Decide which is the BEST answer and blacken the corresponding brackets. (1 mark each)

1. Put the following scientific advances in the proper historical order.

A. The structure of DNA
B. The laboratory use of restriction enzymes
C. The concept of genes

a) ABC
b) ACB
c) *CAB
d) CBA
e) BAC

2. Which of the following is NOT a feature that defines a living thing?

a) growth
b) reproduction
c) *adhesion
d) response to external stimuli
e) movement

3. Which of the following statements is FALSE?

a) *Nuclear pores traverse the single layer nuclear membrane permitting communication between the nucleus and cytoplasm.
b) Nuclear pores vary in number with the transcriptional activity of the cell.
c) Nuclear pores are highly structured and are comprised of several glycoproteins.
d) Nuclear pores are comprised of 8 protein structures forming "rosettes".
e) Nuclear pores limit the size of molecules that can pass between the nucleus and cytoplasm.

4. Which of the following statements is FALSE?

a) Nuclear matrix associates with specific regions of DNA, termed "matrix association regions" or MARs.
b) Nuclear matrix contains at least three major classes of lamins.
c) Nuclear matrix forms a highly branched network structure.
d) *Nuclear matrix maintains chromatin in a highly compacted state.
e) The interactions between DNA and nuclear matrix is altered during the cell cycle by phosphorylation of lamins.

5. Which one of the following statements is FALSE.

a) Histone acetyltransferases acetylate some histones.
b) Histone acetyltransferases fascillitate transcription.
c) Histone deacetylases repress transcription.
d) Lysine residues on histones are targets for acetylation.
e) *Histone acetylation increases the positive charge of histones.

6. Which of the following events is believed to regulate re-replication of DNA in yeast?

a) synthesis of ORC in S-phase
b) phosphorylation of Cdc6
c) exclusion of ORC from the nucleus
d) phosphorylation of ORC by a G2 kinase
e) *phosphorylation of MCM

7. Which factor is NOT associated with density-dependent growth inhibition?

a) high cell density
b) low concentration of nutrients or growth factors
c) *high levels of cyclin D
d) high levels of p130 and pRB
e) low levels of p107

8. Which of the following properties is NOT a difference between G1 and mitotic chromosomes? Provide the most accurate answer.

a) Mitotic chromosomes contain twice the amount of DNA.
b) G1 chromosomes are less condensed than mitotic chromosomes.
c) Mitotic chromosomes become attached to spindles, G1 chromosomes do not.
d) Chromatin in G1 nuclei is more highly acetylated than that in mitotic cells.
e) *All the above statements are true.

9. Which of the following events is NOT associated with mitosis?

a) spindle formation

b) chromosome condensation
c) breakdown of the nuclear envelope
d) disappearance of the nucleolus
e) *synthesis of cyclin B

10. Which of the following is NOT a substrate for mammalian MPF?

a) histone H1
b) regulator of mitotic spindle assembly (RMSA-1)
c) *lamin B
d) microfilamental protein myosin
e) cyclin B protease

11. What is the major regulator of entry of yeast G2 cells into mitosis?

a) the level of nutrients
b) the level of Cdc2/28
c) the amount of chromosome condensation
d) completion of S-phase
e) *the level of cyclin B

12. In late S-phase in yeasts what cyclins are present? Provide the most accurate answer.

a) only Cln1 and Cln2
b) all cyclins
c) only cyclin B
d) only Cln3
e) *only cyclin B and some Cln3

13. What is the major target of many growth factor signal transduction pathways?

a) inhibition of cyclin B synthesis.
b) *synthesis of cyclin D
c) activation of cyclin H/Cdk7 kinase activity
d) synthesis of cyclin E
e) activation of cyclin A/Cdk2 activity

14. Which of the following is NOT correct about the RB tumor suppressor.

a) *The RB gene encodes a cytoplasmic phosphoprotein.
b) RB activity is regulated by phosphorylation.
c) The underphosphorylated form of RB binds transcription factor E2F.
d) Overexpression of RB causes growth arrest.
e) RB binds cyclin D-Cdk4/6.

