b. Child Y does not belong to Parents B
c. One child could belong to either parent
d. a and b are correct
e. a and c are correct

47. The experiment in question 24 was repeated using a different probe for a different region of the genome. (Think carefully)

a. The new probe can confirm or negate the positive identification of the parents of either child
b. If the probe used in question 24 leads to the conclusion that a child can not belong to a particular set of parents, can the new probe reverse the conclusion
c. a and b apply
d. The question can not be answered

48. The sequence cleaved by the enzyme Ha. III is:

--- GG __ CC---
--- CC __ GG---

Using a probe for a portion of the sequence of the gene for Malterase you obtain the following result in normal and mutant lives cells, after cleanage of DNA, electrophonesis and assay with the probe and find

	Normal	Mutant
base pairs 103	_____	_____

. DNA sequencing shows a single base change Malterase and find a single amino acid has been changed. Using the genetic code can you distinguish which of the following alternatives is incoming

a. Glycine – Arginine
b. Proline – Isoleucine
c. Proline – Thréonine

50. In procaryotes the synthesis of enzymes required to make essential amino acids/vitamins/sugars depends on the availability of these in the fluid in which cells grow. Repressors are best described as

a. Proteins that control nutrient uptake by cells
b. Proteins that bind to DNA at promoter regions, dependent on concentration of specific ligands in cells, for example, an amino acid
c. Are a component of RNA polymerase

51. Each eucaryotic gene is controlled by

a. Single regulatory protein
b. Multiple regulatory proteins
c. Both may apply

52. A given regulatory protein may

a. Control expression of a single gene
b. Can control expression of multiple genes

53. The statement, "The expression of each gene is controlled by the sum of the positive and negative regulatory proteins that affect this gene," is

a. Correct
b. False

54. A number of proteins contain motifs (sequences) which repeat two or more times. These arose most likely during evolution by

a. Exon shuffling
b. Mistakes in DNA synthesis
c. Homologous recombination
d. a and b apply
e. a and c apply

55. Higher organisms often contain multiple proteins which have apparently evolved from a common ancestral gene. The most likely origin of these is (for example, hemoglobin)

a. Unequal crossing over
b. Bacterial infections
c. Insertion of enhancer molecules close to the initiation site of gene transcription

56. The life cycle of a retrovirus

a. Requires functional DNA repair enzymes
b. Requires functional reverse transcriptase
c. host cell RNA polymerase
d. a and b apply
e. b and c apply

57. Homologous recombination cell occur between DNA molecules which at the site of recombination

    a. Have highly different nucleotide sequences
    b. Identical or nearly identical nucleotide sequences

58. The site of mRNA splicing (i.e., removal of introns) occurs at

    a. Exon/intron junctions
    b. Within exon coding sequence
    c. At precise nucleotide sequences
    d. a and c apply
    e. b and c apply

59. Restriction enzymes cleave DNA

    a. At random sites
    b. At unique sequences
    c. The sequence at the site is often a palindrome
    d. a and c apply
    e. b and c apply

60. When DNA fragments are separated by Gel electrophoresis, the separation of fragments depends primarily on

    a. Size of fragment
    b. The nucleotide sequence of fragment
    c. Both a and b apply

The next two questions are related

61. You clone the portion of mouse DNA that codes for the enzyme hexokinase (involved in glycolysis) as well as a small portion of adjacent DNA. You sequence a portion of this DNA and you use it to identify clones for the same DNA region (coding for hexokinase) from pig/human/horses/baboons using hybridization and a radioactive oligonucleotide with the mouse sequence as a probe. In order to accomplish this you hybridize the protein to your clones at

    a. High stringency
    b. Low stringency
    c. It does not matter, either will work

62. Having obtained clones for the gene for hexokinase from mouse/pig/horse/ baboon/human, you examine their pattern of cleavage by restriction enzymes. You expect

a. The pattern to be totally different
b. The pattern of cleavage of baboon and human genes to be more similar than mouse and human
c. The pattern of cleavage of baboon and human genes to be as different from each other as mouse and human

63. You completely sequence the hexokinase genes from all species and you compare the sequence not only at nucleotide level but also of the protein (i.e., hexokinase) for which they code. You expect

a. More divergence in introns than in exons
b. Less divergence in introns than in exons
c. The amino acid sequence of protein to be more related than nucleotide sequence
d. a and c apply
e. b and c apply

64. The dideoxy nucleotide method for sequencing DNA is based on

a. The chain termination of DNA polymerase action after a dideoxy nucleotide is incorporated into DNA
b. The separation of DNA molecules that differ in length by one nucleotide
c. The knowledge of DNA sequence to synthesize a primer
d. a and b apply
e. a, b and c apply

65. You wish to clone the gene for red hair, so everyone can look like Luis Glaser. You determine a partial amino acid sequence of a protein that determines hair color as

Ala-Phy-Gly-Gly-Leu

and after looking up the genetic code (attached), you synthesize an oligonucleotide probe to identify the gene from a genome library. The oligonucleotide that you synthesize has the sequence

GCC-UUC-GGU-GGG-UUA

and you fail to find after five years of work any sign of the gene. You should have

a. Come to class more often
b. Synthesized a series of random oligonucleotides
c. Synthesized all possible oligonucleotides that can code for the amino acid sequence above

66. A cDNA library differs from a genomic DNA library because

a. It is less complex
b. The coding sequence is intact
c. It requires reverse transcriptase in its preparation
d. All the above apply

67. The polymerase chain reaction requires the following components

a. Deoxyribonucleoside triphosphates, DNA polymerase
b. A primer oligonucleotide and DNA ligase
c. Two different primer oligonucleotides
d. a and b apply
e. a and c apply

68. DNA fingerprinting detects differences between individuals by

a. Determining nucleotide sequence of several genes
b. Determining the sites of cleavage of DNA by restriction enzymes
c. Determining the length of DNA fragments resulting from cleavage by specific restriction enzymes using sequence specific probes

69. Chromosome walking allows us to identify gene sequences for genetic diseases by

a. Successively sequencing DNA starting at remote site
b. Determining binding of fluorescent DNA to chromosomes
c. Examining the DNA sequence of wild type (normal) and mutated (disease) chromosomes for consistent differences
d. a and b apply
e. a and c apply

70. A cDNA library from liver compared to muscle will

a. Consist of totally different DNA sequences
b. Some common sequences and some different sequences

71. You clone a DNA fragment in a plasmid using EcoRi cleavage of the plasmid. This DNA is expressed in E.coli. It codes for an enzyme in amino acid metabolism. You have no amino acid sequence or DNA sequence for this gene but you wish to obtain the DNA sequence. You have a full DNA sequence of the original plasmid. The restriction map for plasmid with this gene inserted is

____ original plasmid

inserted gene

Hind III Not 1

EcoRi EcoRi

In order to sequence this DNA you would release gene from plasmid with

a. EcoRi
b. Hind III
c. Not 1
d. Any will work
e. b and c will work

72. A mutation removes three successive nucleotides from the coding region of a gene (think very carefully). The most likely effect is

a. The gene codes for a shorter protein
b. The gene does not code for a functional protein

73. A particular cell type can potentially utilize 3 different regulatory proteins that control gene expression to generate different phenotypes by utilizing any possible combination of these proteins from 0 to 3. How many potential phenotypes can arise?

a. 3
b. 6
c. 8
d. none of the above

74. For the expression of a eucaryotic protein in a procaryotic (bacterial) cell, using a plasmid, the plasmid needs minimally to have DNA sequences that code for

a. An origin of DNA replication, a procaryotic ribosome binding site, a procaryotic promoter
b. A complete copy of the eucaryotic gene coding for the protein
c. A complete copy of the cDNA for the protein
d. a and b apply
e. a and c apply

75. Consider the following restriction fragment length polymorphism detailed by hybridization to a DNA probe after digestion of human DNA with a restriction enzyme

