

## BIOPHYSICS TUTORIAL QUESTIONS

1. How would you convert a nucleotide to a nucleoside?
  - (a) Add a  $\text{OH}^-$  group
  - (b) Add a  $\text{PO}_4^{3-}$  group
  - (c) Remove a  $\text{OH}^-$  group
  - (d) Remove a  $\text{PO}_4^{3-}$  group
2. Who proposed the double helical structure of DNA and when?
  - (a) Erwin Chargaff in 1928
  - (b) Frederick Griffith in 1928
  - (c) Watson And Crick in 1944
  - (d) Avery, Macleod and McCarty in 1944
3. The ultraviolet absorption maxima of DNA is
  - (a) 260nm or 280nm
  - (b) 280 nm
  - (c) 260 nm
  - (d) None of the above
4. The role of ribonuclease in determining the transformation ability of the *S. pneumoniae* virulent extract was to
  - (a) destroy DNA
  - (b) Introduce DNA
  - (c) Destroy RNA
  - (d) Introduce RNA
5. The physical characteristics of a protein include which of the following?
  - A) Size and function
  - B) Size and shape
  - C) Composition and function
  - D) Composition and shape
  - E) All of the above
6. Which of these is not a biophysical technique used for the detection of tiny quantities of RNA transcript?
  - A) Electron microscopy
  - B) Liquid scintillation counting
  - C) Phosphorimaging
  - D) Autoradiography
7. Which of these is a nucleic acid hybridization technique?
  - A) Ultracentrifugation
  - B) Gel mobility shifts
  - C) Restriction mapping
  - D) DNase footprinting
  - E) None of the above
8. Which of these is not a nucleic acid hybridization technique?
  - A) Northern blot

- B) Eastern blot
- C) Southern blot
- D) Western blot
- E) None of the above

9. Elemental analysis of DNA giving a nitrogen: phosphorus ratio of 1.76 indicates

- A) Pure DNA
- B) Pure RNA
- C) DNA contaminated with RNA
- D) DNA contaminated with protein
- E) Both (A) and (B)

10. Western blotting is a technique based on

- A) Electrophoresis and microscopy
- B) Only electrophoresis
- C) Electrophoresis and labeling with antibodies
- D) Electrophoresis of antibodies or radioactive material
- E) All of the above

11. Who laid the foundation for identification of DNA as the genetic material and when?

- (a) Erwin Chargaff in 1928
- (b) Frederick Griffith in 1928
- (c) Watson And Crick in 1944
- (d) Avery, Macleod and McCarty in 1944
- (e) Erwin Griffith in 1928

12. Which is the correct sequence of events in the central dogma of molecular genetics?

- A) Transport → RNA processing → Transcription → Translation
- B) Transcription → Translation → RNA processing → Transport
- C) Translation → Transport → RNA processing → Transcription
- D) RNA processing → Transport → Transcription → Translation
- E) Transcription → RNA processing → Transport → Translation

13. Choose the correct order of events in research on a macromolecule based on biophysical technique.

- A) Isolation → Characterization → Modification → Function
- B) Isolation → Characterization → Function → Modification
- C) Characterization → Isolation → Function → Modification
- D) Characterization → Modification → Isolation → Function
- E) None of the above

14. Which of these biophysical techniques does not involve labeling with antibodies?

- A) Microscopy
- B) Northern blotting
- C) Western blotting
- D) Gel mobility shift
- E) All of the above

15. The technique which combines electrophoresis with labelling with antibodies is

- A) Western blotting
- B) Northern blotting
- C) Southern blotting
- D) None of the above

16. Which of these best describes the Hershey-Chase experiment?

- A) Labelling phage T2 with  $^{32}\text{S}$  and  $^{35}\text{P}$  in *E. coli* culture revealed DNA as the transforming principle
- B) Labelling phage T2 with  $^{32}\text{S}$  and  $^{35}\text{P}$  in *E. coli* culture revealed DNA to contain phosphorus
- C) Labelling phage T2 with  $^{32}\text{P}$  and  $^{35}\text{S}$  in *E. coli* culture revealed that DNA does not contain sulphur
- D) Labelling phage T2 with  $^{32}\text{P}$  and  $^{35}\text{S}$  in *E. coli* culture revealed genes to be made up of DNA

17. In the Watson-Crick model of DNA the direction of each strand is

- (a)  $5' \rightarrow 3'$  on one strand and  $3' \rightarrow 5'$  on the complementary strand
- (b)  $3 \rightarrow 5$  on both strands
- (c)  $5 \rightarrow 3$  on both strands
- (d)  $5' \rightarrow 3'$  on both strands

18. Which of these statements is false?

- (a) G+C content of DNA is not related to the complexity of an organism
- (b) Melting temperature of bacteriophage T4 is lower than the melting temperature of *E. coli*.
- (c) The G+C content of *B. megaterium* is 38% and its corresponding melting temperature is between 60 and 70°C
- (d) Renaturation of DNA depends on concentration

19. The most extended form of DNA is called

- (a) Z-DNA
- (b) B-DNA
- (c) A-DNA
- (d) none of the above

20. Which of these statements is true?

- (a) When adenine pairs with guanine, thymine will pair with cytosine
- (b) Adenine and guanine are found in the major groove
- (c) Thymine and cytosine are found in the minor groove
- (d) None of the above

21. Which of these statements is true? In DNA, bases pair in a particular fashion:

- (a) adenine with cytosine
- (b) guanine with adenine
- (c) thymine with guanine
- (d) adenine with thymine

22. The G+C content of *M. phlei* is 70%, while that of yeast is 36%. Which of the following inferences can be made from this statement?

- (a) *M. phlei* DNA is expected to show a relatively weaker hyperchromic shift
- (b) *M. phlei* DNA is expected to show a relatively stronger hyperchromic shift
- (c) The rate of denaturation of *M. phlei* DNA at high pH will not differ from that of yeast
- (d) Rate of denaturation using high pH will be faster in *M. phlei* than in yeast DNA

23. Which of these statements is true? In adenosine structure,

- (a) N3 is bonded to C1 of ribose
- (b) N3 is bonded to C1' of ribose
- (c) N9 is bonded to C1 of ribose

(d) N9 is bonded to C1' of ribose

24. Which of these statements is true? In uridine structure,

- (a) N3 is bonded to C1 of ribose
- (b) N1 is bonded to C1' of ribose
- (c) N3 is bonded to C1' of ribose
- (d) N9 is bonded to C1' of ribose

25. Who discovered this phenomenon: DNA is a repeating molecule arranged in a corkscrew (helix) structure?

- (c) (a) Pauling
- (b) Chargaff
- Wilkins and Franklin
- (d) Franklin and Pauling

26. Which of these bonds will produce a bulge in a DNA structure?

- (a) cytosine-guanine
- (b) cytosine -cytosine
- (c) guanine-guanine
- (d) thymine-thymine

27. Which of the following will be the correct annealing temperature of a sample of DNA having a melting temperature of 86°C?