15. Which is the correct order of events in mating factor signalling?

A. degradation of G1 cyclins
B. activation of a kinase cascade
C. binding of mating factor to receptor
D. activation of a G protein

a) A to B to C to D
b) D to C to A to B
c) C to D to A to B
d) C to B to D to A
e) *none of the above

16. Repression of some promoters containing E2F binding sites does NOT involve which one of the following?

a) Binding of E2F
b) Binding of RB members to E2F
c) Histone deacetylases
d) *The activation domain of E2F
e) The ‘pocket’ of RB members

17. Overexpression of how many of any of the following genes could lead to growth arrest?

RB, cyclinD, E2F1, Cdk4

a) none
b) *one
c) two

d) three
e) four

18. What is acquired during the progression of ALL tumors?

a) loss of the RB gene
b) *mutations
c) the ability to synthesize growth factors
d) activation of tumor suppressors
e) all of the above

19. If a growth factor released by one cell acts on cells in close proximity, this results in

a) Exocrine growth stimulation
b) Juxtacrine growth stimulation
c) Autocrine growth stimulation
d) *Paracrine growth stimulation
e) Endocrine growth stimulation

20. Members of the steroid receptor gene family

a) *bind hydrophilic ligands
b) activate a kinase cascade
c) have intrinsic enzymatic activity
d) are localized only in the cytoplasm
e) none of the above

21. Signal transduction requires a series of protein:protein interactions. Proteins containing a proline rich domain interact with proteins containing

a) phosphotyrosine residues
b) proline rich domains
c) SH2 domains
d) *SH3 domains
e) kinase domains

22. Activation of MAP kinase-

a) is mediated only by receptor tyrosine kinases.
b) is mediated by receptor tyrosine kinases through phosphatidylinositol 3 kinase
c) requires activation of protein kinase A.
d) always requires activation of Ras.
e) *is mediated by G-protein linked receptors through protein kinase C.

23. Binding of a growth factor to a receptor tyrosine kinase, promotes receptor dimerization, activates the receptor and leads to -

a) association of the receptor with trimeric G proteins
b) phosphorylation of all SH2 domain containing proteins on tyrosine residues
c) activation of protein kinase A
d) phosphorylation of the receptor on tyrosine and serine residues
e) *none of the above

24. Activation of G-protein linked receptors following binding of ligand can lead to-

a) activation of the intrinsic GTPase activity of the receptor.
b) *activation of protein kinase A.
c) formation of a complex between the receptor and phosphatidyl inositol 3 kinase (PI3kinase).
d) activation of the Ras GTPase.
e) formation of a complex between the receptor and protein kinase C.

25. Protein tyrosine phosphatases

a) are always cytoplasmic proteins
b) bind ATP
c) *form a phosphoryl intermediate
d) require a metal ion for activity
e) dephosphorylate threonine residues

26. The src tyrosine kinase is:

a) A transmembrane protein
b) Is maintained inactive through an interaction of its SH2 domain with a tyrosine residue in its kinase domain.
c) Is recruited to the plasma membrane by an activated receptor tyrosine kinase.

d) *Is activated through interaction of its SH2 domain with a phosphorylated tyrosine residue on a receptor tyrosine kinase.
e) None of the above

27. Proteins molecules are made up of:

a) nucleic acid bases arranged in a specific sequence and held together solely by hydrophobic forces
b) amino acid residues arranged in a specific sequence and held together solely by ionic interactions
c) a peptide backbone with amide bonds all is cis conformation
d) *a peptide backbone with amino acid side chain projecting out from this backbone such that the alpha carbon atoms of neighboring amino acid residues are spaced 3.7-3.8 Ångstroms apart from each other.
e) none of the above

28. Non covalent forces important in providing stabilization energy and holding a protein in a specific conformation include:

a) ionic forces
b) hydrogen bonds
c) hydrophobic forces
d) van der Waals interactions
e) *all of the above

