Protein Modeling Event

School Name: _____

School Number: _____

Team Member 1: _____

Team Member 2: _____

Team Member 3: _____

For Judges Use Only:	
Pre-Build Score:	
On-Site Build Score:	
Test Score:	
Tie Breaker:	
Total:	
Final Rank:	

Part I: Pre-Build (40% of total score)

Your Pre-Build Model should have been impounded the morning of the competition. You may pick up your Pre-Build model at the end of the competition after all models have been scored. Unclaimed models will be thrown away.

Part 2: On-Site-Build (30% of total score)

The workstation should have the On-Site Model Competition Environment open on the computer. Using the 176cm and 166cm Mini-Toobers provided, construct a model of chains A and B of 2kt0.pdb. The scale should be 2 cm per amino acid. A meter stick/ruler has been provided for you. Your Mini-Toober model of chains A and B of 2kt0.pdb should include the following:

A: Four amino acids: Arg215, Leu267, Arg914 and Leu967 (use metal clips to connect amino acids to your Mini-Toober)

B: Two blue end caps indicating the amino termini (N-terminal end) of the two chains

C: Two red end caps indicating the carboxylic acid termini (C-terminal end) of the two chains

Part 3: On-Site Exam (30% of total score)

The On-Site Exam consists of both multiple choice and short answer questions. You may use any materials provided at your work station as well as the five sheets you brought with you to answer these questions. You may NOT use the Internet to answer these questions.

There are ten multiple choice questions on the On-Site Exam (each worth 1 point for a total of 10 points). Clearly print the letter of the one BEST answer to each question in the blank provided for that question. Illegible answers will be incorrect.

There are also short answer questions on the On-Site Exam. The point value for each question is given in parentheses at the end of the question (20 pts total). The points for the tie-breaker questions (identified with ★ Tie Breaker) will be included in the final score but may be used to determine team placement in case of a tie.

On-Site-Exam

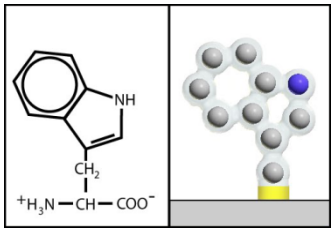
Multiple Choice Questions:

_____A_____ 1. How many nitrogen atoms are found in the backbone of each amino acid?

A. 1
B. 2
C. 3
D. 4

_____A_____ 2. The amino acid sidechain shown below is best characterized by which of the following chemical properties:

A. Hydrophobic
B. Negatively-charged
C. Positively-charged
D. Can form a covalent disulfide bond



_____C_____ 3. What is the name of the reaction in which a peptide bond is form?

A. Oxidative-reductive Reaction
B. Combustion
C. Dehydration Synthesis
D. Hydrolysis

_____B_____ 4. Which of the following amino acids contains sulfur?

A. Tryptophan
B. Methionine
C. Glutamic Acid
D. Histidine

_____C_____ 5. Induced pluripotent stem cells have the same developmental potential as

A. Hematopoietic stem cells
B. Neuronal stem cells
C. Embryonic stem cells
D. Dental pulp stem cells

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_____D_____ 6. Which of the following proteins has NOT been shown to be essential in the reprogramming of somatic cells?

A. Klf4
B. Oct4
C. Sox2
D. Mad2

_____A_____ 7. If you are discussing the sequence of amino acids in a polypeptide chain then you are talking about a protein's

A. Primary sequence
B. Secondary sequence
C. Tertiary sequence
D. Quaternary sequence

_____B_____ 8. If a protein is membrane bound, where would you expect to find hydrophilic amino acids?

A. On the surface of the protein, interacting with the phospholipids.
B. Buried in the protein, thereby avoiding interaction with the phospholipids.
C. Only in the alpha helices of the protein.
D. Alternating with the hydrophobic amino acids.

