Friday 11/12/04

7.012 Quiz 3 Answers

A ≥ 85	18% of test takers
B 72-84	41% of test takers
C 60-71	23% of test takers
D 50-59	11.4% of test takers
F ≤ 58	6.6% of test takers

REGRADE Requests with attached notes describing the problem due by November 24th noon.

Question	Value	Score
1	25	
2	19	
3	15	
4	15	
5	26	
	100	

Question 1

a) Circle whether the following antigens **can be** specifically and **directly** recognized by Antibodies and/or T cell receptors. 9 points-Graded horizontally. 1 Point each row,both have to be correct to get the point. The bottom row is 2 points.

Can be recognized by Antibodies	Can be recognized by T cell receptors	Antigens
YES NO	YES NO	Lipids
YES NO	YES NO	Carbohydrates
YES NO	YES NO	Bacterial surface proteins
YES NO	YES NO	Viral capsids
YES NO	YES NO	3-Dimensional polypeptide folds in native proteins
YES NO	YES NO	Linear oligopeptides
YES NO	YES NO	Non-Self MHC Class I/II molecules
YES NO	YES NO	MHC Class I/II molecules complexed with linear oligopeptides

b) True or False. 7 points

T F i) B cells can generate higher affinity antibodies for antigens over time.

T **F** ii) T cells can generate higher affinity T cell receptors for antigens over time.

T **F** iii) A **single** B cell might make antibodies that recognize many different epitopes on a viral capsid protein.

T **F** iv) Each of us is born with hundreds of genes each of which encodes an antibody to recognize a specific virus.

T F v) Macrophages envelope and digest foreign antigens nonspecifically.

T **F** vi) T-cell receptors are membrane bound and thus can signal the T cell to ingest antigen.

T **F** vii) Cytotoxic T cells can activate B cells to proliferate.

Name_____

d) Which ONE of the following does NOT provide innate immunity against pathogens? 2pts

blinking macrophages
ciliated cells in trachea mucous membranes
low pH of stomach **plasma cells**
lysozyme in tears skin

e) Which of the following cells can you be **sure** CAN **NOT** have the same genetic content of a skin cell. For any circled, on the adjacent line, explain why in 5 words **or less**. 4 pts

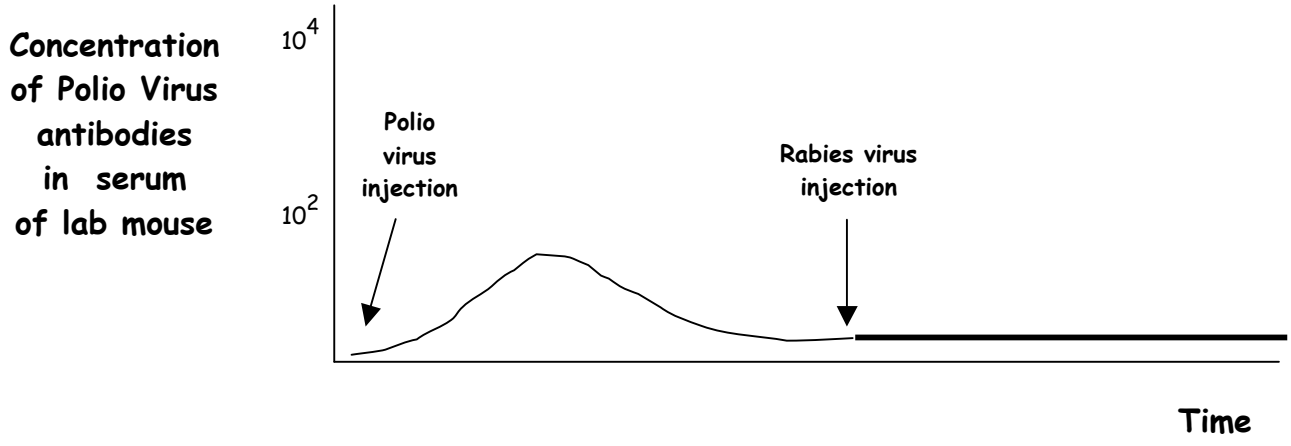
Helper T cell ___dna rearrangement of TCR____ or ___VDJ rec.__