	Parents A		Parents B		Infant	Infant
	Father	Mother	Father	Mother	X	Y
(–)						
			—		—	
	—	—		—		—

— — —

— — — —

(+) _____

Think carefully, based on this evidence alone

a. Infant X is the child of Parents B
b. Infant Y is the child of Parents A
c. One infant is the child of neither Parents A or B
d. a and c apply
e. b and c apply

76. Exons can move over evolutionary time to new locations in the genome. This is likely due to

a. Bacterial infections
b. Transposons
c. Chemically induced mutations

77. To create a transgenic cow that would synthesize a human protein in milk, you would

a. Inject total human DNA into the mammary gland
b. Select embryonal stem cells (ES) transfected with human gene under control of a promoter expressed in all somatic cells
c. Select ES cells transfected with a human gene under control of a DNA sequence specific for proteins secreted in milk such as lactalbumin and transfer these cells to early blastulas
d. None of the above

78. A cDNA library is prepared from muscle cells and liver cells. You expect the genes found in these two libraries to be

a. The same
b. Partially overlapping
c. Totally different

79. Reverse transcriptase is an enzyme that transcribes RNA into DNA. Its normal substrate is the RNA genome of a retrovirus. The DNA is then incorporated into host cell genome as part of the normal life cycle of a retrovirus. You expect this DNA to (think carefully)

a. Have introns and exons
b. Have only exons

MEMBRANES AND

1. The lipid molecules in a cell membrane are

   a. Equally distributed in the two leaflets of the bilayer
   b. Each leaflet has a different composition

2. The formation of tight junctions between cells allows the cell to have

   a. Two areas in the surface membrane of different composition
   b. The exchange of molecules between cells

3. The entry and exit of proteins from the nucleus is

   a. By simple diffusion through nuclear pores
   b. Restricted to proteins that have an import or export signal

4. The Ran proteins helps to control the import and export of proteins from the nucleus, in order to accomplish this (pick the best answer)

   a. It is phosphorylated by a Kinase
   b. It alternates between a form that has bound GTP and a form that has bound GDP
   c. It binds to proteins that have an import signal

5. Cells strive to maintain an optimal concentration of cholesterol in their membranes. To accomplish this they

   a. Have a protein that controls transcription of the enzymes involved in cholesterol biosynthesis and which binds cholesterol
   b. They have a protein in the endoplasmic reticulum that degrades cholesterol
   c. They have a protein complex in the endoplasmic reticulum that is released and travels to the Golgi when cholesterol levels are low
   d. The protein complex in the Golgi is cleaved and a proteolytic fragment controls transcription of cholesterol biosynthetic enzymes

6. Nitric oxide is a local mediator between cells is derived from

a. Aspartic acid
b. Arginine
c. Oxidation of ammonia

7. Could nitric oxide function as a hormone for example, insulin, glucagon, etc. which affect tissues distant from the site of synthesis (pick the best answer)

a. Yes
b. No
c. No, because it decays rapidly

8. The classical experiments of E. Sutherland led to the discovery that

a. cAMP directly activates glycogen phosphorylase
b. cAMP acts by activation of a protein kinase
c. cAMP only acts in liver cells to activate glycogen degradation

9. Caffeine is an inhibitor of cAMP phosphodiesterase. Would you expect that it

a. Inhibits the effect of low concentrations of ACTH on the adrenal cortex resulting in cortisol secretion
b. Stimulates the effect of low concentration of ACTH on the adrenal cortex resulting in cortisol secretion

10. A variety of receptors bind hormones or cytokines that activate phosphorylation of tyrosine residues in protein. This phosphorylation is

a. Always of the hormone/cytokine receptor
b. Sometimes is of the other proteins that bind to the receptor

11. By genetic engineering techniques you generate a mutant receptor for EGF in which one of the 3 tyrosines normally phosphorylated upon addition if EGF to a cell has been replaced by phenylalanine. You expect:

a. All the effects of EGF on cells that contain this altered receptor to be abolished
b. Some of the effects of EGF on cells that contain this altered receptor to be abolished

12. Which of the following statements is correct regarding ATP driven pumps?

a. The only ATP driven pump is the Na^+/K^+ ATPase
b. Eucaryotic cells contain a variety of ATP driven pumps including Na^+/K^+ ATPase, Ca^{++} ATPase and H^+ ATPase
c. All ATP driven pumps are in the cytoplasmic membrane
d. b and c are correct

13. Cellular membranes are best described as

    a. Lipid bilayers that separate two aqueous compartments
    b. A fluid lipid bilayer containing multiple lipids and proteins
    c. A hydrophobic environment which allows proteins to move
    d. All apply

14. Some proteins form pores that allow entry or exit of hydrophilic (water soluble) molecules from cellular compartments. You expect such proteins to traverse membranes

    a. Once
    b. Twice
    c. Multiple times

15. Which of the following statements is correct?

    a. The main function of lysosomes is generation of ATP
    b. Lysosomes are an acidic compartment of cells
    c. Lysosomes degrade a number of different cellular components
    d. a and c are correct
    e. b and c are correct

16. The synthesis of most membrane proteins in cells is best described as

    a. Initiated in the endoplasmic reticulum (ER)
    b. Requires a signal sequence
    c. Some mitochondrial proteins are synthesized in the cytoplasm and others in the mitochondria
    d. All of these statements are correct

17. The signals that direct proteins to endoplasmic reticulum (ER) are

    a. Always at the amino terminal of the protein
    b. Some signals are at amino terminal, others are internal
    c. Internal signal sequences do not occur in secreted proteins only membrane proteins
    d. b and c apply

18. The docking of a vesicle at the target membrane is

    a. Sufficient to cause membrane fusion
    b. Requires additional proteins that cause membrane fusion
    c. Requires GTP
    d. a and c apply
    e. b and c apply

19. Could nitric oxide function as a hormone for example, insulin, glucagon, etc. which affect tissues distant from the site of synthesis (pick the best answer)

    a. Yes
    b. No
    c. No, because it decays rapidly

20. The classical experiments of E. Sutherland led to the discovery that

    a. cAMP directly activates glycogen phosphorylase
    b. cAMP acts by activation of a protein kinase
    c. cAMP only acts in liver cells to activate glycogen degradation

21. A variety of receptors bind hormones or cytokines that activate phosphorylation of tyrosine residues in protein. This phosphorylation is

    a. Always of the hormone/cytokine receptor
    b. Sometimes is of the other proteins that bind to the receptor

22. By genetic engineering techniques you generate a mutant receptor for EGF in which one of the 3 tyrosines normally phosphorylated upon addition of EGF to a cell has been replaced by phenylalanine. You expect:

    a. All the effects of EGF on cells that contain this altered receptor to be abolished
    b. Some of the effects of EGF on cells that contain this altered receptor to be abolished

23. The lipid molecules in a cell membrane are

    a. Equally distributed in the two leaflets of the bilayer
    b. Each leaflet has a different composition

24. Cellular membranes are best described as

    a. Lipid bilayers that separate two aqueous compartments
    b. A fluid lipid bilayer containing multiple lipids and proteins
    c. A hydrophobic environment which allows proteins to move
    d. All apply

25. Which of the following statements is correct regarding ATP driven pumps?

    a. The only ATP driven pump is the Na^+/K^+ ATPase
    b. Eucaryotic cells contain a variety of ATP driven pumps including Na^+/K^+ ATPase, Ca^{++} ATPase and H^+ ATPase
    c. All ATP driven pumps are in the cytoplasmic membrane
    d. b and c are correct

