SBL201 (High-dimensional Biology): Major exam

May 10, 2016
Total: 30 marks
Time: 2 hour

Part I: Choose the most appropriate answer or fill in the blanks (1X15 = 15 marks)

1) In order to obtain the best resolution in a light microscope which of the following light sources will you pick?
a) Blue light
b) Green light
c) Yellow light
d) Red light
e) None of the above

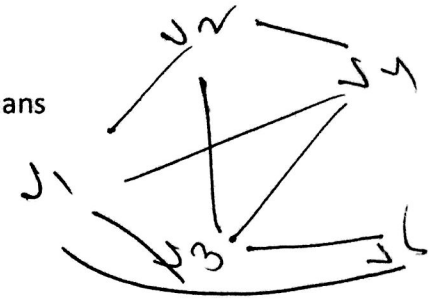
2) Which of the following is NOT true about mitochondrial DNA?
a) Mitochondrial DNA is much smaller than nuclear DNA
b) Mitochondrial DNA is present in fewer copies than nuclear DNA in most cells
c) Mitochondrial DNA is analyzed to resolve maternity disputes
d) If necessary mitochondrial DNA may also be used to resolve criminal cases
e) None of the above

3) Tissue microarrays are used to analyze
a) Gene expression
b) Protein expression
c) SNPs
d) miRNA
e) None of the above

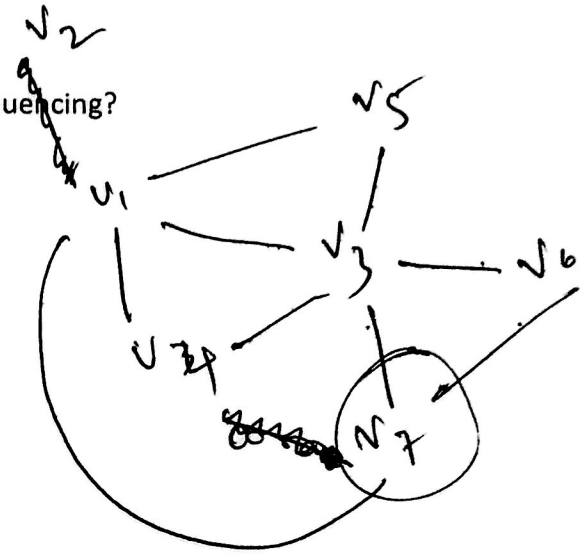
4) Which of the following is TRUE about the control line for an antigen detection assay using immunochromatograhy?
a) It is coated with anti-species antibodies
b) It is coated with colloidal gold antibodies
c) It is coated with colloidal gold
d) It is coated with human antibodies
e) None of the above

5) Which of the statements is NOT true about telomeres?
a) Telomere shortening occurs in all chromosomes in a given cell at a similar rate
b) The length of the telomere is critical for initiation of cell division
c) The average telomere length will be comparable in all the cells of a 60 year old lady
d) Telomeres prevent inappropriate DNA repair
e) None of the above

6) Which of the following is NOT true about micro RNAs
a) They inhibit transcription
b) They regulate gene expression at a post-transcriptional level
c) There are more than 1500 species of miRNAs reported in humans
d) They are non-coding RNA sequences
e) None of the above



7) Most of the over-the-counter local anesthetics target
a) receptors
b) enzymes
c) transportation proteins
d) the pain center in the brain
e) none of the above

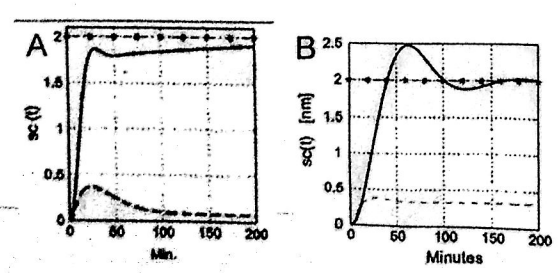


8) Which of the following is NOT true about Sanger sequencing?
a) It uses both dNTPs and ddNTPs
b) It requires the use of two primers
c) The ddNTPs used are fluorescently labelled
d) It does not require the use of a DNA polymerase
e) None of the above

9) Werner syndrome is linked to
a) Shorter length of telomeres at birth
b) Complete lack of telomerase expression
c) Mutations in the telomerase gene
d) Point mutations in the telomere sequence
e) None of the above

10) The following sequence of human DNA is heavily methylated "ACACTCGGCCGCGAATCATAACC". If you were to subject this DNA fragment to bisulfite conversion and then sequence it, the sequence in the electropherogram would read "_____"(write the expected sequence or its complement).