_____C_____ 9. Which of the following motifs can be found in the Myc-Max protein?

A. Zinc finger
B. EF hand
C. Basic helix-loop-helix
D. Beta barrel
E. Cysteine and Glutamine

_____D_____ 10. What is the difference between a totipotent stem cell and an induced pluripotent stem cell?

A. An induced pluripotent stem cell can become any cell of the developed organism, but cannot produce trophoblast and placenta to support organismal development, whereas a totipotent stem cell can produce anything.
B. A totiptent stem cell can give rise to multiple, but limited number of lineages. An induced pluripotent stem cell can give rise to any cell within the organism.
C. An induced pluripotent stem cell can give rise to a single directed cell lineage whereas a totipotent stem cell can give rise to multiple, but limited number of cell lineages.
D. A totipotent stem cell can become any cell of the developed organism, but cannot produce trophoblast and placenta to support organismal development, whereas an induced pluripotent stem cell can produce anything.

Short Answer Questions:

1. For your onsite model of Myc-Max, you added Leucine 267, Leucine 967, Arginine 215 and Arginine 914. What role do these amino acids play in the structure and/or function of Myc-Max? (4 pts)

   Arginine is a positively charged amino acid that because of its position on the protein, interacts with the negatively charged sugar-phosphate backbone of the DNA. This interaction is essential for the function of Myc-Max as a transcription factor. (2 pts)

   The Leucine amino acids form a leucine zipper, a structural motif found in proteins that stabilizes the structure of the protein. (2 pts)

2. When researchers use the phrase "introduced a protein in a cell", they are referring to the techniques needed to get the cell to produce the protein when it normally would not. How do researchers introduce a protein into a cell? (4 pts) ★ Tie Breaker

   In order for a cell to make a protein, the genetic code (DNA) must be present within the host cell (1 pt); therefore the researchers must be able to give the cell the necessary DNA to make the appropriate protein. Genes that are inserted directly into a cell usually do not function. Carriers, called vectors, are genetically engineered to deliver the gene into the target cell (1 pt). Some viruses are modified to be a vector for the gene of interest because viruses can infect the cell. The virus integrates the genetic material into a chromosome in the host cell (1 pt), where it can be transcribed and the translated to generate a protein, as if part of the host cell's own genetic code (1 pt).

3. What are two fundamental properties that distinguish all stem cells from other somatic cells? Explain why these properties are unique to stem cells. (4 pts)

   Self-renewal

   Self-renewal describes the process where a stem cell undergoes mitotic cell division that yields at least one daughter cell with equivalent developmental potential as the mother cell - i.e. creating another stem cell. (2pts)

   Potency

   A general term that describes the capability of a cell (stem cell or progenitor) to differentiate into another more committed cell type. (2 pts)

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4. One of the steps in the process of developing induced pluripotent stem cells is the need to determine whether the cell line is indeed pluripotent. One assay that has been used to determine the state of pluripotency is a teratoma forming assay. (4 pts) ★ Tie Breaker

   What is a teratoma? (1 pt)

   Teratoma are tumors of multiple lineages containing tissue derived from all three germ layers, which is unlike other tumors, which typically are of only one cell type.

   Why is the formation of a teratoma indicative of a pluripotent state? (3 pts)

   To be considered "pluripotent", a cell must be able to differentiate into any cell type derived from the three germ layers (1 pt) (endoderm, mesoderm or ectoderm). If a teratoma forms, researchers can confirm the presence of these three tissue types within the teratoma. If the teratoma does produce tissues from all three germ layers, the cell line is considered to be pluripotent. If the teratoma does not have all three germ layers present, then the cell line is not considered to be pluripotent. (2 pts)

5. The selected proteins that you have modeled this year for the Protein Modeling event are involved with reprogramming cells to regain pluripotency and they are all transcription factors. (4 pts)

   What is transcription?

   Transcription is the process of creating a complementary RNA copy of a sequence of DNA. (1 pt)

   What are transcription factors?

   Transcripton factors are proteins that bind to specific sequences on DNA controlling (regulating) the transcription of genetic information from DNA to mRNA. (1 pt)

   Why is transcription an important part of reprogramming cells?

   Each cell has all of the DNA information needed to become any type of cell within the body. The blueprint information is there, but in a differentiated cell, specific genes not needed for the identity of that cell have been turned off. The transcription factors that are introduced into an adult somatic cell to induce a pluripotent state are able to turn on the genes needed to dedifferentiate the cell. In a differentiated cell, these genes are still a part of the cell, but they are not transcribed. The introduced transcription factors are able to transcribe these genes necessary for reprogramming the cell. (2 pts)

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