Lung Cell _____

Macrophage _____

Plasma Cell _____VDJ REC or somatic mutation or hypermutation or junctional diversity____

f) Continue the graph following the exposure to rabies virus in this laboratory mouse. **3 points**



Question 2

Winston, an avid cigarette smoker, detects tumors in 3 of his 6 dogs. Lucky Strike has an ear tumor, Virginia Slims has a paw tumor, and Kool has a tail tumor. Bob, a biologist friend, takes cells from each tumor as well as cheek cell samples from the dogs as controls and cultures them in Petri dishes. All of the cheek cell cultures grow as a monolayer but all of the tumor cell cultures exhibit foci.

a) Which ONE of the following properties do the tumor cells lack, resulting in this growth difference.3 pts

ATP hydrolysis | Contact Inhibition | G5 processing | Retinoblastoma | Signaling cascade

b) Bob brushes up on the molecular nature of different cancer mutations. Match the following mutations to their respective phenotypes at the cellular level. 4 pts

___o_ Tumor Suppressor mutation

___l_ Oncogene mutation

l) dominant
m) G5 processing defective
n) opportunistic
o) recessive
p) none of these

To determine the cause of each of the dogs' tumors, he performs the following experiments.

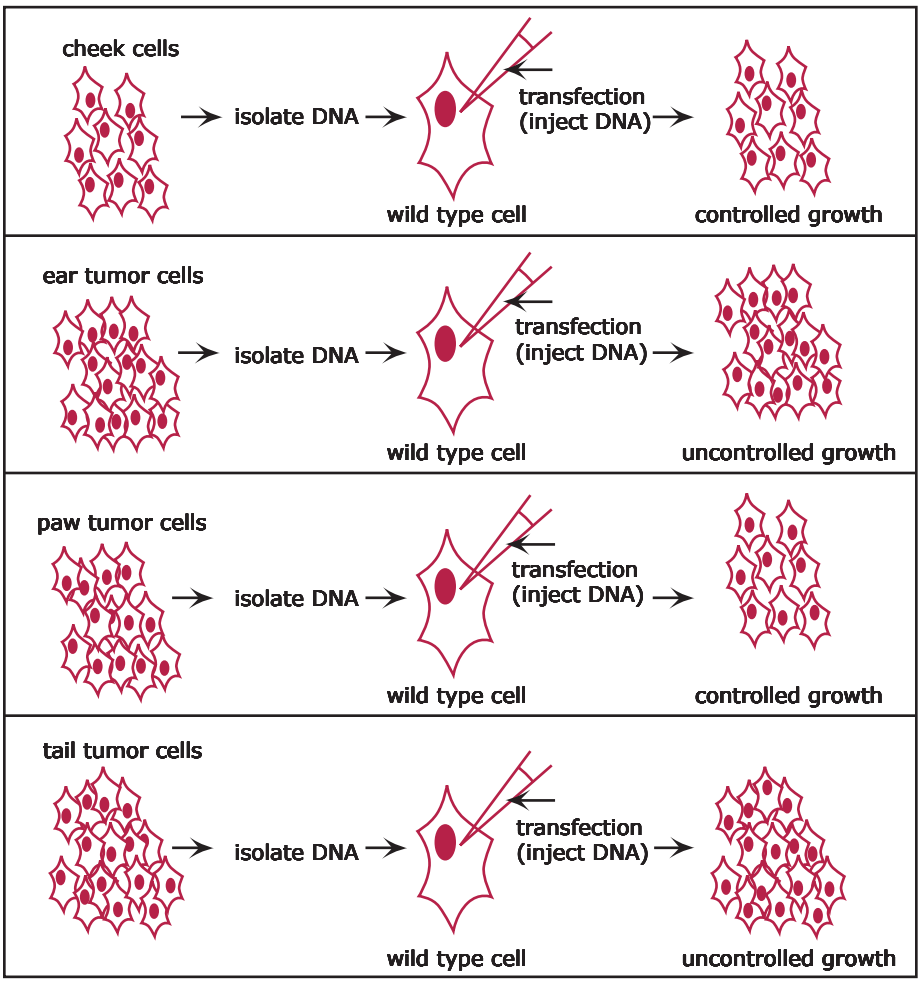


Figure by MIT OCW.

