Please print your name: ______________________________________

Instructions:

Please write only on these pages, in the spaces allotted. Write your number on each page (not your name), so that we can split them up and grade them anonymously. There are a total of 6 pages including this cover page. You may not use any books or notes, and no electronic aids, including calculators.

Answer only in the space provided; short, concise answers are preferred and will be rewarded. Please be as neat as possible.

When you are finished, turn this in to the TA.
Weber Lectures (15 points)

1. The Rb pathway is frequently mutated in cancers. Give a detailed molecular explanation of the Rb signaling pathway. (5 points)

2. What is the definition of an oncogene? What are the three ways in which a proto-oncogene can be mutated to an oncogene? (4 points)

3. In class 5 classical features of a tumor suppressor were discussed. List 3 of the classical features. (3 points)
4. Cyclins and CDKs are the proteins involved in driving the cell cycle. Which cyclin is expressed during G1 of the cell cycle? This cyclin binds to which CDK in order to activate its kinase activity? Name an inhibitor of this cyclin-CDK complex. (3 points)

Stewart Lecture (11 points)

1. What are the two functions of telomeres discussed in lecture? (2 points)

2. When telomeres shorten past a certain length, cells enter senescence. How can cells escape senescence and continue proliferation? The telomeres continue shortening, and cells enter 'crisis'. What are two mechanisms by which cells can escape crisis and continue dividing? (4 points)

3. True or False- (Correct if false) Proteins on the telomere modify the function of DNA repair and replication machinery. (2 points)
4. In human cells the SV40 T-ag protein (large and small), H-ras, and TERT are capable of creating tumorigenic cells. Explain the function of each of the proteins and how it can lead to cancer. (3 points)

Minor Lectures (20 points)

1. List three functions of the ECM. (3 points)

2. Name the four primary components of all basement membranes. (4 points)

3. Which laminin subunit contains the LG domain? What is the function of this domain? (2 points)
4. What is the general structure of collagen? What amino acid can be found at every third position? Why? (3 points)

5. Fibrillar collagens require crosslinking by a number of different enzymes, name two of these enzymes. Scurvy results from a deficiency of which enzymatic cofactor? What two enzymes make use of this cofactor? (4 points)

6. What are the two processes involved in integrin activation? (2 points)

7. What is anikis and why is it important? (2 points)
Huettner Lecture (10 points)

1. Briefly explain the two defining characteristics of stem cells. (2 points)

2. List the 4 types of 'potency' that we discussed in class, briefly explain each type, and provide an example of a cell type that exhibits each kind of potency. (8 points)

Schlesinger Lecture (9 points)

1. Apoptosis is important for many aspects of normal physiology in multicellular organisms. Give two examples and the type of organism where they occur. (4 points)
2. Explain one way in which the extrinsic pathway of apoptosis can be activated. Explain one way the intrinsic pathway can be activated. (2 points)

3. Which protein, once released from the mitochondria, is capable of driving the cell into apoptosis? How is this protein released from the mitochondria? (2 points)

4. Is apoptosis an ATP dependent or independent event? (1 point)

**Fremont Lecture (15 points)**

1. What are the 7 steps for determination of protein structure by x-ray crystallography? (7 points)
2. What are two ways to determine protein purity? What are two ways to decrease the protein heterogeneity? (2 points)

3. At what resolution can holes in Phe or Tyr rings be seen? (1 point)

4. What are two experimental ways to solve the phase problem? Listing acronyms will not get credit. (2 points)

5. What are three methods for validating crystal structures? (3 points)

Amarasinghe Lecture (15 points)

1. What are two things that can be investigated by NMR other than determination of protein structure? (2 points)
2. What are two advantages of using NMR compared to other structural methods? What are two disadvantages relative to other structural methods? (4 points)

3. What information about macromolecules can be obtained by the following NMR measurements: (5 points)

   Chemical shift

   Spin-spin coupling (J)

   Nuclear Overhauser Enhancement (NOE)

   Spin relaxation times

   Chemical exchange rates
4. Explain how rates of Hydrogen-deuterium exchange can be used to gain insight into protein structure and dynamics. (2 points)

5. List two ways to validate a structure obtained by NMR. (2 points)