29. A polypeptide's backbone conformation is determined by:

a) the phi (f) and psi (y) torsion angles along the main chain of the polypeptide
b) the torsion angles about each of the side chains in the polypeptide chain
c) *the phi (f), psi (y) and theta (q) torsion angles along the main chain atoms of the polypeptide chain
d) a and b above
e) none of the above

30. A Ramachandran diagram:

a) *can be used to classify the secondary structure elements within a protein structure.
b) shows the regions of conformational space physically accessible to the side chains of amino acid residues
c) shows that a smaller region of space is accessible to glycines than other amino acid residues.
d) is a plot of psi (y) versus theta (q) torsion angles for amino acid residues along the protein chain.
e) none of the above

31. Alpha helices

a) *are stable secondary structure elements where the carbonyl oxygen atom of the residue i makes a hydrogen bond with the N-H of residue i+4.
b) are arranged such that the carbonyl groups lie perpendicular to the axis of the helix and make hydrogen bond interactions to the amide N-H groups on the neighboring secondary structure element.
c) are found in disallowed regions of the Ramachandran plot
d) are formed by twisting the polypeptide unit by the same amount about each nitrogen atom in the main chain.
e) are arranged so that the central core of the helix contains a channel through which ions can pass.

32. The calcium binding motif

a) is made up of a continuous region of the polypeptide chain that folds into a helix-loop-strand structure
b) *is characterized by a conserved pattern of glutamate (E) and aspartate (D) residues which bind a calcium atom
c) is found in a large number of proteins that bind DNA
d) a and b above
e) none of the above.

33. Beta sheet structures:

a) are always found next to left handed helical structures in a protein and are characterized by networks of hydrogen bonds between side chain atoms of the strands in the sheet and those within the neighboring helix.
b) are found to be composed of hydrophobic residues only
c) *are found in two stable arrangements: the parallel b pleated sheet in which all the chains are aligned in the same direction and the antiparallel b-pleated sheet in which the chains alternate in direction.
d) b and c above
e) none of the above.

34. Loop regions found in protein structures

a) are most often buried in the internal core of the molecule
b) are always rich in tryptophan residues
c) *are the most common locations for amino acid insertions and deletions amongst homologous proteins
d) form intricate hydrogen bonding networks with the internal core of the molecule.
e) none of the above.

35. Ras proteins are a large superfamily of monomeric GTPases which act as signal transduction units. The structures of p21-ras

have been determined for the GDP-bound and the GTP-bound form and for various mutants.

a) *Differences between the GTP-bound and GDP found forms are limited primarily to two loops of the protein.
b) All of the activating mutants are located in the core of the protein structure.
c) The structure suggests an a-helix, located in the core region of the molecule is involved in interaction with the effector molecule,GAP.
d) The overall protein fold was found to be completely different for the GDP-bound and the GTP-bound forms of the molecule.
e) The structures are found to contain an EF hand motif which is important for binding calcium ions and mediates the interaction with the effector molecule.

36. The SH2 domain is a protein module found in a large number of signal transduction molecules.

a) The structure binds a 10-residue peptide substrate in a helical conformation.
b) *The binding site for the phospho-Tyr side chain consists of a pocket containing positively charged residues
c) Peptide specificity is mediated entirely through interaction with hydrophobic residues downstream of a phospho-tyrosine group.
d) The complexed and uncomplexed forms of Src SH2 adopt completely different protein conformations suggesting a major refolding of the molecule as a result of binding to the phospho-Tyr ligand.
e) None of the above.