Name_____

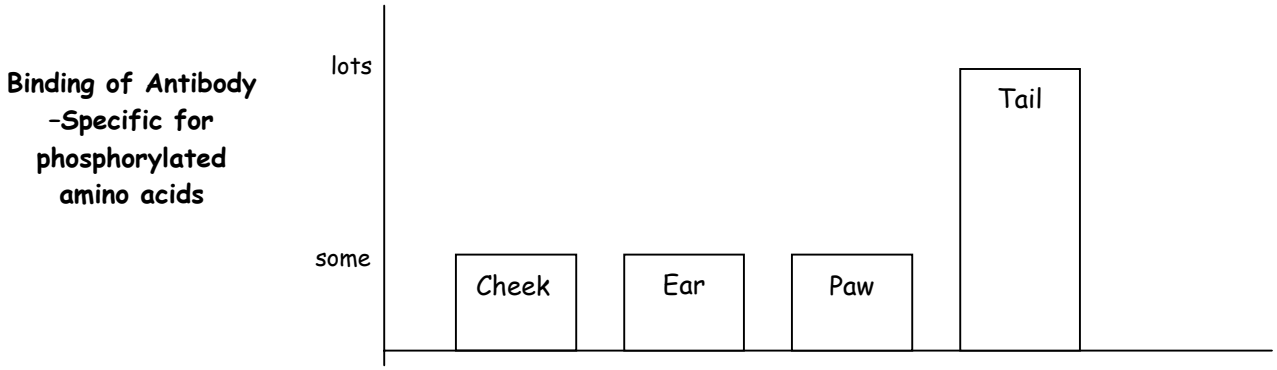
c) Based on previous data, which tumor(s) has/have a mutation in a tumor suppressor gene? Circle ALL that apply. 2 pts

Cheek Ear Paw Tail

d) Based on the data above, which tumor(s) has/have a mutation resulting in an oncogene? Circle ALL that apply. 4 pts

Cheek Ear Paw Tail

Bob isolates the cells from each dish and fractionates them to isolate the membranes. Bob measures the amount of phosphorylated amino acids present, using a specific antibody. See the results below.



Membrane Fractions from Cells

Bob reads that the three most likely causes for canine tumors are…

1) Ras oncogene mutations.

2) Mutations resulting in constitutively active tyrosine kinase receptors.

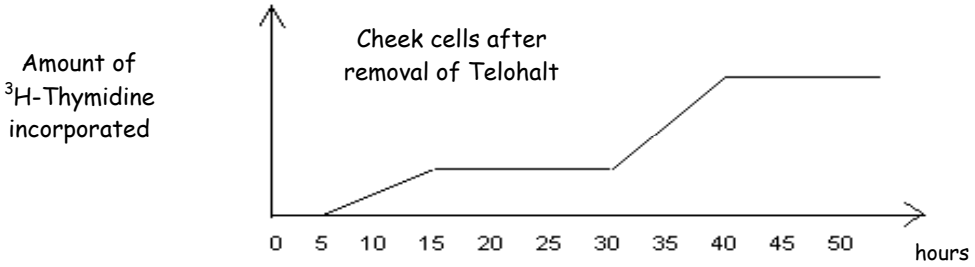
3) Mutations inactivating the *p53* tumor suppressor gene.

e) Based on the data above, match the different tumor types with the likely cancer causes listed above. 6 points

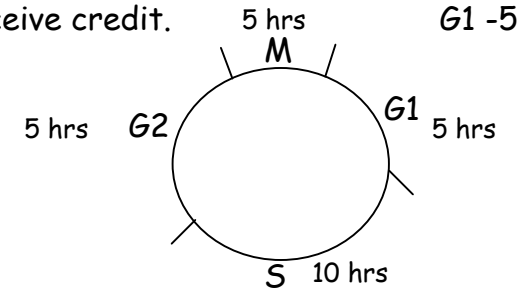
__1___Ear tumor ___3__Paw tumor ___2__Tail tumor