26. Some proteins form pores that allow entry or exit of hydrophilic (water soluble) molecules from cellular compartments. You expect such proteins to traverse membranes

    a. Once
    b. Twice
    c. Multiple times

27. The concentration of amino acids in liver cells is generally higher than in extracellular fluid. Is the presence of ouabain which inhibits Na^+/K^+ ATPase you expect to find for the amino acid alanine (Ala)

    a. $Ala_{inside} \leq$ Ala outside
    b. $Ala_{inside} \geq$ Ala outside

28. Gatorade is a bad tasting mixture of glucose and NaCl, very effective in restoring glucose to the body. You attempt to improve the taste of gatorade by replacing NaCl with either NH_4Cl or KCl, and neither works. you consult a student well trained in BIO 255 who explains to you that

    a. NaCl is required to match the Na^+ concentration in blood
    b. NaCl facilitates the exit of glucose into blood stream from intestinal epithelial cells
    c. NaCl is required for glucose transport into intestinal epithelial cells

29. Which of the following statements is correct?

    a. The main function of lysosomes is generation of ATP
    b. Lysosomes are an acidic compartment of cells
    c. Lysosomes degrade a number of different cellular components
    d. a and c are correct
    e. b and c are correct

30. The synthesis of most membrane proteins in cells is best described as

    a. Initiated in the endoplasmic reticulum (ER)
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    c. Some mitochondrial proteins are synthesized in the cytoplasm and others in the mitochondria
    d. All of these statements are correct

31. The signals that direct proteins to endoplasmic reticulum (ER) are

    a. Always at the amino terminal of the protein
    b. Some signals are at amino terminal, others are internal

c. Internal signal sequences do not occur in secreted proteins only membrane proteins
d. b and c apply

32. The docking of a vesicle at the target membrane is

a. Sufficient to cause membrane fusion
b. Requires additional proteins that cause membrane fusion

33. Many proteins in membranes as well as secreted proteins contain covalently linked carbohydrate

a. This carbohydrate is linked to protein in the Golgi stack
b. Carbohydrate is linked to protein in ER and modified in Golgi stack

34. Misfolded proteins in endoplasmic reticulum (ER) are

a. Always secreted
b. Degraded in ER
c. Degraded in cytoplasm

35. You expect the pH in trans Golgi to be relative to ER

a. $pH_{Golgi} < pH_{ER}$
b. $pH_{Golgi} > pH_{ER}$

36. After endocytosis, the LDL receptor

a. Returns to cytoplasmic membrane
b. Is degraded

37. Which of the following statements is correct?

a. All endocytic vesicles deliver their content into lysosomes
b. Some endocytic vesicles deliver their content to lysosomes, others move content to other areas of the cell surface
c. Neither statement is correct

38. You chemically synthesize a gene which at its 5' end has the sequences from the gene coding for pepsin, a secreted protein, and the remainder of the sequences is that of enolase, a cytoplasmic protein. You insert the DNA into cell and the gene is expressed. You expect the hybrid protein to be found in

a. Mitochondria
b. Cytoplasm
c. Lysosomes

d. Secreted

39. Steroid hormones, for example cortisone, control gene transcription by

a. Intercalating in DNA and distorting the helix
b. Binding to a specific steroid binding protein that acts as an RNA polymerase
c. Binding to a specific steroid binding protein that binds to an enhancer sequence for steroid sensitive genes

40. The cytoplasmic membrane of eucaryotic cells contains glycoproteins and glycolipids. You expect the carbohydrate portion of these molecules to be primarily

a. Facing the inside of the cell
b. Facing the outside of the cell
c. Both

41. Flipases are proteins that "flip" lipids between the two leaflets of the bilayers. Do you believe that in the case of the cytoplasmic membrane this results in

a. Equal distribution of lipid classes between the two leaflets
b. A non-random distribution of lipid classes between the two leaflets

42. It is believed that mitochondria originated from

a. Aerobic bacteria
b. Anaerobic bacteria

43. Complex carbohydrates are covalently linked to many proteins on asparagine residues. Which of the following statements is correct?

a. The carbohydrates are built by adding one sugar residue at a time to the protein in the ER
b. The carbohydrates are preassembled on a lipid (dolichol) and then transferred to protein in the ER

44. Some proteins form pores that allow entry or exit of hydrophilic (water soluble) molecules from cellular compartments. You expect such proteins to traverse membranes:

a. Once
b. Twice
c. Multiple times

45. The entry and exit of proteins from the nucleus is

a. By simple diffusion through nuclear pores
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46. The Ran proteins helps to control the import and export of proteins from the nucleus, in order to accomplish this (pick the best answer)

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    b. It alternates between a form that has bound GTP and a form that has bound GDP
    c. It binds to proteins that have an import signal

47. Cells strive to maintain an optimal concentration of cholesterol in their membranes. To accomplish this they

    a. Have a protein that controls transcription of the enzymes involved in cholesterol biosynthesis and which binds cholesterol
    b. They have a protein in the endoplasmic reticulum that degrades cholesterol
    c. They have a protein complex in the endoplasmic reticulum that is released and travels to the Golgi when cholesterol levels are low
    d. The protein complex in the Golgi is cleaved and a proteolytic fragment controls transcription of cholesterol biosynthetic enzymes

48. When phosphatidyl ethanolamine is present in a lipid bilayer you expect the ethanolamine to be

    a) At the center of the bilayer
    b) In the aqueous phase

49. Where two cells are fused, after a short period of time you expect

    a) All membrane proteins are now randomly distributed
    b) Some membrane proteins are constrained from free diffusion

50. Some proteins form pores that allow entry or exit of hydrophilic (water soluble) molecules from cellular compartments. You expect such proteins to traverse membranes

    a) Once
    b) Twice
    c) Multiple times

51. Gatorade is a bad tasting mixture of glucose and NaCl, very effective in restoring glucose to the body. You attempt to improve the taste of gatorade by replacing NaCl with either NH_4Cl or KCl, and neither works. you consult a student well trained in BIO 255 who explains to you that

    a) NaCl is required to match the Na^+ concentration in blood
    b) NaCl facilitates the exit of glucose into blood stream from intestinal epithelial cells
    c) NaCl is required for glucose transport into intestinal epithelial cells

52. In a cell under physiological conditions activation of the Na^+/H^+ antiport will

a) Increase cellular pH (i.e., cell becomes alkaline)
b) Decrease cellular pH (i.e., cell becomes more acid)
c) The question cannot be answered

53. The synthesis of most membrane proteins in cells is best described as

a) Initiated in the endoplasmic reticulum (ER)
b) Requires a signal sequence
c) Some mitochondrial proteins are synthesized in the cytoplasm and others in the mitochondria
d) All of these statements are correct

54. Helicase is required for DNA replication. It:

a) Unwinds the DNA helix
b) Unwinds the DNA helix in an ATP dependent manner
c) Neither statement is correct

55. The origin during evolution of various cellular membranes and organelles in eucaryoties has been subject of much debate. Based on current thinking you would expect:

a) Mitochondrial ribosomes to resemble procaryotic ribosomes
b) Cytoplasmic ribosomes in eucaryotic cells to resemble procaryotic ribosomes.

56. In order for a symport to function the change of orientation of the binding site for the ligands occurs:
a. When either of the binding site is occupied
b. When no binding site is occupied
c. When both sites are occupied
d. a and c apply
e. b and c apply

57. The origin during evolution of various cellular membranes and organelles in eucaryoties has been subject of much debate. Based on current thinking you would expect:

a. Mitochondrieal protein ribosomes to resemble procaryotic ribosomes
b. Cytoplasmic ribosomes in eucaryotic cells to resemble procaryotic ribosomes.