37. In the helix-turn-helix family of transcription factors, the recognition helices are separated by a distance of:

a) 3.4 angstroms
b) *10 base pairs
c) 2 turns of DNA helix
d) exactly 2 lengths of stabilization helix
e) 7 amino acids

38. In the S1 nuclease assay which molecule must be radiolabeled

a) the oligo primer
b) the S1 nuclease
c) the mRNA to be tested
d) *the DNA chain containing the start point
e) the reverse transcriptase

39. In most eukaryotic genes, what is the approximate position on the promoter between the mRNA start site and the TATAA and CAAT regions.

a) *TATAA (-25 to -35) and CAAT (-75 and -95)
b) TATAA (-25 to -35) and CAAT (-35 and -45)
c) TATAA (20 to 40) and CAAT (50 and 55)
d) TATAA (0 to -15) and CAAT (-25 and -35)
e) None of the above

40. In the zinc finger domain containing transcription factors, to which amino acids must the zinc atom attach in an amino to a carboxyl direction, where (X) represents one or more amino acids.

a) His (X) His (X) Leu (X) Leu
b) Cys (X) Cys (X) Ala (X) Ala
c) *Cys (X) Cys (X) His (X) His
d) Cys (X) Leu (X) Cys (X) Leu
e) His (X) Cys (X) Cys (X) His

41. In conditions where cells are in excess of iron, by which of the following scenarios would the cytosolic aconitase protein in part modulate iron levels.

a) The aconitase will bind iron and associate with the transferrin receptor mRNA to prevent its translation.
b) The aconitase will be free from iron and unbind from the 5' noncoding sequence of the ferritin gene, allowing its translation.
c) The aconitase will rapidly associate with iron and bind the 3' end of the transferrin receptor to prevent its translation.
d) The aconitase protein will release iron and prevent the translation of the ferritin gene by binding to the 3' end of the transferrin mRNA.
e) *The aconitase protein will bind iron and dissociate from the 3' end of the transferrin protein, leading to its degradation.

42. Assuming the following mRNA sequence, what will be the most likely polypeptide length made after translation.
AUACUAAAUGCAAUGAGGCCGCCUCCAUGAUUAGCCGAUGGGUAUAAAGGU

a) *6
b) 9
c) 2
d) 12
e) 5

43. Which one of the following splicing factors interacts with the heterogeneous RNA branch point.

a) U1
b) *U2
c) U3
d) U4
e) U5

44. Comparison between a large number of RNA splice sites has provided a core consensus sequence that is recognized by the splicing machinery. Which one of the following minimum consensus sequences is typically found at the donor splicing site?

a) AA / GU
b) CAG / G
c) *AG / GU
d) AA /AA
e) GGG / UUA

45. Which one of the following RNA sequence motifs is associated with RNA instability?

a) AAUAAA repeat
b) *AUUUA repeat
c) AAAAA repeat
d) AUGAUG repeat
e) None of the above

46. What is the role of the small peptide ubiquitin?

a) to bring splicing factors to spliceosomes.
b) to bring the snRNA7 to the 3' end of the histone mRNA
c) to bring the eIF4e protein to the ribosomes
d) to degrade the proteosomes
e) *none of the above

47. What happens to the RNA during RNA editing?

a) Transesterification of an adenine residue
b) Studdering of the polymerase complex when bound to an initiator
c) Methylation of the 2' oxygen of the ribose in the ribonucleotide
d) Production of an antisense message
e) *Deamination of the amino group of adenine and cytosine.

48. Poliovirus has developed an extremely ingenious way to promote the translation of its own genes to the detriment of the host message.

a) It destroys the cell ribosomes
b) It phosphorylates the eIF5 translation factor to activate its own translation
c) *It produces a viral protease that specifically destroys the p220 translation factor
d) It increases the formation of ternary complex to hasten the viral translation
e) It blocks the transport of the host message towards the cytoplasm

49. One of the key mechanisms of translation inhibition occurs via the phosphorylation of which translation factor?

a) eTF
b) eIF-2B
c) *eIF-2
d) eRF
e) EIF-4E

50. What is the embryonic stage that is more amenable for the production of transgenic mice by pronucleus injection?

a) an unfertilized egg
b) *a zygote
c) a morula
d) a blastocyst
e) an embryonic stem cell

51. One answer is correct.

According to the Nernst equation, the equilibrium potential for potassium is -86 mV. What is the electrochemical gradient for potassium if the actual potential in the membrane is -60 mV?