Question 3

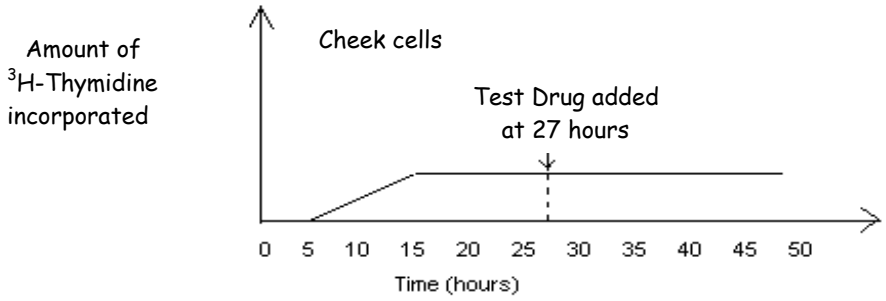
Bob grows dog cheek cells and adds Telohalt, a chemical that arrests cells at the end of mitosis. After removing Telohalt, he adds ^{3}H-Thymidine to the cells and measures its incorporation over time.



a) Bob knows M phase is 5 hours long in these cells. Label and fill in the durations of the remaining phases. You must write legibly to receive credit. G1 -5 hrs, S –10 hrs, G2 -5 hrs 9pts



b) In a similar experiment Bob adds a drug with unknown effects, 27 hours after the removal of Telohalt, and gets the results shown below.

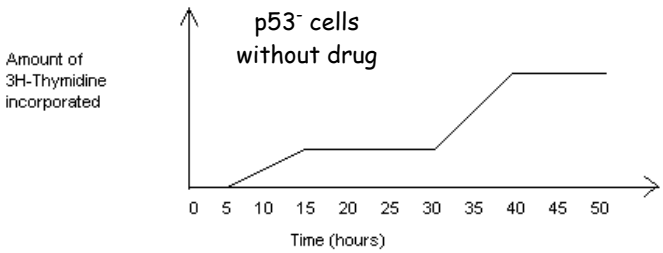


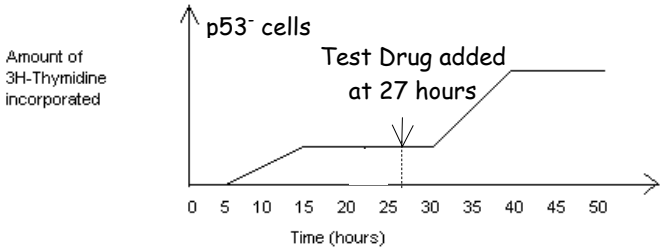
Circle the phase in the cell cycle where the drug acts…3 pts

G1-G2 transition | G1-S transition | G2 | G2-G3 transition | G2-S transition

G3-S transition | G2-M transition | Cyclin | G3-G4 transition | G4 | G5 processing

Bob repeats the experiments above with p53 tumor suppressor deficient tumor cells, and gets the following results. (Assume the cell cycle phase times of the tumor cells are similar to those of cheek cells.)





c) Circle the point in the cell cycle where the p53 tumor suppressor mutation acts.3 pts

G1-G2 transition | G1-S transition | G2 | G2-G3 transition | G2-S transition

G3-S transition | G2-M transition | Cyclin | G3-G4 transition | G4 | G5 processing

Name_____

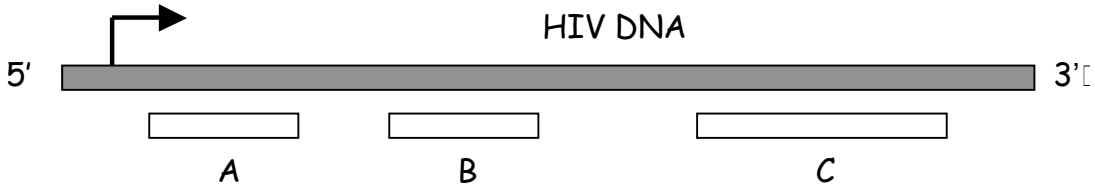
Question 4

Efficient infection by HIV requires the expression of the HIV *tat* gene. All *tat*$^-$ mutants are unable to spread from the cells of an initial infection to infect other cells.