58. Procaryotic cells do not have an endoplasmic reticulum. Considering the presumed evolutionary origin of the endoplasmic reticulum, when you synthesize a protein in E.coli that is normally secreted by liver cells using a complete cDNA for this protein in an expression vector you expect this protein

a. to accumulate in E.coli cells
b. to be degraded
c. to be secreted into growth medium

59. Children born with I cell disease lack the ability to phosphorylate mannose residues in glycoproteins destined to go to lysosomes. Think carefully. Would you expect the lysosomal enzymes to:

a. Remain in the ER
b. Be secreted by cells
c. Degrade the trans Golgi

60. Procaryotic cells do not have an endoplasmic reticulum. Considering the presumed evolutionary origin of the endoplasmic reticulum, when you synthesize a protein in E.coli that is normally secreted by liver cells using a complete cDNA for this protein in an expression vector you expect this protein
a. to accumulate in E.coli cells
b. to be degraded
c. to be secreted into growth medium

61. An inhibitor blocks the removal of glucose from N-linked oligosaccharides in the endoplasmic reticulum. When you add this inhibitor to cells you expect the movement of glycoproteins to the Golgi (pick best answer)
a. be enhanced
b. be inhibited
c. be inhibited and the protein degraded.

62. The effect of cholesterol on a lipid bilayer is to

a. Make it more fluid
b. Restrict mobility

63. The region of a membrane protein that traverses the lipid bilayer is usually arranged on

a. An extended chain of amino acids
b. An α helix
c. A pleated sheet

64. When phosphatidyl ethanolamine is present in a lipid bilayer you expect the ethanolamine to be

a. At the center of the bilayer
b. In the aqueous phase

65. Where two cells are fused, after a short period of time you expect

a. All membrane proteins are now randomly mixed
b. Some membrane proteins are constrained from free diffusion

66. Tight junctions

a. Promote movement of proteins in membranes
b. Restrict movement of proteins in membranes

67. Membrane proteins that bind to the extracellular matrix are usually

a. Transmembrane proteins
b. Highly restricted in their mobility
c. a and b apply

68. Ouabain inhibits Na^+/K^1 ATPase. After treatment of cells with ouabain you expect

a. K^+ inside = K^+ outside
b. K^+ inside > K^+ outside
c. K^+ inside < K^+ outside

69. The concentration of amino acids in liver cells is generally higher than in extracellular fluid. Is the presence of ouabain which inhibits Na^+/K^+ ATPase you expect to find for the amino acid alanine (Ala)

a. $Ala_{inside} \leq$ Ala outside
b. $Ala_{inside} \geq$ Ala outside

70. Glucose and mannose are monosaccharides of identical size (Mol wt. 180) yet glucose readily enters muscle cells and mannose does not. The concentration of glucose in the intracellular fluid (cytoplasm) is never higher than in extracellular fluid and often lower. Based on these observations, you expect glucose entry into muscles to be

a. Via a pore
b. By a glucose specific carrier
c. by a Na^+/glucose cotransporter (symport)

71. Active transport is the movement of molecules across a membrane against its concentration gradient. Cells have evolved several mechanisms to accomplish this. Which of the alternatives below describe these mechanisms?

a. A GTP driven glucose transport system and a light driven pump
b. Light driven pumps, ATP driven pumps and coupled transporters
c. ATP driven transport of sugars, and ion driven transport of amino acids
d. All are correct

72. The Na^+/K^+ ATPase is best described as

a. A protein that alternates between a phosphorylated and dephosphorylated state
b. A protein which alternatively bind Na^+ or K^+
c. A protein that simultaneously binds Na^+ and K^+
d. a and b apply
e. a and c apply

73. In a cell under physiological conditions activation of the Na^+/H^+ antiport will

a. Increase cellular pH (i.e., cell becomes alkaline)
b. Decrease cellular pH (i.e., cell becomes more acid)
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c. All ATP driven pumps are in the cytoplasmic membrane
d. b and c are correct

75. Which of the following statements is correct?

a. The main function of lysosomes is generation of ATP
b. Lysosomes are an acidic compartment of cells
c. Lysosomes degrade a number of different cellular components
d. a and c are correct
e. b and c are correct

76. Mitochondria are closely related to

a. Retroviruses
b. Transposones
c. Procarycotes

77. A "stop transfer" sequence is required to

a. Transfer proteins from cytoplasm to lumen of endoplasmic reticulum
b. to insert nascent membrane proteins into lipid bilayers

78. The signals that direct proteins to endoplasmic reticulum (ER) are

a. Always at the amino terminal of the protein
b. Some signals are at amino terminal, others are internal
c. Internal signal sequences do not occur in secreted proteins only membrane proteins

d. b and c apply

79. Proteins move between cellular compartments

a. By vesicular traffic
b. Movement is determined by specific amino acid sequences
c. Both a and b apply

80. The docking of vesicles at targets requires

a. v-Snares
b. t-Snares
c. v-Snares and t-Snares that are complementary and bind to each other

81. Many proteins in membranes as well as secreted proteins contain covalently linked carbohydrate

a. This carbohydrate is linked to protein in the Golgi stack
b. Carbohydrate is linked to protein in ER and modified in Golgi stack

82. Movement of protein between cis, medial and trans Golgi is

a. Random
b. Via vesicular transport
c. Directional from cis to trans Golgi
d. a and b apply
e. b and c apply

83. Proteins that are destined to the cytoplasmic membrane are oriented in the Golgi so that the portion of the protein that will face the outside of the cell faces (think carefully)

a. The lumen of the Golgi
b. The cytoplasm around the Golgi

84. Proteins destined for secretory vesicles are expected to

a. Aggregate in trans Golgi
b. Remain soluble in trans Golgi

85. Endocytosis of LDL requires

a. LDL receptor
b. Clathrins
c. Both

86. After endocytosis cytoplasmic membrane proteins are

a. All returned to cell surface
b. Some are returned to cell surface

87. Na^+/H^+ antiport is one of the primary regulators of intracellular pH. When the fluid surrounding a cell contains no Na^+ would you expect the cells cytoplasm

a. To become more acid
b. To become more alkaline

88. Is the statement, "Membrane proteins are associated with the membrane via one or more α-helices."

a. Correct
b. False

89. Some proteins have covalently attached to them fatty acids or more complex lipid molecules. You expect these lipid molecules to be

a. Located in the interior of the protein
b. Located on the surface of the protein
c. Inserted into lipid bilayers
d. a and c apply
e. b and c apply

90. The preferred arrangement of a lipid bilayer (lowest energy) in contact with water is

a. Sheet
b. Helix
c. A closed sphere

91. The asparagine linked carbohydrate residue on mature proteins are

a. Already present on the protein as it exits the ER
b. The result of further modification of the carbohydrate chains as the protein transits through the Golgi

92. Glycoproteins and glycolipids are major constituents of the cytoplasmic membrane of many cells. They

a. Are present on both leaflets of the membrane
b. Are only present on the exterior of the cell
c. Are only present on the interior of the cell
d. Are involved in all recognition and "a" applies
e. Are involved in all recognition and b applies

93. Flipase moves lipids from one side of the bilayer to the other. Its activity is best described as

a. Equalize the lipid composition of both leaflets of the bilayer
b. An enzyme that translocates lipid unidirectionally
c. An enzyme that is lipid class specific
d. a and c apply
e. b and c apply

94. The fluidity of a membrane is reduced by

a. Cholesterol and presence of unsaturated fatty acids
b. Cholesterol and the presence of saturated fatty acid
c. Transmembrane proteins

95. One of the earliest effects of the addition of the hormone to cells is a change in intracellular pH, the cells transiently become more alkaline. You pretreat cells with ouabain to block Na^+/K^+ ATPase and find that this alkalinization of cells is abolished. This observation is

a. Consistent with alkalinization being the result of activation of Na^+/H^+ antiport
b. These results argue against a role of Na^+/H^+ antiport in the alkalinization of these cells

96. Active transport is the movement of molecules across a membrane against its concentration gradient. Cells have evolved several mechanisms to accomplish this. Which of the alternatives below describe these mechanisms?

a. A GTP driven glucose transport system and a light driven pump
b. Light driven pumps, ATP driven pumps and coupled transporters
c. ATP driven transport of sugars, and ion driven transport of amino acids
d. All are correct