11) In translation control, the 48S initiation complex (SC) was measured (black dots) and this response was modeled (filled line); the unforced system response is shown is dashed lines. Which of the following statements is correct?



a) The model in Fig A is correct because It gives a smooth response
b) The model in Fig B is not correct because it gives an oscillatory response
c) The response in Fig B shows how nature has evolved to eliminate error
d) The response in Fig A shows how nature gradually eliminates error
e) None of the above

12) Henry Markram and his team simulated a rat's neocortical column, a small functional unit of brain tissue containing about 10,000 neurons, as a part of his blue brain project. The following is correct statement:

a) 10,000 neurons were distributed over 10 columns
b) 10,000 neurons were distributed over the entire rat brain
c) All 10,000 neurons were of the same type distributed over 10 columns
d) Several different types constituted the 10,000 neurons that made up 1 column
e) None of the above

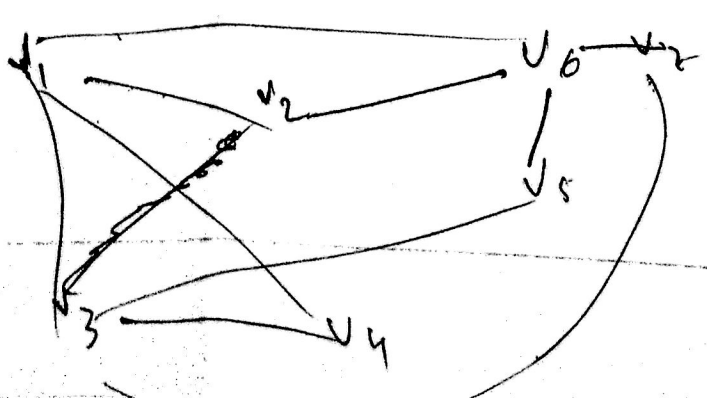
13) Naturally occurring networks in cells are different from random networks because
a) Natural networks have more edges that random networks
b) Natural networks have more self edges that random networks
c) Random networks are more dense than natural networks
d) Random networks have more self edges that natural networks
e) The number of sub-networks in nature are higher than in random networks

14) The elements in a biological network, they be signal molecules, proteins, genes or other biological entities, are usually the vertices of the graph and the edges represent some sort of interactions between them. One of the reasons for using graph theory to understand biological networks is:
a) Not all the kinetic parameters of the biological entities are known
b) Since variables are not known, large networks can be described by using curved lines
c) Feed-forward loop variables can be represented by ordinary differential equations
d) Nonlinear complexity parameters can be removed using Laplace transforms
e) None of the above

15) Which of the following are graphs G { (name of node, number of edges of node) ... }

a. G{(v1, 4), (v2, 3), (v3, 5), (v4, 2), (v5, 2)}
b. G{(v1, 4), (v2, 3), (v3, 5), (v4, 2), (v5, 2), (v6,1)}
c. G{(v1, 4), (v2, 1), (v3, 5), (v4, 2), (v5, 2), (v6,4), (v7,3)}
d. G{(v1, 4), (v2, 1), (v3, 5), (v4, 1), (v5, 2), (v6,4), (v7,3)}

a) b & c
b) c & d
c) a, b & c
d) a & d
e) None of the above



Part II: Write short notes on <u>any 3</u> of the following (3 x 3 = 9 marks)

1) Real time PCR
2) Causes of cancer
3) STR typing
4) Telomeres and aging

Part III: case study (2 x 3 = 6 marks)

1. You are the head of a research lab and are doing a PCR-RFLP to identify the genetic mutation causing sickle cell anemia. The wild-type sequence is "5'.....TGAG.....3' " the mutant sequence is "5'.....TGTG.....3' " (It is a A to T mutation). You use a restriction enzyme that recognizes the sequence "TGTG" and cleaves it. If a sample contains the sequence "5'.....TCTG.....3' " (i.e. the A to T mutation and an additional G to C mutation). Will your PCR-RFLP type this sample as wild-type or mutant. Explain. (2 marks)

2. Your are a PhD student and your objectives are to find out gene expression signatures for the diagnosis of Merkel cell cancer, a rare type of skin cancer. Assuming that clinical samples are available and resources are not a limiting factor - what are the samples you would test and what are the methods that you will use for finding out gene expression signatures for the diagnosis of Merkel cell cancer? (2 marks)

3. You are the head of a genetic analysis consortium analyzing circulating tumour cells (CTCs) from blood. You have developed a method to enrich CTCs (i.e. eliminate non CTCs from blood cells and increasing the CTC ratio from 1: 1 billion cells to 1: 100 cells). A scientist from your group who is performing the enrichment followed by next generation sequencing of the enriched cells make one mistake – he forgets to make the "water-in-oil" emulsion for the bead-based PCR used for NGS (pyrosequening). He adds all other reagents as required and makes no errors in the pyrosequencing. Assuming that he has made no other errors during the entire process - what is the impact of his failing to make the "water-in-oil" emulsion on the results? Why ?(2 marks)