- a. 54 °C
- b. 58 °C
- c. 61 °C
- d. 65 °C

28. Which of these reagents would denature ds DNA to get single strands?

- A) Only high salt
- B) High salt plus low pH
- C) Low salt plus high pH
- D) Only low salt
- E) All of the above

29. Which sequences are found at centromeres

- A) Single copy
- B) Moderately repetitive
- C) Highly repetitive
- D) Both single copy and moderately repetitive
- E) Both moderately repetitive and highly repetitive

30. In a DNA denaturation experiment, the  $C/C_0$  of *E. coli* strains K12 and RY 13, plus bacteriophage T4 and MS2 were found to be 0.76, 0.54, 0.81 and 0.33, respectively. Which of these DNA samples will demonstrate higher percentage reannealing?

- (A) MS2 and K12
- (B) Only RY 13
- (C) Only MS2
- (D) Only T4
- (E) K12 and T4

31. The  $Cot_{1/2}$  of denaturation/annealing experiment on MS2 is  $10^{-2}$ . Which of these is an estimate of its DNA size?

- (A)  $10^3$  to  $10^4$  bp

- (B)  $10^7$  to  $10^8$  bp
- (C)  $10^1$  to  $10^2$  bp
- (D)  $10^0$  to  $10^1$  bp
- (E)  $10^5$  to  $10^6$  bp

32. The  $Cot_{1/2}$  of denaturation/annealing experiment on T4 is 1. Which of these is an estimate of its DNA size?

- (A)  $10^7$  to  $10^8$  bp
- (B)  $10^4$  to  $10^5$  bp
- (C)  $10^2$  to  $10^3$  bp
- (D)  $10^1$  to  $10^2$  bp
- (E) 1 to  $10^1$  bp

33. Which of these is the correct sequence of immunostaining of western blot?

- (A) Blot → Blocking → Horseradish Peroxidase → Antibody → CSPD → Blue color
- (B) Blot → Blocking → Antibody → Horseradish Peroxidase → BCIP/NBT → Blue color
- (C) Blot → Antibody → Blocking → Horseradish Peroxidase → CSPD → Luminiscence
- (D) Blot → antibody → Blocking → Alkaline Phosphatase → BCIP/NBT → Blue color
- (E) Blot → Blocking → Alkaline Phosphatase → Antibody → BCIP/NBT → Luminiscence

34. Select the best method for separating DNA fragments which differ by one base pair

- A) Denaturing gel electrophoresis on polyacrylamide
- B) Nondenaturing gel electrophoresis on polyacrylamide
- C) Denaturing gel electrophoresis on agarose
- D) Nondenaturing gel electrophoresis on agarose

35. Which of the following buffers would you select for resolving a mixture of large fragment sizes linear and supercoiled DNA?

- A) TBE
- B) TPE
- C) TAE
- D) None of the above

36. You want to determine the molecular weight of a DNA of size 1 million base pair

Which of the following methods is most suitable?

- A) Nondenaturing low percentage agarose gel electrophoresis
- B) Pulsed Field gel electrophoresis
- C) Denaturing low percentage agarose gel electrophoresis
- D) Nondenaturing low percentage polyacrylamide gel electrophoresis

37. Which of these applications of electrophoresis are employed in criminal investigations?

- I. RFLP
- II. Southern blotting
- III. Northern blotting
- IV. Western blotting

- A) I only
- B) II only

- C) III only
- D) I and III
- E. III and IV

38. Which of these applications of electrophoresis are employed in gene expression studies?

- I. RFLP
- II. Southern blotting
- III. Northern blotting
- IV. Western blotting

- A) I only
- B) II only
- C) **III only**
- D) I and III
- E. III and IV

39. Predict the mobilities of the following hemoglobin types on a cellulose acetate paper electrophoresis

- A) HbA>HbC>HbS
- B) HbC>HbA>HbS
- C) **HbA>HbS>HbC**
- D) HbS>HbC>HbA
- E) None of the above

40. Electrophoresis of blood gamma globulins in a patient showed elevated peaks. Which of the following disease conditions are likely?

- A) **Rheumatoid arthritis**
- B) Hyperthyroidism
- C) Gastrointestinal diseases
- D) Hemolytic anemia
- E) Problems with the immune system

41. To investigate an event of myocardial infarction, a clinician would request for which of the following electrophoresis

- I) Electrophoresis of troponins T and I
- II) Electrophoresis of isozymes of lactate dehydrogenase enzyme  $\alpha$  and  $\beta$
- III) Electrophoresis for the isozyme pattern of creatine kinase MM, BB, MB

- A) I and II
- B) II and III
- C) II only
- D) III only
- E) **All of the above**

42. Given  $\ln(N_t/N_0) = -\lambda t$  and that the half-life of  $^{32}\text{P}$  is 14.2 days, how long would it take a solution containing 42,000 d.p.m. of  $^{32}\text{P}$  to decay to 500 d.p.m.?

- (A) 100 days
- (B) 55 days
- (C) 4 days
- (D) 21 days
- (E) 91 days

43. The complexity of *Streptococcus pneumoniae* is 102 bp. Which of these will be a good estimate of its  $Cot_{1/2}$  in a denaturation/annealing experiment?

- (A) 10-5
- (B) 10-2
- (C) 100
- (D) 10-1
- (E) 10-3

44. In a denaturation/annealing experiment,  $Cot_{1/2}$  of bacteriophage  $\lambda$  and *E. coli* were 100 and 104, respectively. How can you predict the relative distribution of various DNA compositions in the two bacteria?

- (A) Equal proportion of highly repetitive sequences in both
- (B) Equal proportion of moderately repetitive sequences in both
- (C) More moderately repetitive sequences in  $\lambda$  than in *E. coli*
- (D) More single copy sequences in *E. coli* than  $\lambda$
- (E) Equal proportion of highly repetitive sequences and single copy sequences in both

45. Given that the  $Cot_{1/2}$  of *Puccinia polysora* DNA is  $3.0 \times 10^2$  and that of *E. coli* is 104, and that the size of *E. coli* genome is  $4.2 \times 10^6$  bp, what is the complexity of *P. polysora* DNA?