1. When glucagon is added to hepatocytes (liver cells) the level of cAMP in these cells is elevated and glucose is released by the cells. Caffeine is an inhibitor of cAMP phosphodiesterase. Do you expect (think very carefully)

a. Caffeine to potentiate the action of glucagon, i.e., small amounts of glucagon become more effective
b. Caffeine to inhibit the action of glucagon
c. Cannot answer based on these facts

2. The binding of ACTH to its receptor in the adrenal cortex results in a large increase in intracellular cAMP. Each ACTH molecule generates many cAMP molecules because (think very carefully)

a. Each receptor can activate many G proteins
b. Each G protein can activate many adenylcyclase molecules
c. Adenylcyclase has high catalytic activity
d. a and c apply
e. b and c apply

3. You return to the study of the hormone receptor in normal cells and decide to measure Ca^{++} levels in the cytoplasm of these cells before and after the addition of hormone. You find that the addition of hormone increases the level of Ca^{++} from 10^{-7}M to 10^{-5}M. You decide to measure the level of phospholipase C activity in these cells and expect to find that after the hormone addition

a. Phospholipase C levels are elevated
b. Phospholipase C levels are reduced
c. Phospholipase C levels are unchanged

4. When glucagon is added to hepatocytes (liver cells) the level of cAMP in these cells is elevated and glucose is released by the cells. Caffeine is an inhibitor of cAMP phosphodiesterase. Do you expect (think very carefully)

a. Caffeine to potentiate the action of glucagon, i.e., small amounts of glucagon become more effective
b. Caffeine to inhibit the action of glucagon
c. Cannot answer based on these facts

5. The binding of ACTH to its receptor in the adrenal cortex results in a large increase in intracellular cAMP. Each ACTH molecule generates many cAMP molecules because (think very carefully)

a. Each receptor can activate many G proteins
b. Each G protein can activate many adenylcyclase molecules
c. Adenylcyclase has high catalytic activity
d. a and c apply
e. b and c apply

6. Upon addition of epidermal growth factor (EGF) to cells, the EGF receptor is phosphorylated at multiple sites on tyrosine residues. This phosphorylation

a. Is irrelevant to signal transduction by EGF
b. Provides sites for activation of other proteins in the cell
c. Each site is specific for a different pathway
d. b and c apply

7. Cyclins are

a. Protein kinases
b. Proteins that control protein kinases
c. Each cyclin only controls one protein kinase
d. b and c apply

8. Programmed cell death (apoptosis) is mediated by

a. Ion leakage from the cell
b. Loss of ATP from mitochondria
c. A series of proteolytic events that destroy cell components

9. In a classical experiment in embryology, the implantation of supernumerary limbs in chick embryos resulted in

a. Neuronal death
b. Survival of more neurons than in a normal embryo
c. No effect on the number of neurons

10. Normal cells stop transit through the cell cycle when DNA is damaged. This process

a. Requires DNA ligase and p53
b. Requires p53 and expression of p21
c. Occurs in S phase
d. a and b apply and results in inactivation of S phase cyclin-CdK
e. b and c apply and results in inactivation of S phase cyclin-CdK

11. Oncogenes act as dominant agents to control cell growth. You expect a mutation in the retinoblastoma gene to behave as a:

a. Dominant mutation
b. Recessive mutation

12. Cancer cells usually arise as a result of

a. A single mutation
b. Multiple mutations

13. An antibody to the EGF receptor (epidermal growth factor) when added to cells, mimics the action of EFG. You isolate very rapidly the EGF receptor from antibody stimulated cells, you expect to find

    a. The receptor is phosphorylated on serine residues
    b. The receptor is phosphorylated on multiple tyrosine residues

14. The G protein consists of 3 subunits, α, β, γ. Which statement is correct?

    a. Only the α subunit is active in signal transduction
    b. The α and βγ subunits are active in signal transduction
    c. Signal transduction can be both stimulatory as well as inhibitory
    d. a and c apply
    e. b and c apply

15. Retinoblastoma protein is a

    a. Positive regulator of cell growth
    b. Negative regulator of cell growth
    c. Is itself controlled by phosphorylation
    d. a and c apply
    e. b and c apply

The next six questions are related

16. You discover a new hormone which stimulates the growth of α-cells of the pancreas which makes glucagon. After much effort, you clone the gene for the hormone and obtain it in large quantities. It codes for a small protein molecule weight of 10,000. You inject the hormone into rats and after several weeks the animals look ill. You measure their blood glucose and find it to be (pick the most likely answer)

    a. High
    b. Low

17. You work very hard to find a receptor for this hormone on α-cells of the pancreas and you identify a protein present on the surface of the α-cells to which the hormone binds. As part of your work you have prepared a series of monoclonal antibodies against this presumed-hormone receptor and find that one of them mimics the action of the hormone, but a monovalent fragment of this antibody has no effect. From your vast knowledge about hormone receptors, you presume that this receptor belongs to a

    a. Family of hormone receptors that increase the level of cAMP in cells
    b. Family of hormone receptors that function as tyrosine specific protein _____ kinases

18. Since your new hormone stimulates cell growth, you examine the level of phosphorylation of the retinoblastoma protein (which is important for the growth of α-cells) eight to ten hours after the addition of hormone to cells and find

    a. The retinoblastoma protein is not phosphorylated
    b. the retinoblastoma protein is phosphorylated

19. You want to better understand how this hormone works and you develop conditions for growing α-cells in a Petri dish in the laboratory. You are however quite careless and you grow your cells in an incubator next door to your dentist, who does a lot of dental X-rays. To your horror you discover that most of your cells have died. You rush over to see your dentist and discover that she forgot to shield her X-ray machine. After two days of crying you return to your laboratory and discover that some of your α-cells have survived, look peculiar, and are growing in the Petri dish. You decide to measure the presence of p53 in these cells and are likely to find

    a. Normal levels of p53
    b. Low or non-functional levels of p53

20. You return to the study of the hormone receptor in normal cells and decide to measure Ca^{++} levels in the cytoplasm of these cells before and after the addition of hormone. You find that the addition of hormone increases the level of Ca^{++} from 10^{-7}M to 10^{-5}M. You decide to measure the level of phospholipase C activity in these cells and expect to find that after the hormone addition

    a. Phospholipase C levels are elevated
    b. Phospholipase C levels are reduced
    c. Phospholipase C levels are unchanged

21. Which of the following statements is correct:

    a. Only the α subunit of the G protein has biological activity when released from the α β complex
    b. The α subunit as well as the Bγ complex have biological activity

22. The interaction of hormones with cells elicit biological responses on a variety of term scales. (Pick the best answer)
    a. changes in the activity of pre-existing enzymes occurs in hours
    b. changes in the activity of pre-existing enzymes occurs in seconds to minutes
    c. Enzyme levels change in minutes
    d. a and c apply
    e. b and c apply

23. Ca^{++} levels in the cytoplasm often occur following the binding of specific hormones to the cell. The source of the Ca^{++} can be:

a. The extracellullar fluid
b. The endoplasmic reticulum
c. Both
d. Neither

24. Which statement is correct? In any given cell type:

a. A given biological response can only be elicited by one hormone
b. Multiple hormones can elicit the same response.

The next two questions are related:

25. Cholera toxin is a protein from Vitorio cholera which covalently modifies a G protein in the intestinal epithelium. You measure CAMP in these cells and find it is elevated.

Which of the following possibilities appear likely:
a. Cholera toxin inactivates the GTPase activity of G Protein
b. Cholera toxin inactivates CAMP phosphocliesterase
c. Both a and b could apply

26. Individuals affected with cholera loose electrolytes and water. Treatment with glucose + Na U increases survival of people affected with cholera but neither alone works. Given your thoughts of why this occurs do you believe that

a. Glucose can be substituted by mannose
b. Na U can be substituted by M U
c. Both a and b would work
d. Neither a nor b would work

27. You develop in the laboratory a new E. coli strain that has a CAP protein that binds to appropriate DNA sequence independent of the concentration of cAMP in the cells. You expect to see β galactosidase synthesis in these cells:

a. Only when cells are grown without glucose
b. Only when cells are grown in the presence of a P - galactoside
c. Both a and b must attain

The next two questions are related:

28. Cholera toxin is a protein from Vibrio cholera, which covalently modifies a G protein in the intestinal epithelium. You measure cAMP in these cells and find it is elevated.

