1. Please define bioadhesives. Describe the difference between bioadhesives and general glues. In the material specifications for bioadhesives, "rapidly solidify under the physiological condition" is listed. Please explain why this is important, and give one application for which this spec is important. (5 points)

2. List the differences in the tissue response at a wound site following implantation of a non-degradable biomaterial as compared to a simple lesion such as a stab wound. (3 points)

tendency to heal

3. In experiments to evaluate the tissue response to a biomaterial, a control group is often included involving the complete surgical procedure but without implanting the biomaterial. What is the rationale for the inclusion of this control group, and what is the expected tissue response? (5 points)

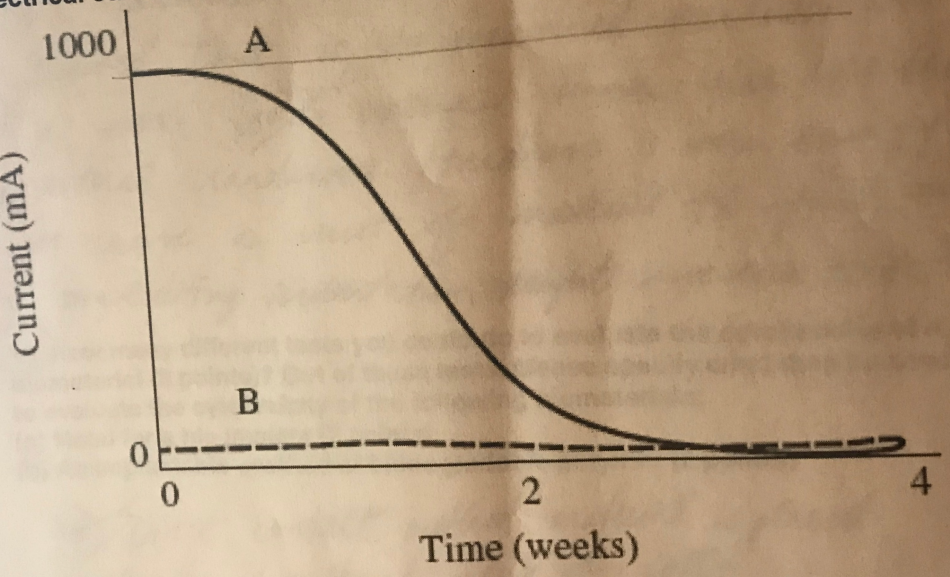
4. Is tissue regeneration necessary to repair a defect? Why? (3 points)

5. What is the difference between intraocular lens (IOLs) and contact lens? What are the major functions for each? What are in common vs. the differences in material specifications for each? (5 points)

6. In the treatment of chronic ulcers, do you prefer hydrophobic or hydrophilic wound dressing materials? What are other specs you need to consider for wound dressing materials, and why? (4 points)

7. You are performing a project in which a biomaterial implant is developed. You are planning to use animal models to evaluate the in vivo biocompatibility of the implant in soft tissue, specifically, the muscular tissue. What considerations (List 3) that you need in developing animal models (3 points)? What methods (List 3) of assessment that you may use for tissue samples harvested at different time points following implantation (3 points)?

8. Mandatory question: You are developing an electrode to stimulate neurons when implanted into the brain tissue. During the in vivo evaluation, you implant the electrode in a rat brain and measure the electrical current. You obtain the solid line (A) in the plot below.



Explain the following:

a. The mechanism underlying the observation (i.e., line A). (2 points)

b. To enhance the sensitivity of the electrode, you develop a coating. The coated electrode yields a response of line (B). Explain whether the response is desirable for the performance of the electrode, and why? (4 points)

9. When making hardness measurements, what will be the effect of making an indentation very close to a preexisting indentation? Why? (2 points)

10. How many different tests you could do to evaluate the cytotoxicity of a biomaterial (3 points)? Out of these tests, please specify what may be used to evaluate the cytotoxicity of the following biomaterials:

(a) Metal for a hip implant (2 points)

(b) An implantable scaffold of biodegradable polymer (2 points)

11. You are developing an injectable hydrogel which can be injected to soft tissue to facilitate tissue regeneration. You are not planning to load the hydrogel with any cells at the time of implantation, instead, you will load the hydrogel with a chemotactic agent, which will be released from the hydrogel upon implantation to elicit the migration of the cells from the surrounding tissue into the hydrogel. Please design an in vitro test (draw a diagram to show the experimental set-up) to screen candidate chemotactic agents for the desired effect. Describe your experimental set-up and the parameters you are measuring. (5 points)

12. Based upon the cellular structure that we have learnt in Lecture 10, speculate on 2 possible intracellular reasons why transfection efficiency of non-viral vectors is magnitude lower when compared to viral vectors for gene therapy. (4 points)

13. Mandatory question: Your friend, Sam, has developed a material with very good mechanical properties. He wants to use it for blood vessel replacement. However, the blood biocompatibility is not good. He sent some samples to you for help. You found that samples are very hydrophobic. Since you know that increasing the hydrophilicity may improve the blood compatibility, you modified the surface with a hydrophilic coating and achieved better blood compatibility. Then you sent the samples back to him and asked him to test again. When he tested the modified samples several months later, he found that the blood compatibility was not improved. He then sent some samples back to you, and you found the samples were hydrophobic again. 1) What's the possible reason for the changing hydrophilicity after storage for some time? 2) What techniques (list 2) you may use to determine the surface chemistry of your material? Please specify which technique to determine what. (6 points)

14. Do you expect difference in protein adsorption profiles (types and amounts of adsorbed proteins) between rough vs. smooth surface of the same biomaterial using the same protein mixture solution? Why? (3 point

15. In the in vivo biocompatibility test of a biomaterial implant that is developed for cardiovascular applications, your classmate Tom performed subcutaneous implantation in a rat model. He observed that the implant was well-tolerated and the response was very minimal at the subcutaneous implantation site. Later, you performed implantation of the same biomaterial in the form of a vascular graft in a rat model and observed severe coagulation in response to the implant. Please explain the discrepancy between your and Tom's observations regarding the in vivo biocompatibility of the biomaterial. Which observation is more reliable, and why? (6 points)

16. How many different types of resolution may occur in response to biomaterial implants, and what are they (Please specify) (4 points)? What type of resolution response occurs with each of the following (0.5 point/each):

(a) Catheter c
(b) Titanium bone screw integration
(c) Breast implant b encap
(d) Degradable biomaterial scaffold d
(e) Artificial heart valve leaflet b
(f) Coral implant for bone repair b
(g) Splinter a

17. Based upon what you have learnt from the Biomaterials course, if you were the instructor for this course, please design a question for the final exam, and provide the answer key to this question. (5 points)

18. Most degradable polymers go by a hydrolysis-based degradation, in which the degradation rate in the tissue is difficult to control. You are developing a new degradable polymer, which will be degraded by cells through an on-demand mechanism. Please describe your design rationale, and specifics on this new polymer. (5 points)

19. Briefly explain why glass-ceramics are generally not transparent. Please recommend two possible ways to make a material transparent. (4 points)