- (A)  $1.40 \times 10^3$  bp
- (B)  $1.26 \times 10^3$  bp
- (C)  $1.26 \times 10^2$  bp
- (D)  $1.40 \times 10^2$  bp
- (E)  $0.71 \times 10^3$  bp

46. Which of these sequences is translated into protein

- (A) Single copy
- (B) Moderately repetitive
- (C) Highly repetitive
- (D) Both moderately repetitive and highly repetitive
- (E) Highly repetitive and single copy

47. Which of these DNA sequences is most likely to have mismatch during reassociation?

- (A) Moderately repetitive
- (B) Single copy
- (C) Highly repetitive
- (D) All of the above

6. Which of these DNA sequences is most likely to have a lowest  $T_m$ ?

- (A) Single copy
- (B) Highly repetitive
- (C) Moderately repetitive
- (D) None of the above

48. You want to separate a mixture of proteins. Choose the correct method.

- (A) You would use acrylamide and vertical gel systems.
- (B) You would use acrylamide and horizontal gel system

- C) You would use agarose and vertical gel system
- D) You would use agarose and horizontal gel system

49. You want to separate a mixture of small nucleic acids. Choose the correct method.

- A) You would use acrylamide and vertical gel systems
- B) You would use acrylamide and horizontal gel system
- C) You would use agarose and vertical gel system
- D) You would use agarose and horizontal gel system

50. You want to separate a mixture of large nucleic acids. Choose the correct method.

- A) You would use acrylamide and vertical gel systems
- B) You would use acrylamide and horizontal gel system
- C) You would use agarose and vertical gel system
- D) You would use agarose and horizontal gel system

51. Proteins are electrophoresed on polyacrylamide gels whereas nucleic acids are separated on agarose gels because

- A) Proteins have small sizes that fit the small pores of polyacrylamide gels, while nucleic acids have large sizes that fit the large pores of agarose gels
- B) Proteins have large size that fit the large sizes of polyarylamide gels, while nucleic acids have small sizes that fit the small pores of agarose gels
- C) Proteins have mixture of sizes that are good for separation on polyacrylamide gels
- D) Nucleic acids have mixture of sizes that are good for separation on agarose gels

52. Which of these statements is true?

- a). By convention DNA is run at constant voltage and protein is run at constant current
- b). Proteins have varying charges depending on the amino acid content of the specific polypeptide
- c). SDS imparts only identical charges to proteins
- d). Proteins with net positive charges will move from anode to the cathode during SDS-PAGE

53. Which of the gels are used for loading the Protein sample?

- A) Resolving gel
- B) Stacking gel
- C) Both resolving and stacking gel
- D) None of the above

54. A researcher used TEMED to prepare isoelectric focusing gels and never had formation of a gel. Which of the statements below is the reason for no gel formation?

- A) Polymerization falls rapidly at pH below 6

B) Polymerization falls rapidly at pH above 6

55. Choose the correct sequence in Western blotting

- (A) Assemble the transfer stack> Prepare and run SDS-PAGE> Semi-dry transfer > Detection
- (B) Prepare and run SDS-PAGE>Semi-dry transfer>Assemble the transfer stack>Detection
- (C) Prepare and run SDS-PAGE> Assemble the transfer stack > Semi-dry transfer > Detection
- (D) Assemble the transfer stack > Prepare and run SDS-PAGE> Detection > Semi-dry transfer

56. Which of these buffers has the lowest buffer capacity required to produce the best resolution for agarose gel electrophoresis of large double-stranded DNA fragments?

- (A) NaOH/EDTA
- (B) Tris acetate EDTA (TAE),
- (C) Tris/Borate/EDTA (TBE) and
- (D) Tris-phosphate/EDTA

57. Which of the radioisotopes emits an energetic  $\beta$  particle that is easily detected by autoradiography

- (A)  $^{32}\text{P}$
- (B)  $^3\text{H}$
- (C)  $^{14}\text{C}$
- (D)  $^{35}\text{S}$

58. Which of the radioisotopes decay by electron capture?

- (A)  $^{131}\text{I}$
- (B)  $^{125}\text{I}$
- (C)  $^{131}\text{Xe}$
- (D)  $^{125}\text{Te}$

59. Given  $\ln(N_t/N_0) = -\lambda t$  and that the half-life of  $^{32}\text{P}$  is 14.2 days, how long would it take a solution containing 42,000 d.p.m. of  $^{32}\text{P}$  to decay to 500 d.p.m.?

- (A) 100 days
- (B) 55 days
- (C) 4 days
- (D) 21 days
- (E) 91 days

60. Which of these is the approximate mass of a proton?

- (A)  $1.67 \times 10^{-28} \text{ kg}$
- (B)  $0.67 \times 10^{-27} \text{ kg}$
- (C)  $1.67 \times 10^{-27} \text{ kg}$
- (D)  $9.01 \times 10^{-32} \text{ kg}$
- (E)  $9.10 \times 10^{-31} \text{ kg}$

61. Which of these elements are expected to undergo radioactive decay?

- I.  ${}_{x-2}^{x+2}\text{A}$       II.  ${}_x^x\text{A}$       III.  ${}_x^{x+2}\text{A}$       IV.  ${}_{x+2}^{x+2}\text{A}$       V.  ${}_{x-2}^x\text{A}$

- (A) I only  
(B) II and III only  
(C) V only  
(D) I, III and V  
(E) II and IV

62. Which of these elements are not expected to undergo radioactive decay?

- I.  ${}_{x-2}^{x+2}\text{A}$       II.  ${}_x^x\text{A}$       III.  ${}_x^{x+2}\text{A}$       IV.  ${}_{x+2}^{x+2}\text{A}$       V.  ${}_{x-2}^x\text{A}$

- (A) I only  
(B) II and III only  
(C) V only  
(D) I, III and V  
(E) II and IV

63. A radioactive decay event in which the nucleus loses a neutron but gains a proton is

- (A)  $\alpha$  emission  
(B)  $\beta^-$  emission  
(C)  $\beta^+$  emission  
(D)  $\gamma$  radiation  
(E) None of the above

64. The phenomenon of electrophoresis was observed for the first time by

- (A) Oswald Avery in 1807  
(B) F. Reuss in 1828  
(C) Oswald Avery in 1828  
(D) F. Reuss in 1807

65. Electrophoresis is a technique used for \_\_\_\_\_ different types of molecules based on their patterns of movement in an electric field.

- (A) Separating  
(B) Detecting  
(C) Quantifying  
(D) Only (A) and (B)

66. An electrophoresis unit consists of

- (A) A power pack, gel slab, and gel comb  
(B) A plastic frame, power pack and buffer  
(C) A tank, plastic frame and gel comb  
(D) A power pack, tank, plastic frame and gel comb

67. The force, in newtons that drives a macromolecule with charge  $q$  toward an electrode, when placed in an electric field of potential difference  $E$  and separated by a distance  $d$ , is given by

- (A)  $qE$

- (B)  $qd$
- (C)  $dE$
- (D)  $qdE$

68. The velocity,  $v$ , of the charged macromolecule in Question 5 which encounters frictional resistance,  $f$ , is given by the equation

- (A)  $v = qE / f$
- (B)  $v = qf / E$
- (C)  $v = qdE / f$
- (D)  $v = qfE / d$

69. The electrophoretic mobility,  $\mu$ , of the charged macromolecule in Question 5 and 6 is given by

- (A)  $v/d$
- (B)  $v/Ed$
- (C)  $v/Eq$
- (D)  $v/E$

70. During electrophoresis, the current in the solution between the electrodes is conducted

- (A) mainly by the buffer ions, with a small proportion conducted by the sample ions
- (B) by buffer ions and sample ions equally
- (C) by only buffer ions
- (D) mainly by sample ions with a small proportion conducted by the buffer ions

71. The generation of heat in the medium during electrophoresis produces which of the following effects:

- (A) A decreased rate of diffusion of sample and buffer ions leading to broadening of the separated samples
- (B) The formation of convection currents, which leads to mixing of separated samples
- (C) A decrease of buffer viscosity and hence a sharpening of separated bands
- (D) All of the above