Which of the following possibilities appear likely:

a. Cholera toxin inactivates the GTPase activity of a G Protein
b. Cholera toxin inactivates cAMP phosphodiesterase

c. Both a and b could apply

29. Individuals affected with cholera loose electrolytes and water. Treatment with glucose plus NaCl increases survival of people affected with cholera but neither alone works. Given your ideas of why this occurs do you believe that

a. Glucose can be substituted by mannose
b. NaCl can be substituted by KCl
c. Both a and b would work
d. Neither a nor b would work

30. Steroid hormones, for example cortisone, control gene transcription by

a. Intercalating in DNA and distorting the helix
b. Binding to a specific steroid binding protein that acts as an RNA polymerase
c. Binding to a specific steroid binding protein that binds to an enhancer sequence for steroid sensitive genes

31. In order for a polypeptide hormone to affect a cell's metabolism, the cell must have

a. A nuclear receptor for the protein
b. A cytoplasmic receptor for the protein
c. A receptor on the cytoplasmic membrane

32. When glucagon is added to hepatocytes (liver cells) the level of cAMP in these cells is elevated and glucose is released by the cells. Caffeine is an inhibitor of cAMP phosphodiesterase. Do you expect (think very carefully)

a. Caffeine to potentiate the action of glucagon, i.e., small amounts of glucagon become more effective
b. Caffeine to inhibit the action of glucagon
c. Cannot answer based on these facts

33. Cholera toxin is an enzyme that modifies some G proteins so that their GTPase activity is abolished. When you add cholera toxin to hepatocytes in tissue cultures in the presence of epinephrine (adrenaline) cAMP levels rise in these cells, and remain high even after adrenaline is removed. In this absence of cholera toxin, removal of adrenaline results in an immediate drop in cAMP. If you could examine in these cells the state of the α, β, γ subunits of G protein, would you expect

a. To find most of the G proteins as α, β, γ complex
b. Most of the G protein as α subunit separate from β, γ complex

34. You are given an antibody that allows you to identify the thyroxine receptor and localize it in the cell. You expect to find

a. The receptor in the absence of thyroxine is in the nucleus
b. The receptor in the presence of thyroxine is in the cytoplasm
c. The receptor in the presence of thyroxine is in the nucleus

35. The binding of ACTH to its receptor in the adrenal cortex results in a large increase in intracellular cAMP. Each ACTH molecule generates many cAMP molecules because (think very carefully)

a. Each receptor can activate many G proteins
b. Each G protein can activate many adenylcyclase molecules
c. Adenylcyclase has high catalytic activity
d. a and c apply
e. b and c apply

36. Enzymes can act as on/off switches because

a. Their catalytic activity can be altered by phosphorylation/ dephosphorylation
b. Their activity can be altered by allosteric regulation
c. both a and b are correct

37. ACTH addition to adrenal cortisol cells results in increased production of cAMP and increased synthesis of cortisol. Epinephrine addition to skeletal muscle results in increased production of cAMP but **not** in increased synthesis of cortisol, yet the action of both hormones is mediated by cAMP. Furthermore, ACTH has no effect on muscle cells. These observations reflect the fact that

a. Muscle cells lack the transcription regulators that control synthesis of the enzymes that make cortisol
b. Muscle cells do not have a receptor for ACTH
c. Both a and b apply

38. Upon addition of epidermal growth factor (EGF) to cells, the EGF receptor is phosphorylated at multiple sites on tyrosine residues. This phosphorylation

a. Is irrelevant to signal transduction by EGF
b. Provides sites for activation of other proteins in the cell
c. Each site is specific for a different pathway
d. b and c apply

39. The best description of a cell cycle is

a. A series of random events that culminate in cell division
b. A series of sequential events that culminate in cell division
c. A process with multiple check points
d. a and b apply
e. b and c apply

40. MPF (M/phase promoting factor) is best described as a

    a. Cyclin
    b. Protein kinase
    c. A complex of cyclin and protein kinase
    d. A complex of a specific cyclin and a specific protein kinase

41. Neurons depend for their survival on

    a. Their ability to contact target cells
    b. The release of "survival factors" from target cells
    c. Both a and b apply

42. In a classical experiment in embryology, the implantation of supernumerary limbs in chick embryos resulted in

    a. Neuronal death
    b. Survival of more neurons than in a normal embryo
    c. No effect on the number of neurons

43. Oncogens are

    a. Viral genes
    b. Mutants of cellular genes that alone or in combination cause abnormal cell growth

44. Normal cells stop transit through the cell cycle when DNA is damaged. This process

    a. Requires DNA ligase and p53
    b. Requires p53 and expression of p21
    c. Occurs in S phase
    d. a and b apply and results in inactivation of S phase cyclin-CdK
    e. b and c apply and results in inactivation of S phase cyclin-CdK

45. Which of the following statements is/are correct?

    a. Cells contain one CdK and many cyclins
    b. Cells contain many CdKs and one cyclin
    c. Cells contain multiple CdKs and multiple cyclins that pair at random
    d. Cells contain multiple CdKs and multiple cyclins that form specific pairs

46. Cyclins are

    a. Metabolically stable, i.d., active at all times in the cell cycle
    b. Activated by phosphorylation
    c. Metabolically unstable and targeted for proteolytic degradation

47. The concentration of CdK proteins is

    a. Highly variable during the cell cycle
    b. Constant during the cell cycle

48. Oncogenes act as dominant agents to control cell growth. You expect a mutation in the retinoblastoma gene to behave as a:

    a. Dominant mutation
    b. Recessive mutation

49. Which of the following events are likely to predispose a cell to become a cancer cell

    a. Loss of p53 gene
    b. Loss of DNA repair protein
    c. Decrease in cellular ATP levels
    d. a and c apply
    e. a and b apply

50. Which of the following statements is/are correct?

    a. Cells have a single check point before they enter the cell cycle.
    b. Cells have multiple check points that control progression through the cell cycle
    c. Cell size determines in part whether cells can enter the cell cycle
    d. a and c apply
    e. b and c apply

51. An antibody to the EGF receptor (epidermal growth factor) when added to cells, mimics the action of EFG. You isolate very rapidly the EGF receptor from antibody stimulated cells, you expect to find

    a. The receptor is phosphorylated on serine residues
    b. The receptor is phosphorylated on multiple tyrosine residues

52. Which of the following lists best describe mutations you might expect in a cancer cell?

    a. Constitutive production of a growth factor (example EGF), deletion of a DNA repair enzyme, absence of retinoblastoma gene, Ras proteins with no GTPase activity
    b. Absence of growth factor receptor, deletion of p53, nonfunctional DNA ligase, absence of ubiquitin
    c. Mutation in steroid hormone receptor that activates transcription absence of hormone, deletion of Ras gene, hyperexpression of p21, constitutive expression of CdK

53. Which of the following statements is correct?

    a. The exchange of GDP for GTP in G proteins is spontaneous
    b. The exchange of GDP for GTP in G proteins is the result of the interaction of G protein with other proteins such as hormone receptors

54. Damage to DNA results in arrest of the cell cycle. This process requires (pick the best answer)

    a. Proteolytic degradation of MPF
    b. p53 to activate synthesis of p21
    c. Inhibition of S phase cyclin/CdK complex
    d. a, b and c apply
    e. b and c apply

55. MPF activity rises in a cell in an autocatalytic manner because MPF

    a. Activates itself by proteolysis
    b. Activates a phosphatase that activates MPF
    c. The phosphatase is activated by phosphorylation
    d. a and b apply
    e. b and c apply