A) -146 mV
B) *-26 mV
C) +26mV

D) +146mV
E) none of the above

52. One answer is incorrect.

The voltage gated sodium channel

A) opens in response to a voltage loss across the membrane.
B) preferentially passes sodium ions.
C) after 0.5 msecs the channel closes preventing the movement of sodium ions into the cytosol.
D) *leads to a wave of depolarization whereby the outer surface becomes more positive and the cytosolic surface more negative.
E) returns to its responsive form when the gating helices return to their normal position and the channel returns to the normal gate closed conformation.

53. One answer is incorrect

At the neuromuscular junction, synaptic vesicles are loaded with acetylcholine.

A) The wave of depolarization from the axon triggers synaptic vesicle fusion with the axonal plasma membrane at the synaptic cleft.
B) Synaptic vesicle exocytosis leads to the extracellular diffusion of acetylcholine.
C) *Acetylcholine binds to the voltage gated sodium channel on the muscle cell membrane.
D) Acetylcholine triggers a depolarization of the plasma membrane of the muscle cell.

E) Muscle cell depolarization leads to muscular contraction.

54. One answer is incorrect.

An action potential triggers the exocytosis of synaptic vesicles at the axon terminal

A) by first opening a voltage gated calcium channel at the axon terminal.
B) by activating a calmodulin dependent protein kinase.
C) *by severing SNARES on the synaptic vesicle by proteolysis.
D) Disruption of synaptic vesicles from actin filaments leads to synaptic vesicle release.
E) Synaptic vesicles fuse with the axon terminal plasma membrane via SNARES

55. One answer is incorrect.

Glucose transport across the small intestinal epithelium

A) *occurs through junctional complexes between epithelial cells.
B) involves a sodium : glucose symport.
C) involves a metabolically driven sodium potassium ATPase.
D) Involves a potassium leak channel.
E) involves a glucose carrier.

56. One answer is incorrect.

Phospholipids of the plasma membrane:

A) The carboxyl residues of the fatty acids along with the glycerol phosphate and associated head groups are hydrophilic.
B) *The hydrocarbon chains of the fatty acids are amphipathic
C) Sphingomyelin is localized mainly to the outer face.
D) Phosphatidylethanolamine is distributed mostly in the cystolic face.
E) Phosphatidylserine is exclusively in the cytosolic face.

57. One answer is incorrect.

Membrane fluidity.

A) Certain phospholipids must flip across the bilayer during their biosynthesis.
B) Phospholipids spin with ease.
C) *Phospholipids are usually prevented from moving laterally.
D) Cholesterol preserves the fluid nature of the membrane.
E) The lipid portion of the membrane is a continuous phospholipid bilayer.

58. One answer is incorrect.

Proteins which span the membrane

A) *must readily flip-flop during carrier mediated transport of water soluble substances.
B) have extracellular domains which are often decorated with carbohydrate groups.
C) may act as receptors for extracellular ligands.
D) may link structures outside the cell to structures inside.

E) Different membrane proteins may have various numbers of spanning domains.

59. One answer is incorrect.

The sodium potassium ATPase

A) is essential for transporters depending on a sodium gradient.
B) is essential for the regulation of cell volume.
C) is essential for the maintenance of membrane excitability.
D) is localized to the basolateral domain of the small intestinal epithelial plasma membrane.
E) *is activated by digitalis, a cardiotonic steroid.

60. One answer is incorrect

Membrane transport proteins

A) *may be channels which are highly selective such as the acetylcholine receptor which only allows sodium transport.
B) channels may pass 10,000,000 ions per second.
C) channels allow diffusion along an electrochemical gradient.
D) the rate of transport through a channel responds to a very wide range of solute concentrations.
E) carriers transport solutes at slower rates than channels.