72. Electroendosmosis is a problem in electrophoresis caused by

- (A) heating fluctuations when power supply is not constant
- (B) presence of charged groups on the surface of the support medium
- (C) conduction of current by the buffer ions
- (D) the zone center migrating faster than the edges

73. For a good separation, electrophoresis grade agarose must have

- (A) many sulfate groups
- (B) few sulfate groups
- (C) moderate content of sulfate, carboxyl, and methoxyl groups
- (D) none of the above

74. In electroendosmosis the movement of electrolyte ions can be toward the

- (A) anode
- (B) cathode
- (C) zone center
- (D) no movement of electrolyte ions

75. Which of these is true?

- (A) Agarose is a linear polysaccharide made up of the basic repeating unit agarotriose
- (B) Agarose is a branched polysaccharide made up of the basic repeating unit agarobiose
- (C) Agarose is a linear polysaccharide made up of the basic repeating unit agarobiose
- (D) Agarose is a branched polysaccharide made up of the basic repeating unit agarotriose

76. In what way does agarose support medium overcome convective currents during electrophoresis?

- (A) The cross-linked structure
- (B) The variable pore size
- (C) both (A) and (B)
- (D) None of the above

77. Gelling properties of agarose is attributed to

- (A) both inter- and intramolecular hydrogen bonding within and between the long agarose chains
- (B) cross-linking of agarose chains with sulfate groups
- (C) both inter- and intramolecular methylene bridges within and between the long agarose chains
- (D) All of the above

78. 1% agarose gel is good for the separation of

- (A) only proteins
- (B) only nucleic acids
- (C) Either proteins or nucleic acids
- (D) both proteins and nucleic acids

79. Polyacrylamide gel is good for the separation of

- (A) only proteins
- (B) only nucleic acids
- (C) both proteins and nucleic acids
- (D) None of the above

80. The relative size of separated proteins on a gel is indicated by which of the following parameters?

- (A) Height of band from start point
- (B) Rate of migration through the gel
- (C) Thickness of band
- (D) None of the above

81. A cell is known to have about 2,000 proteins. Which method of gel electrophoresis would you select to resolve these proteins?

- A) SDS gel electrophoresis
- B) Native gel
- (C) Two-dimensional gel
- D) Western blotting

82. Which of these steps is/are not taken to improve resolution of continuous gel electrophoresis?

- I. Direct loading of sample on separating gel
- II. Use of high concentration of buffer ions
- III. Use of low concentration of buffer ions
- IV. Apply low concentration of sample

- A) Only I
- B) I and III
- C) Only III
- D) II and IV

83. Which of these gels would you use to separate 100 bp from 150 bp nucleic acid?

- (A) Agarose with high  $-\text{COOH}$  content
- (B) Agarose with high  $\text{SO}_4^-$  content
- (C) Polyacrylamide gel or agarose with high  $\text{SO}_4^-$  and  $-\text{COOH}$  content
- (D) Polyacrylamide gel or agarose with low  $-\text{SO}_4^-$  content
- (E) Only polyacrylamide gel

84. Which of these gels would you use to separate proteins by immunoelectrophoresis?

- (A) 12.5 %: 5 % acrylamide: BIS-acrylamide gel
- (B) 7.5 % : 5 % acrylamide: BIS-acrylamide gel
- (C) 3 % agarose
- (D) 1 % agarose
- (E) None of the above

85. Which of these reactions occur during polymerization of acrylamide?

- (A) Vinyl addition of straight polymer in head-to-tail fashion and copolymerization of acrylamide monomers
- (B) Vinyl addition of acrylamide monomers to form crosslinks and copolymerization straight polymers in head-to-tail fashion
- (C) Vinyl addition of acrylamide monomers in head-to-tail fashion and copolymerization straight polymers to form crosslinks
- (D) Vinyl addition of straight polymer to form crosslinks copolymerization of acrylamide monomers in head-to-tail fashion
- (E) None of the above

86. You want to improve upon the resolution of protein separation on a polyacrylamide gel. Which of these gel systems is the right one to use?

- (A) Gradient gel alone
- (B) Stacking gel alone
- (C) Gradient gel with stacking gel
- (D) Gradient gel with resolving gel
- (E) Resolving gel alone

Use Fig. 1. to answer questions 87 to 90.

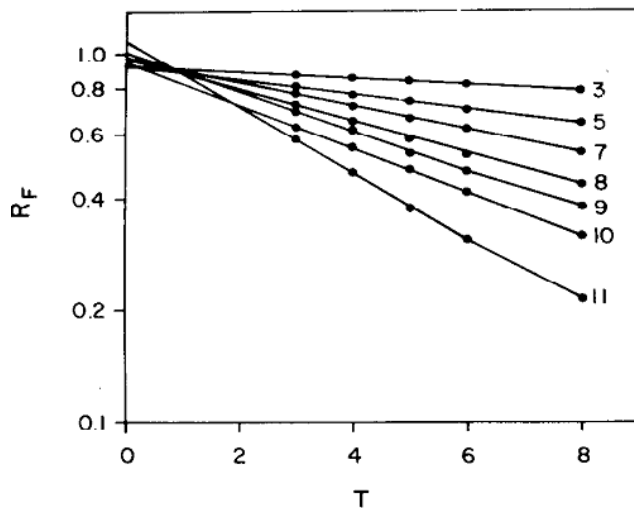


Fig. 1. A typical Ferguson plot of several soluble proteins.

87. The retardation coefficient of protein 11 is

- A) 0.54
- B) 0.43
- C) 0.59
- D) 0.22

88. The retardation coefficient of protein 10 is

- A) 0.54
- B) 0.43
- C) 0.32
- D) 0.22

89. The retardation coefficient of protein 9 is

- A) 0.54
- B) 0.43
- C) 0.32
- D) 0.81

90. Which protein has the least molecular weight?

- A) Protein 8
- B) Protein 9
- C) Protein 10
- D) Protein 11

91. Electrophoretic stacking of a discontinuous buffer system is achieved by which of the following sequence of events?

- (A) High concentration stacking gel →  $\text{Cl}^-$  leads glycinate trails → Kolrausch discontinuity develops → protein stacks
- (B) High concentration stacking gel → glycinate leads →  $\text{Cl}^-$  trails → protein stacks → Kolrausch discontinuity develops
- (C) Low concentration stacking gel → glycinate leads → Kolrausch discontinuity develops →  $\text{Cl}^-$  trails → protein stacks
- D) Low concentration stacking gel →  $\text{Cl}^-$  leads → glycinate ions trail → Kolrausch discontinuity develops → protein stacks
- (E) High concentration stacking gel →  $\text{Cl}^-$  leads → Kolrausch discontinuity develops → glycinate trails → protein stacks

92. Sodium dodecyl sulfate is of denaturing of polyacrylamide gel electrophoresis of proteins as \_\_\_\_\_ and \_\_\_\_\_ are for denaturing of polyacrylamide gel electrophoresis of DNA

- (A) Dithiothreitol and NaOH
- (B) Urea and formamide
- (C)  $\beta$ -mercaptoethanol and urea
- (D)  $\beta$ -mercaptoethanol and formamide
- (E) Uric acid and formaldehyde

93. Following SDS electrophoresis of histones that you have isolated from the nucleus of a eukaryote, you are getting one band per lane and/or some lanes show no band at all. What would be the reason for such results?