56. Adrenaline (epinephrine) causes the degradation of glycogen in liver and skeletal muscles, while glucagon only has this effect in the liver. Knowing that the pathway for glycogen degradation in the liver and muscles involves the same enzymatic reaction, you speculate that the **most** likely reason for this is

    a. Adrenaline can enter both liver and muscle cells, but glucagon only liver cells
    b. Liver and muscle have epinephrine receptors but only liver has glucagon receptors
    c. Muscle degrades glucagon and liver does not

57. A mutation in G protein makes its affinity for GDP very low either in the presence and absence of a hormone receptor. You expect cAMP in cells with this G protein to be

    a. High
    b. Low

58. Receptor tyrosine kinase when activated by a signal molecule are phosphorylated on some of their own tyrosine residues. A mutant form of such a receptor has two of these tyrosine residues replaced by phenylalanine while a third is still present. You expect

    a. This mutation silent, i.e., the receptor is still fully functional
    b. The receptor is non-functional

c. The receptor can activate some but not all of the metabolic pathways it normally activates

Additional questions added on Fall Semester of 2005

1. You treat human fibroblast in culture with an inhibitor of the glucosidase that removes 2 glucose residues from the glicosilated protein. You expect:
   a) Glycosylated proteins to be secreted
   b) Glycosylated proteins to go to the lysosomes
   c) Glycosylated proteins to remain in the ER

2. A mutant protein normally present in the ER lacks the KDEL signal (Lys, Asp, Gluy. Leu).As a result, the protein (pick the best answer):
   a) Is absent from ER
   b) Does not return from the Golgi to the ER, thus XXX the amount available in the ER
   c) Is degraded in lysosomes

3. The import of proteins into the nucleus:
   a) Requires RAN protein ATP and a specific transporter
   b) Requires RAN protein GTP ans a specific transporter
   c) The protein must have a nuclear import sequence
   d) a and c apply
   e) b and c apply

4. The nuclear pores are openings which:
   a) Allow cell proteins to move in and out of the nucleus
   b) Allow specific proteins with appropriate signal sequences to move either in or out of the nucleus

5. In order for a protein to have transmembrane sequences it needs: (think carefully)
   a) 3 start transfer sequences and 2 stop transfer sequences
   b) 2 start transfer sequences and 3 stop transfer sequences

Extra credit

1. Steroid hormones, for example cortisone, control gene transcription by

   a. Intercalating in DNA and distorting the helix
   b. Binding to a specific steroid binding protein that acts as an RNA polymerase

c. Binding to a specific steroid binding protein that binds to an enhancer sequence for steroid sensitive genes

2. You wish to desing a plasmid to clone various genes in *E. coli*, to do so, you expect the plasmid minimally to have the following components:

a. Code for an antibiotic resistant gene
b. Have an origin of DNA replication
c. Have a sequence that can be cleaved by a restriction enzyme
d. The sequence in "c" can not occur in "a" or "b"
e. All apply

6. The carboxy region of RNA polymerase II is phosphorilated before the enzyme starts to transcribe DNA. The function of this is:

a) Provide a negative charge so the polymerase does not bend tightly to DNA
b) Provide binding sites for the enzymes that modify the primary transcript, so that the processing of the RNA to form mRNA occurs contranscriptionally.

7. To amplify a particular region of DNA, by PCR you need:

a) Knowledge of the nucleotide sequence at one end of the region you wish to amplify
b) Knowledge of the nucleotide sequence at both ends of the region you wish to amplify
c) DNA polymerase which is thermostable and all four deoxynucleoside triphosphate
d) a and c apply
e) b and c apply

8. Messenger RNAs are degraded in cells (pick the best answer)

a) All messenger RNAs are degraded at same rate
b) Different mRNAs are degraded at different rate
c) The 3'UTR (unstranslated region) influences the rate of mRNA degradation.

9. Stem cells are maintained because when they divide they undergo:

a) Assymetrical division
b) Daughter cells are subject to environmental asymmetry
c) Both apply

10. Adult stem cells are progenitor of

a) Only one differentiated cell
b) Can give rise to multiple differentiated cells in the same tissue/organ.

New Questions added on Exams Spring 2006

11. The signal recognition particle (SRP) interacts with the nascent polypeptide chains of: (Pick the best answer)

a. secreted proteins
b. proteins of the cytoplasmic membrane
c. lysosomal proteins
d. a, b and c apply

12. When the signal recognition particle (SRP) binds to the nascent polypeptide chain:

a. the ribosomes continues proteins synthesis
b. protein synthesis stops until the nascent chain can transit through the ER membrane
c. the attachment of the ribosome and the nascent polypeptide chain to the ER by SRP requires energy in the form GTP hydrolysis
d. the transit of the polypeptide chain through the ER membrane occurs over a channel and is driven by the energy used for peptide synthesis
e. b, c and d apply

13. The lipid bilayer is impermeable to several substances, while others can pass freely through the membrane:

a. Glucose and amino acids can move freely through a lipid bilayer
b. Cortisol can only traverse the membrane when bound to a transport protein
c. a and b are correct
d. a and b are incorrect

14. Many mitochondrial proteins are coded by nuclear genes. These proteins when located in the mitochondrial matrix:

e. are synthesized by cytoplasmic ribosomes
f. are synthesized by mitochondrial ribosomes
g. require chaperones and ATP to become functional after synthesis by ribosomes
h. a and c apply

i. b and c apply

15. By genetic techniques you create a gene that codes for the amino terminal region of alcohol deshydrogenase, a mitochondrial protein coded by a nuclear gene, followed by a region coding for green fluorescent protein (GFP), (gene I) and a second gene which has the GFP gene sequence followed at its 3' end by the 3' end of the alcohol deshydrogenase (gene II). You transfect cells with a plasmid containing one or the other of these artificial genes and appropriate promoters and you expect to:

j. GFP in mitochondria of cells with gene I
k. GFP in mitochondria of cells with gene II

16. Many proteins which are modified in the ER by glycosylation initially have attached at an asparagins residue a complex carbohydrate chain, with three terminal glucose residues

l. When these proteins arrive at the Golgi they have this complete carbohydrate chain including glucose attached to them
m. The glucose residues are removed before the protein leaves the ER
n. One of the glucose residues is part of the recognition in the ER of misfolded proteins which are then degraded
o. a and c apply
p. b and c apply

17. Misfolded proteins in the ER are degraded:

q. in the lumen of the ER
r. exported into the cytoplasm and degraded in proteosomes

18. The degradation of proteins tagged with ubiquitin in the proteosome

s. also results in the degradation of ubiquitin
t. requires ATP
u. a and b apply

19. When peptide hormones bind to receptor on the cell surface, they elicit an intracellular response. This response:

v. is transient and depends on the persistence of the hormone
w. it often triggers with a delay pathway to silence the hormone response (turn off)
x. a and b are both correct

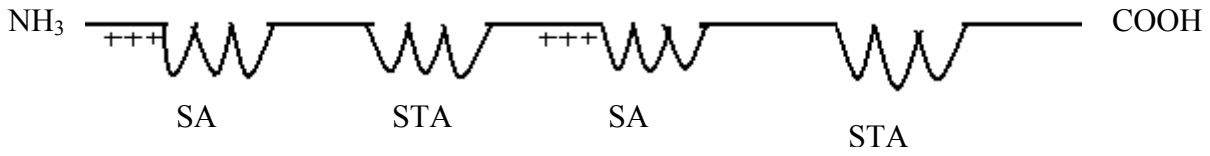
20. The β adrenergic receptor is phosphorylated by β- adrenergic receptor kinase (BARK) the result of this phospholylation is:
y. activation of the receptor

z. inactivation of the receptor
aa. binding of β arrestine to the receptor
bb. a and b apply
cc. b and c apply