a) What cell type would you use to study wildtype HIV infectivity? 3 pts

canine kidney cells *E. coli* human neurons yeast **none of these**

You choose to study how *tat* works so you can design a drug to combat HIV infection. You find that cells infected with WT HIV make a long viral RNA that hybridizes to the viral DNA probes, A, B and C shown below. In contrast, cells infected with *tat*$^-$ mutants produce shorter viral RNAs that can only hybridize to the A probe.



b) Which of the following statements could be true based on the above observation? 3 pt

i) The *tat* gene product allows RNA polymerase to transcribe through a transcriptional terminator located in the DNA between probes A and B.
ii) The *tat* gene product is necessary for initiation of transcription.
iii) The *tat* gene product is necessary for initiation of translation of the + sense mRNA.
iv) In the tat- mutant, a single nucleotide insertion causes a frameshift and changes the downstream DNA making it unable to hybridize to probes B and C.

In the early 1990's AIDS researchers began to see strains of HIV that were resistant to the treatment drug AZT, a thymidine analogue.

c) What enzyme is the target of AZT? 2 pts ____Reverse Transcriptase_____

d) Explain briefly why HIV is liable to develop drug resistance to AZT. 3 pts

_____error-prone Replication → Mutation in Reverse Transcriptase_____

e) A group of Eastern Europeans is resistant to infection by HIV. What is the best explanation for their immunity to infection? 4 pts

i) Their RNA polymerase does not recognize DNA of viral origin.
ii) Their cells do not use the same genetic code as HIV.
iii) Their CD4 T-cells lack a T-cell receptor.
iv) Their CD4 T-cells have a mutated CD4 co-receptor.
v) Their neurons have an unusual shape.
vi) There is a mutated receptor on HIV.

Question 5

Part A

a) Which of the following is true about viruses? (Circle all that apply.) 3 pts

i) They encode genes for synthesizing their own ATP.

ii) They are single cell organisms.

iii) They can have a genome made of DNA.

iv) They package ribosomes into their virion.

v) They can have a single stranded or double stranded RNA genome.

vi) They can have a membrane-like envelope.

b) Some viruses like influenza can cause disease in humans. Which of the following can clonally expand to respond to an influenza infection. (Circle all that apply.) 6 pts

i) B cells

ii) Macrophages

iii) Killer T cells (CTLs)

iv) CD4+ T cells

v) Neurons

c) Both bacterial viruses and plasmids can be used as cloning vectors. Which of the following is true AND **distinguishes** a virus from a plasmid? (Circle all that apply.) 2 pts

i) Plasmids use the translation machinery of the cell.

ii) Viruses have a protein capsid.

iii) Viruses can replicate in the absence of a cellular host.

iv) Plasmids carry genes.

v) Plasmids have restriction sites.

d) Which of the following is true about retroviruses? (Circle all that apply.) 6pts

i) A viral genome is integrated into the host genome during infection.

ii) Viral genome can be made of lipids.

iii) Viral genome encodes gene for reverse transcriptase.

iv) Viral genome encodes gene for RNA polymerase.

v) Virus packages reverse transcriptase protein in its virion.

vi) Virus packages RNA polymerase protein in its virion.

vii) Virus encodes genes for synthesizing lipid envelope.

Name_____

Part B

You are studying a tumor virus that is capable of transforming healthy cells into cancer cells. 5 pts

e) What is the **single most likely** explanation for this viral transforming property?

i) Virus genome encodes an oncogene.

ii) Virus genome encodes a tumor-suppressor gene.

iii) Virus genome encodes an inactivated tumor-suppressor gene.

iv) Virus genome encodes an inactivated proto-oncogene.

v) Virus packages growth factors in its virion.

To further study this transforming property, you make a radioactive probe that is identical to the viral genome.

f) Would you expect this probe to hybridize with genomic DNA from healthy uninfected cells? 1 pt

Yes No

g) Would you expect this probe to hybridize with genomic DNA from infected cancereous cells? 1 pt

Yes No

h) How can you best explain your choices from f) and g)? 2 pts

i) Uninfected cells do not contain the virus, infected cells do.

ii) Virus does not affect host genome.

iii) Virus and host both encode a version of the capsid gene.

iv) Integrated viral genome cannot be recognized by viral probe.

v) Virus and host both encode a version of the cancer-causing gene.

vi) Viral and host RNA polymerase genes are similar.

vii) Viral and host ribosomal genes are similar.