- (I) Anomalous migration of histones due to presence of extra charged groups on the protein
- (II) No migration of histones due to absence of charged groups on the protein
- (III) Retention of secondary structure due to incomplete denaturation by SDS
- (IV) Complete denaturation of the histones to produce amino acids which migrate with no impedance by the gel matrix

- (A) Only I
- (B) Only II
- (C) I and III
- (D) II and IV
- (E) II and IV

94. Which of these reagents and processes would you select to enhance denaturation of proteins that are difficult to denature by SDS alone?

- (A) Triton X-100 + formamide + urea
- (B) Triton X-100 + urea + acetic acid
- (C) SDS + Triton X-100 + acetic acid with heating
- (D) SDS + acetic acid + urea with heating
- (E) SDS + Triton X-100 + urea

95. The contents of a good loading buffer for SDS-PAGE of plant tissue would be which of the following?

- (I) More SDS, dithiothreitol, high pH
- (II) More SDS, and mercaptoethanol, high pH
- (III) Less SDS, CHES buffer, dithiothreitol, high pH
- (IV) Less SDS, CHES buffer, mercaptoethanol, high pH

- (A) Only I
- (B) Only II
- (C) I and III
- (D) II and IV
- (E) I, III, and IV

96. Four proteins of sizes, , 10 KD, 12.5 kD 25 kD and 100 kD were loaded in lanes 1 to 4, respectively, on SDS-PAGE gel and run with Tris-glycine buffer in the tank. Electrophoresis was stopped when bromophenol blue dye front was halfway down the gel. Some lanes did not show any band. What are these lanes?

- (A) Lanes 1 and 2
- (B) Lanes 1 and 3
- (C) All lanes
- (D) Only lane 1
- (E) Only lane 4

97. The tank buffer in question 65 is changed to Tris-Tricine buffer, samples reloaded and SDS-PAGE run again. Which lanes would show bands?
- (A) Lanes 1 and 2
  - (B) Lanes 2 and 3
  - (C) All lanes
  - (D) Only lane 1
  - (E) Only lane 4
98. You are using isozyme marker to determine victim, suspect, and a perpetrator in a crime scene where a spot of blood was left. Which method of electrophoresis would you use?
- (A) Isoelectric focusing
  - (B) Clear native PAGE
  - (C) 2-dimensional gel electrophoresis
  - (D) Cellulose acetate electrophoresis
  - (E) Quantitative preparative native continuous PAGE
99. Which is the correct sequence of the events listed below, which occur during fixation of proteins on a gel by methanol:water:glacial acetic acid reagent?
- (I) Protein complex trapped inside gel
  - (II) Low pH disrupts hydrogen bonds
  - (III) Hydrophobic portions of protein exposed by organic solvent
  - (IV) Uncoiling of peptide chains
  - (V) Irreversible association between peptide chains
- (A) I, III, IV, II, V
  - (B) I, II, III, IV, V
  - (C) III, IV, II, I, V
  - (D) IV, I, V, III, II
  - (E) II, III, IV, V, I
100. Which stain would you use to detect proteins up to 200 ng concentration on a polyacrylamide gel?
- (A) Silver stain
  - (B) Fluorescent dye
  - (C) Coomassie Brilliant Blue G250
  - (D) Coomassie Brilliant Blue R250
  - (E) Ethidium bromide
101. You performed electrophoresis on glycoproteins, loaded in two lanes and used horseradish peroxidase as a positive control in the third lane. Only one sample lane showed a band and there was no band in lane 3. Which of these not may be a good reason for your observation?
- (A) Samples were contaminated
  - (B) Lane with no band means sample concentration was below detection limit
  - (C) The horseradish peroxidase was inactive
  - (D) The method did not work well
  - (E) All of the above
102. Which of these systems would make the best IEF gel?
- A) 1% ampholyte, 5 % Bis/2% T, persulfate, TEMED, 1 hr polymerization
  - B) 2% ampholyte, 2 % Bis/4% T, riboflavin, persulfate, TEMED, 1 hr polymerization
  - C) 3% ampholyte, 5 % Bis/2% T, riboflavin, persulfate, TEMED, 2 hr polymerization
  - D) 2% ampholyte, 5 % Bis/4% T, riboflavin, persulfate, TEMED, 2 hr polymerization

103. Choose the correct term to fill in the blank spaces. \_\_\_\_\_ is a major problem in IEF. It can be overcome by treatment with \_\_\_\_\_.
- A) Protein denaturation; octylglucoside
  - B) Protein denaturation; Triton X-100
  - C) Protein aggregation at pI; Urea
  - D) Protein aggregation at pI; SDS**
104. Which stain would you use to detect proteins greater than 200 ng concentration on a polyacrylamide gel?
- (A) Silver stain
  - (B) Fluorescent dye
  - (C) Coomassie Brilliant Blue G250
  - (D) Coomassie Brilliant Blue R250**
  - (E) Ethidium bromide
105. You performed electrophoresis on glycoproteins, loaded in two lanes and used horseradish peroxidase as a positive control in the third lane. Only one sample lane showed a band and there was no band in lane 3. Which of these not may be a good reason for your observation?
- (A) Samples were contaminated
  - (B) Lane with no band means sample concentration was below detection limit
  - (C) The horseradish peroxidase was inactive
  - (D) The method did not work well**
  - (E) All of the above
106. Which of these detection protocols would you use to detect glycoprotein on an electrophoresis gel slab?
- A) Treat gel with periodic acid→Add Schiff's reagent→Wash with dH<sub>2</sub>O→Magenta color develops**
  - B) Treat gel with Schiff's reagent→Add periodic acid→Wash with dH<sub>2</sub>O→Red color develops
  - C) Treat gel with periodic acid→Add Schiff's reagent→Wash with dH<sub>2</sub>O→Red color develops
  - D) Treat gel with Schiff's reagent→Add periodic acid→Wash with dH<sub>2</sub>O→Magenta color develops
107. Select the correct sequence of chromogenic immunostaining for a protein
- A) Protein on gel→Antibody-Phosphatase→Phosphorylated substrate→Catalysis→Color**
  - B) Protein on gel→Antibody-Phosphorylated substrate→Phosphatase→Catalysis→Color
  - C) Protein on gel→Phosphatase-Phosphorylated substrate→Antibody→Catalysis→Color
  - D) None of the above
108. Select the correct sequence of luminogenic immunostaining
- A) Protein on gel→Phosphatase-Luminogenic substrate→Antibody→Catalysis→Color
  - B) Protein on gel→Antibody-Luminogenic substrate→Phosphatase→Catalysis→Color
  - C) Protein on gel→Antibody-Phosphatase→luminogenic substrate →Catalysis→Color**
  - D) None of the above
109. Which of these compounds is not a chromogenic substrate used in immunostaining?
- A) PNPP
  - B) CSPD**
  - C) BCIP
  - D) NBT

110. You performed electrophoresis on glycoproteins, loaded in two lanes and used horseradish peroxidase as a positive control in the third lane. Only one sample lane showed a band and there was no band in lane 3. Which of these not may be a good reason for your observation?