21. The β adrenergic receptor can activate MAP kinase cascade, this requires:

dd. an increase in cAMP
ee. binding of β-arrestin to the receptor
ff. c Src

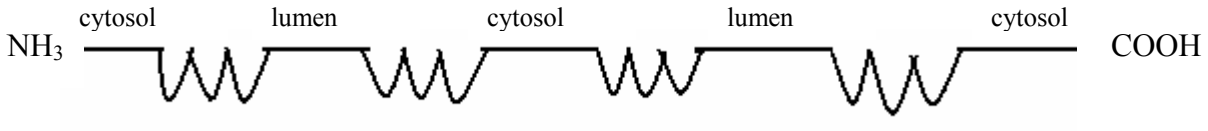
22. Consider a membrane protein with the following signals:



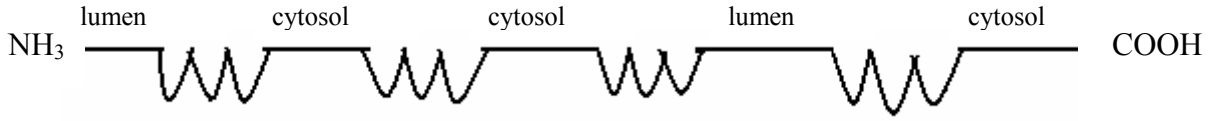
SA= internal signal anchor sequence
STA= internal stop transfer anchor sequence

Which of the following represents the transmembrane conformation of the protein?

a)



b)

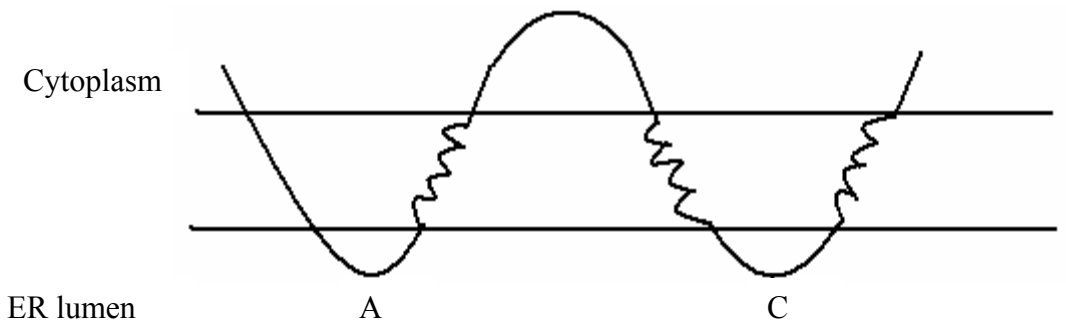


<u>The next two questions are related</u>

23. For the protein with sequence shown in the ER and destined to the cytoplasmic membrane

NH_3 B COOH

NH_3



You expect that glycosylation <u>can occur</u> in:

a. segment A
b. segment B
c. segment C
d. segment A and C

24. When the protein in the previous question is in the cytoplasmic membrane, you expect:

gg. Segment A and C is on the exterior of the cell
hh. Segment B is on the exterior of the cell

25. In order for the sodium channel in axons to be able to conduct an action potential unidirectionally it must:

ii. have an ion selective pore
jj. the pore must be able to transition into a refractory period shortly after opening
kk. be opened by membrane depolarization
ll. all apply

26. Vesicular traffic between organelles involves the binding of cargo molecules to cargo receptors. For a receptor that carries molecules from the ER to the Cis Golgi you expect:

a. the affinity of the receptor for its cargo protein increases with increases in pH (ie. More alkaline)
b. the affinity of the receptor for its cargo protein increases with a decrease in pH (ie. More acidic)

27. Hydrolytic enzymes destine to function in the lysosomes have the following characteristics:

a. are initially inserted into the ER
b. acquire a mannose 6P residue in the Golgi which is required for transport to the lysosomes

c. have and alkaline pH optimum
d. a and b apply
e. a and c apply

28. The presence of a low concentration of cholesterol in the membrane of the ER results in an increase in the rate of cholesterol synthesis. This is due to:
a. an increase in the concentration of cAMP in the cell
b. the transit of a specific protein from the ER to the nucleus with bound cholesterol
c. the transfer of a protein from the ER to the Golgi where it is cleaved and a fragment moves to the nucleus
d. a, b and c apply
e. b and c apply

29. Some hormones bind to membrane receptors and activate a G protein:
a. the G protein always activates other enzymes
b. the G protein always inhibits other enzymes
c. a. and b apply

30. For G proteins
a. only the α subunit interacts with other cellular enzymes/ion channels
b. in different systems the α subunit or the βγ subunits interacts with other enzymes/ion channels.

31. The synthesis and degradation of glycogen are both affected by hormones such as epinephrine or glucagon. For this to happen:

a. protein kinase A must be activated
b. levels of cAMP in the cell decrease
c. glycogen synthesis is increased
d. glycogen synthesis is decreased
e. a and d apply

32. In the presence of EGF the EGF receptor: (pick the best answer)

a. dimerizes
b. becomes phosphorylated in tyrosine residue
c. becomes phosphorylated in serine residues
d. a and b apply
e. a and c apply

33. In many tumor cells there is a mutation in Ras you expect this mutation to:

a. prevent the bending of GTP to Ras
b. abolish the GTPase activity of Ras
c. maintain Ras exa permanently active state
d. a and c apply
e. b and c apply

34. Apoptosis in cells results in (Pick the best answer):

a. an increase in the activity of NA^+/K^+ ATPase
b. activation of a cascade of proteolytic enzymes (caspases)
c. frequently requires the release of cytochrome c from mitochondria
d. b and c apply

35. Which of the following statements are likely to apply to a tumor:

a. independent from external growth factor, inhibition of GTPase activity of Ras, inhibition of telomerase
b. activation of growth factor receptor in the absence of growth factor, inhibition of Ras GTPase activity, absence of p53
c. absence of Retinoblastoma protein
d. a and c apply
e. b and c apply

36. Insulin increases glucose uptake by hepatocytes (liver cells), it does this by:

a. increasing cAMP in cells
b. phosphorylating a protein or tyrosine residue
c. moving glucose transporter to the cytoplasmic membrane
d. a and c apply
e. b and c apply

37. Tumors result from mutations in the genome. In some cases the coding sequence of a gene is not changed, but the gene is involved in tumorogenesis as an oncogene (Pick the best answer):

a. it is translocated so that its expression is greatly increased
b. it is translocated to a new site on the genome where it prevents expression of other genes

38. Protein kinase C requires diacylglycerol and Ca^{++} for activity. When a hormone activates protein kinase C, the most likely source of these molecules is (read the choices carefully):

a. phosphatidylinositol 4,5 bis phosphate cleaved by phospholipase C
b. The Ca^{++} from the ER
c. The Ca^{++} from the ER released by inositol 1,4,5 triphosphate
d. a and c apply

39. In the experiment to isolate human oncogenes by transporting DNA from human tumor cells into 3T3 cells, the human genes where identified:

a. they had a high probability of being next to an alu sequence
b. the alu sequence directs insertion of new DNA fragments in mouse cells
c. the alu sequence is a repetitive DNA sequence present in human but not in mouse cells
d. a and b apply
e. a and c apply

Extra Credit

40. To determine whether a chemical is mutagenic you first perform the Ames test, to do so you require:

a. a set of different yeast mutants in β Galactosidase
b. a set of different *Salmonella* mutants in histidine biosynthesis
c. a rat liver extract

41. The developing of metastasis of a breast tumor to other tissues such as bone or lung:

a. is the result of a mutation in a gene that allows the tumor cells to leave the original site of the tumor
b. is the result of mutation that result in the expression of a group of genes that allow these cells to colonize other tissues
c. the gene expression pattern is different in lung metastasis and bone metastasis
d. a and c apply
e. b and c apply

42. In tumor cells you expect to find modifications that result in:

a. independence of external growth factors and activation of telomerase
b. enhanced apoptosis
c. lack of p53 and Ras which lacks GTPase activity
d. a and c apply
e. b and c apply