- (A) Samples were contaminated
- (B) Lane with no band means sample concentration was below detection limit
- (C) The horseradish peroxidase was inactive
- (D) The method did not work well
- (E) All of the above

111. Which of these is the correct sequence of immunostaining of western blot?

- (A) Blot → Blocking → Horseradish peroxidase → Antibody → CSPD → Blue color
- (B) Blot → Blocking → Antibody → Horseradish Peroxidase → BCIP/NBT → Blue color
- (C) Blot → Antibody → Blocking → Horseradish Peroxidase → CSPD → Luminiscence
- (D) Blot → antibody → Blocking → Alkaline Phosphatase → BCIP/NBT → Blue color
- (E) Blot → Blocking → Alkaline Phosphatase → Antibody → BCIP/NBT → Luminiscence

112. Select the best method for separating DNA fragments which differ by one base pair

- A) Denaturing gel electrophoresis on polyacrylamide
- B) Nondenaturing gel electrophoresis on polyacrylamide
- (C) Denaturing gel electrophoresis on agarose
- D) Nondenaturing gel electrophoresis on agarose

113. Which of the following buffers would you select for resolving a mixture of large fragment sizes linear and supercoiled DNA?

- A) TBE
- B) TPE
- (C) TAE
- D) None of the above

114. You want to determine the molecular weight of a DNA of size 1 million base pair  
Which of the following methods is most suitable?

- A) Nondenaturing low percentage agarose gel electrophoresis
- (B) Pulsed Field gel electrophoresis
- C) Denaturing low percentage agarose gel electrophoresis
- D) Nondenaturing low percentage polyacrylamide gel electrophoresis

115. Which of these applications of electrophoresis are employed in criminal investigations?

- I. RFLP
- II. Southern blotting
- III. Northern blotting
- IV. Western blotting

- A) I only
- (B) II only
- C) III only
- D) I and III
- E. III and IV

116. Which of these applications of electrophoresis are employed in gene expression studies?

- I. RFLP
- II. Southern blotting
- III. Northern blotting
- IV. Western blotting

- A) I only
- B) II only
- C) III only
- D) I and III
- E. III and IV

117. Predict the mobilities of the following hemoglobin types on a cellulose acetate paper electrophoresis

- A) HbA>HbC>HbS
- B) HbC>HbA>HbS
- C) HbA>HbS>HbC
- D) HbS>HbC>HbA
- E) None of the above

118. Electrophoresis of blood gamma globulins in a patient showed elevated peaks. Which of the following disease conditions are likely?

- A) Rheumatoid arthritis
- B) Hyperthyroidism
- C) Gastrointestinal diseases
- D) Hemolytic anemia
- E) Problems with the immune system

119. To investigate an event of myocardial infarction, a clinician would request for which of the following electrophoresis

- I) Electrophoresis of troponins T and I
- II) Electrophoresis of isozymes of lactate dehydrogenase enzyme  $\alpha$  and  $\beta$
- III) Electrophoresis for the isozyme pattern of creatine kinase MM, BB, MB

- A) I and II
- B) II and III
- C) II only
- D) III only
- E) All of the above

120. Given  $\ln(N_t/N_0) = -\lambda t$  and that the half-life of  $^{32}\text{P}$  is 14.2 days, how long would it take a solution containing 42,000 d.p.m. of  $^{32}\text{P}$  to decay to 500 d.p.m.?

- (A) 100 days
- (B) 55 days
- (C) 4 days
- (D) 21 days
- (E) 91 days

121. An experimental sample of  $^3\text{H}$  on a filter paper in scintillation fluid gave a count rate of 1,450 c.p.m. in a liquid scintillation counter. The filter was removed and 5,064 d.p.m. added to it. On recounting, the filter gave a reading of 2,878 c.p.m. What was the d.p.m. of the experimental sample?

- (A) 5,140 d.p.m.
- (B) 5,000 d.p.m.
- (C) 4,152 d.p.m.
- (D) 5,400 d.p.m.
- (E) 4,500 d.p.m.

122. The efficiency of counting 100,000 d.p.m. of a [ $^{35}\text{S}$ ]methionine was estimated in a scintillation counter using two channels, A and B, in a scintillation fluid containing increasing amounts of chloroform. The following data were obtained:

Chloroform (ml)	c.p.m. A	c.p.m. B
0	48,100	54,050
1	31,612	42,150
2	17,608	28,400
3	7,400	15,000

An unknown sample of [ $^{35}\text{S}$ ]methionine gave the following data:

Channel A 3,056 c.p.m.

Channel B 4,900 c.p.m.

How much radioactivity is present in the unknown sample?

- (A) 7,130 d.p.m.
- (B) 6,740 d.p.m.
- (C) 11,200 d.p.m.
- (D) 10,677 d.p.m.
- (E) 16,977 d.p.m.

123. A liquid scintillation counter recorded 564 c.p.m. from a sample over 20 min of counting. What is the accuracy of the measurement for 95.5% confidence?

- (A)  $\pm 9$  c.p.m.
- (B)  $\pm 16$  c.p.m.
- (C)  $\pm 11$  c.p.m.
- (D)  $\pm 15$  c.p.m. (150)
- (E)  $\pm 14$  c.p.m.

124. The decay event in which the nucleus loses a neutron but gains a proton is termed

- A) Beta emission
- B) Positron emission
- C) Electron capture
- D) X- radiation

125. What is the correct arrangement of the half-lives of the following radioisotopes?

- A)  $^{33}\text{P} < ^3\text{H} < ^{35}\text{S} < ^{59}\text{Fe} < ^{32}\text{P}$
- B)  $^{32}\text{P} < ^{33}\text{P} < ^{59}\text{Fe} < ^{35}\text{S} < ^3\text{H}$
- C)  $^3\text{H} < ^{32}\text{P} < ^{59}\text{Fe} < ^{35}\text{S} < ^{33}\text{P}$
- D)  $^{59}\text{Fe} < ^3\text{H} < ^{32}\text{P} < ^{33}\text{P} < ^{35}\text{S}$
- E)  $^{35}\text{S} < ^{32}\text{P} < ^3\text{H} < ^{33}\text{P} < ^{59}\text{Fe}$

126. Select the correct statement governing interaction of radioisotopes with matter

- A)  $\beta$  particles have equal ionization and penetrative power as  $\alpha$ - radiation.
- B)  $\beta$  particles are more ionizing and more penetrating than  $\alpha$ - radiation.
- C)  $\beta$  particles are more ionizing and less penetrating than  $\alpha$ - radiation.
- D)  $\beta$  particles are less ionizing and less penetrating than  $\alpha$ - radiation.
- E)  $\beta$  particles are less ionizing and more penetrating than  $\alpha$ - radiation.

127. Which of these statements about radioisotope emission is not true?

I. All alpha emissions have the same energy

II. All beta emissions have the same energy

III. The energy of  $^{35}\text{S}$  emission is higher than that of  $^{33}\text{P}$

IV. Decay events by alpha particle is accompanied by emission of neutrino

A) All except II

B) All except III

C) Only I

D) Only IV

128. Compton scattering is the result of interaction of \_\_\_\_\_  $\gamma$  radiation with matter as \_\_\_\_\_ is the result of interaction of high-energy  $\gamma$  radiation with matter

A) Low energy, photoelectric absorption

B) High energy, Bremsstrahlung

C) Medium energy, pair production

D) None of the above

129. Select the correct sequence of pulse flow upon increasing the voltage in a gas ionization chamber.

A) Ionization chamber region  $\rightarrow$  Geiger-Müller region  $\rightarrow$  Proportional counter region  $\rightarrow$  Limited proportional region

B) Ionization chamber region  $\rightarrow$  Proportional counter region  $\rightarrow$  Geiger-Müller region  $\rightarrow$  Continuous discharge

C) Ionization chamber region  $\rightarrow$  Limited proportional region  $\rightarrow$  Proportional counter region  $\rightarrow$  Geiger-Müller region

D) Ionization chamber region  $\rightarrow$  Limited proportional region  $\rightarrow$  Geiger-Müller region  $\rightarrow$  Proportional counter region  $\rightarrow$  Continuous discharge

E) Ionization chamber region  $\rightarrow$  Proportional counter region  $\rightarrow$  Limited proportional region  $\rightarrow$  Geiger-Müller region

130. Solid scintillation counting is good for \_\_\_\_\_ while liquid scintillation is good for \_\_\_\_\_

A)  $\gamma$  emission, weak beta emission

B) Weak beta emission, medium-energy beta emission

C) Alpha emission, weak beta emission

D) Medium-energy beta emission,  $\gamma$  emission

131. Coincidence counting systems is for reduction of \_\_\_\_\_ as adjustment of pulse height analyzer is for reduction in \_\_\_\_\_.

A) Chemiluminescence, photomultiplier noise

B) Phospholuminescence, chemiluminescence

C) Photomultiplier noise, phospholuminescence,

D) Chemical quenching, static electricity

E) None of the above

132. When counting dual-labeled samples in a scintillation counter, a pulse height analyzer detects \_\_\_\_\_ of emission, the operator selects \_\_\_\_\_ to accept or reject \_\_\_\_\_.

A) Windows, pulses,  $E_{\text{max}}$ ,

B)  $E_{\text{max}}$ , windows, pulses

C) Pulses,  $E_{\text{max}}$ , windows

D) None of the above

133. Select the right cocktail for liquid scintillation counting on the basis of solvent, primary and secondary fluor

- A) Toluene, naphthalene, Butyl-PBD
- B) Naphthalene, PPO, POPOP
- C) Butyl-PBD, Bis-MSB, POPOP
- D) Toluene, PPO, Bis-MSB

134. Select the right cocktail for liquid scintillation counting on the basis of solvent, primary and secondary fluor.

- A) Phenylxylyl ethane, Naphthalene, BBQ
- B) Butyl-PBD, PPO, Bis-MSB
- C) Naphthalene, Phenylxylyl ethane, POPOP
- D) Phenylxylyl ethane, pseudocumene, POPOP

135. An experimental sample of  $^{14}\text{C}$  in a small vial mixed with scintillation fluid gave a count rate of 900 c.p.m. in a liquid scintillation counter. The filter was removed and a standard [ $^{14}\text{C}$ ] hexadecane 5,481 d.p.m. added to it. On recounting, the filter gave a reading of 2,727 c.p.m. What is the counting efficiency of the scintillation counter?

- A) 16.7%
- B) 23.4%
- C) 30.6 %
- D) 33.3%
- E) 66.2%

137. What is the d.p.m. of the experimental sample in question 65?

- A) 1,360
- B) 2,700
- C) 2,941
- D) 3,846
- E) 5,389

138. The efficiency of detecting  $^{14}\text{C}$  in a scintillation counter was determined by counting a standard sample containing 105,071 d.p.m. at different degrees of quench analyzed by the external standard approach. The counts at each standard quench parameter are listed below.

c.p.m	SQP
87,451	0.90
62,361	0.64
45,220	0.46
21,014	0.21

SQP = standard quench parameter

An experimental sample gave 3,488 c.p.m. at an SQP of 0.65. What is the true count rate?

- A) 5,813 d.p.m.
- B) 5,917 d.p.m
- C) 6,110 d.p.m
- D) 6,300 d.p.m.

139. A scintillation counter recorded 2,412 c.p.m. for  $^{32}\text{P}$  over a period of 1 min. What is the accuracy of the measurement for 95.5% confidence?

- A)  $\pm 59$  c.p.m.
- B)  $\pm 67$  c.p.m.
- C)  $\pm 98$  c.p.m.
- D)  $\pm 102$  c.p.m.

140. The sample in question 68 was recounted. The counter recorded 24,000 c.p.m. over 10 min. What is the accuracy of the measurement for 99 % confidence?

- A)  $\pm 146$  c.p.m.
- B)  $\pm 163$  c.p.m.
- C)  $\pm 191$  c.p.m.
- D)  $\pm 208$  c.p.m.

141. To determine the nutritional quality of protein in fish muscle, the content of histidine was determined by isotope dilution analysis. To an acid hydrolysate of the protein (1 mg) a  $1.0\ \mu\text{mole}$  of  $[^3\text{H}]\text{histidine}$  ( $1\ \text{Ci mol}^{-1}$ ) was added. A sample of histidine was purified from the hydrolysate by chromatography and the specific activity determined by scintillation counting at 50 % efficiency. The value obtained was  $1,890\ \text{c.p.m. }\mu\text{g}^{-1}$ . What is the content of histidine in fish muscle protein? Note:  $1\ \text{Ci} = 22.2 \times 10^{11}\ \text{d.p.m.}$ ;  $M_r\ \text{histidine} = 155$ .

- A)  $74\ \mu\text{g}$
- B)  $268\ \mu\text{g}$
- C)  $432\ \mu\text{g}$
- D)  $636\ \mu\text{g}$

142. What is the length scale used in nanotechnology?

- A. Size of the order of  $10^{-9}\ \text{m}$
- B. Size of the order of  $10^{-8}\ \text{m}$
- C. Size of the order of  $10^{-7}\ \text{m}$
- D. Size of the order  $10^{-5}\ \text{m}$

143. Macroscopic view of properties

- A. Consider behavior of individual molecules.
- B. Consider behavior of all molecules as identical.
- C. Consider gross or average behavior of a number of molecules
- D. Consider behavior of ionic molecules.

144. Nanotechnology rests on the technology that involves devices and systems

- A. Less than 200 nm.
- B. Less than 100 nm.
- C. Less than 1000 nm.
- D. Less than 300 nm.

145. What is a carbon nanotube?

- A. Circular tube made of graphite
- B. Nanotubes are hollow cylinders made up of carbon atoms.
- C. Nanotubes are made of carbon sheet

146. What is a nanofluid?

- A. Fluids in nanosize device
- B. Mixture of different fluids
- C. Fluids with suspensions of solid nano-particles it
- D. Mixture of different solids.

147. Carbon nanotubes are stronger than steel.

- A. Carbon nanotubes are 100 times stronger than steel at one-sixth of the weight.
- B. Carbon nanotubes are 10 times stronger than steel at one-sixth of the weight.
- C. Carbon nanotubes are 1000 times stronger than steel at one-sixth of the weight
- D. Carbon nanotubes are 10000 times stronger than steel at one-sixth of the weight.

148. Single Walled Carbon Nano-Tubes (SWCNT) are:

- A. Excellent conductors
- B. Poor conductor
- C. Semiconductors
- D. Excellent insulators

149. Nanofluid thermal conductivity is increase by a factor of 20-30% by adding:

- A. 10-15 % of nanoparticles
- B. 20-30% of nanoparticles
- C. (3-4%) of nanoparticles
- D. (20-25%) of nanoparticles

150. Nanostructured materials are formed by

- A. Creating increased surface area per unit volume.
- B. Creating decreased surface area per unit volume
- C. Keeping same surface area per unit volume
- D. Keeping same volume per unit surface area

151. Nanoparticle properties are:

- A. Same as in bulk material
- B. Little bit different form bulk material properties.
- C. Significantly different form bulk material properties
- D. Same as in microporous materials

152. Conduction Heat Transfer is primarily important in solid and stationary fluid:

- A. False
- B. For some materials
- C. True
- D. None of the above

153. Thermal conductivity enhancement for nano-fluid reported to be greater than the base fluid

- A. 20-30%
- B. 10-20 %
- C. 30-40%
- D. 40-50 %

154. Typical composition of nano particles in nano-fluids:

- A. 10-20 %
- B. 3-4%
- C. 8-10%
- D. 20-30%

**INDICATE WHETHER THE FOLLOWING STATEMENTS ARE (A) TRUE OR (B) FALSE**

155. Gel electrophoresis is used to separate different nucleic acid or protein species **True**
156. Liquid scintillation counting combines electrophoresis and labeled probes to identify specific DNA or map and quantify transcripts **False**
157.  $^{13}\text{C}$  of ribose is for binding to  $^{15}\text{N}$  of a purine **False**
158.  $^{13}\text{C}$  of deoxyribose is for binding to  $^{15}\text{N}$  of a pyrimidine **False**
159. Given the inexorable progress of technology, it seems inevitable that the sensitivity of detection of molecules will ultimately be pushed beyond the yoctomole level ( $10^{-24}$  mole). *Hint: use Avogadro's number.*
160. Computer-assisted image processing makes it possible to see clear images of objects such as single microtubules ( $0.025\text{ }\mu\text{m}$ ) that are well below the limit of resolution ( $0.2\text{ }\mu\text{m}$ ). **False**
161. Because the DNA double helix is only 10 nm wide – well below the limit of resolution of the light microscope, it is impossible to see chromosomes in living cells without special stains **True**

**Match each definition below with its term from the list provided**

**List**

Polyacrylamide gel	Vertical systems	Tris-Acetate-EDTA buffer
Horizontal systems	Copolymerization	Persulfate
Ed	Acrylamide	Eqd
Paper	Convection currents	Agarose
Eq	Ionized silanol groups	Diffusion
Vinyl addition	Tris-EDTA buffer	TEMED
BIS-acrylamide	Starch	Tris-Acetate-Ethanoate buffer

**Definitions**

11. Gel systems are routinely used for protein separation on acrylamide gels\_\_\_\_ **Vertical systems** \_\_\_\_
12. The force that drives a charged molecule toward an electrode\_\_\_\_ **Convection currents** \_\_\_\_
13. The cause of mixing of separated samples during electrophoresis\_\_\_\_\_
14. This support media gives poor separation of protein and nucleic acids\_\_\_\_ **Paper** \_\_\_\_
15. A cause of electroendosmosis \_\_\_\_ **Ionized silanol groups** \_\_\_\_\_
16. Medium for separation of large nucleic acids\_\_\_\_ **Polyacrylamide gel** \_\_\_\_\_
17. Buffer for making agarose gels\_\_\_\_ **Tris-Acetate-EDTA buffer** \_\_\_\_\_
- A catalyst/initiator for preparing polyacrylamide gel\_\_\_\_ **TEMED** \_\_\_\_\_
- Polymerization of acrylamide in head-to-tail fashion\_\_\_\_ **Vinyl addition** \_\_\_\_\_
- This reagent has a molecular formula of  $\text{C}_7\text{H}_{10}\text{N}_2\text{O}_2$ \_\_\_\_ **BIS-acrylamide** \_

**Match each definition below with its term from the list provided**

Bright-field microscope	Differential-interference-contrast microscope
Confocal microscope	Optical sectioning
SDS-PAGE	limit of resolution
2-D gel electrophoresis	optical tweezers
Dark-field microscope	phase contrast microscope
Green fluorescent protein (GFP)	light microscope
Fluorescence microscope	scanning electron microscope (SEM)
Western blotting	electron microscope
Deconvolution	

1. 18. Technique for protein separation in which the protein mixture is run first in one direction and then in a direction at right angles to the first 2-D gel electrophoresis
2. 19. Technique in which a protein mixture is separated by running it through a gel containing a detergent that binds to and unfolds the protein SDS-PAGE
3. 20. Technique in which proteins are separated by electrophoresis, immobilized on a paper sheet and then analyzed, usually by means of labeled antibody western blotting
4. 21. Fluorescent protein (from a jellyfish) that is widely used as a marker for monitoring the movements of proteins in living cells green fluorescent protein
5. The minimal separation between two objects at which they appear distinct. limit of resolution
6. 23. The normal light microscope in which the image is obtained by simple transmission of light through the object being viewed Bright field microscope
7. 24. The three-dimensional microscopic imaging method that removes the blurring of the image arising from a point source function by means of algorithm phase contrast
8. 25. Similar to a light microscope but the illuminating light is passed through one set of filters before the specimen, to select those wavelengths that excite the dye, and through another set of filters before it reaches the eye, to select those wavelengths emitted when the dye fluoresces Fluorescence microscope
26. The three-dimensional microscopic imaging method that makes it possible to focus on a chosen plane in a thick specimen while rejecting the light that comes from out-of-focus regions above and below that plane Deconvolution
9. 27. Type of microscopy that produces a clear image of a given plane within a solid object. It uses a laser beam as a pin-point source of illumination and scans across the plane to produce a two-dimensional optical section Confocal microscope
10. 28. Type of electron microscope that produces an image of the surface of an object scanning electron microscope
11. 29. Type of microscope that uses a beam of electrons to create an image electron microscope

