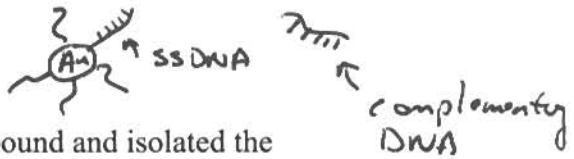
Homework 5&6

1. Suppose you want to capture a specific DNA sequence out a collection of 25 sequences in a test tube.

a) What approach would you take to isolate the sequence?

One approach would be to make gold beads with complementary corresponding single DNA sequence.



b) What simple test would you do to know that you have bound and isolated the sequence?

one way is to have each strand attached to a gold nanoparticle. when DNA gold nanoparticle pair they form a network of nanoparticles that give color change

c) What variables could you use to test for less than perfect matches?

Change in temperature, melting profiles

d) What would be the consequence of having AT rich versus GC rich sequences?

G·C pairs pairs are more stable than A·T base pairs because their bases are held together by three hydrogen bonds rather than 2. Adjacent G·C base pairs interact more strongly with one another than do ajacent A·T base pairs.

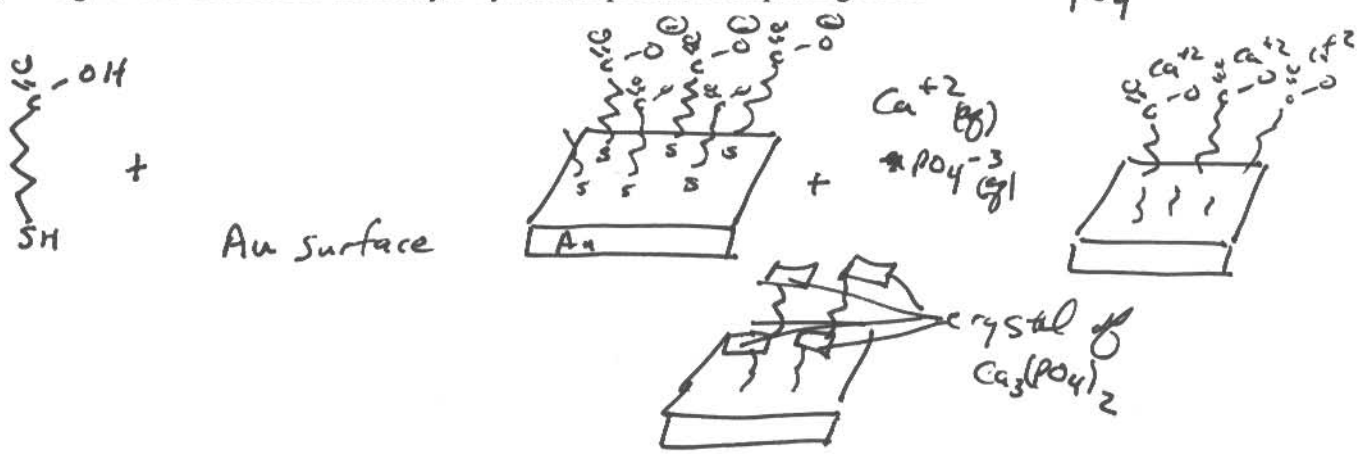
2. You have the idea to enhance bone material $Ca_3(PO4)_2$ at the site of a bone injury. You know that natural proteins in the bone act to template the crystal structure of these materials. You decide to make some synthetic peptides to increase bone deposition at a particular location.

G·C base pairs have a higher melting temperature

a)What types of amino acid sequences would you expect to see for these proteins?

One that are charged. carboxyl groups like aspartic acid & glutamic acid would bind Ca^{+2}, positive charged groups like lysine would attract PO_4^{-3}

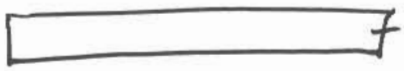
d) Design a self-assembled monolayer system to practice templating bone.

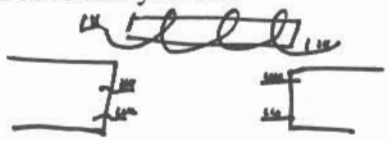


c) Consider ways to deliver your synthetic peptide to a bone location that requires healing.

One way might be to develop lipids that could complex your synthetic bone peptides & have antibodies that could bind to bone proteins.

3. Propose a mechanism for aligning a carbon nanotube between two gold electrodes using any biological molecules. You don't have to synthesize the electrodes and you can order them in any size and spacing you need.



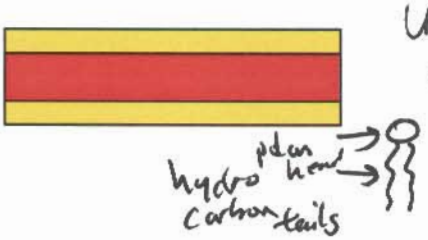


First use DNA library to look for sequence that can wrap carbon nanotubes. Attach to them ss DNA sequence that are complementary to ss DNA sequences you have deposited on gold electrodes. Make a hybrid DNA sequence that has wrap sequence to complementary sequence.

4. You are working for NASA and a Mars rock is brought in that under inspection with a scanning electron microscope contains 2 micrometer spherical objects that are thought to be a life form. Using typical bacterial growth media you are able to get the spheres to reproduce. Devise a set of experiments to see what biological materials are responsible for carrying the genetic information. Think about the "transforming principle" experiments.

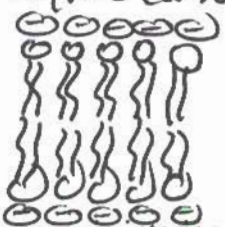
Use cell free extract, fractionate components. Test optical, centrifugal, diffusive and electrophoretic properties and compare with DNA (RNA, proteins, lipids). Test the materials responsible for transforming with DNAase, RNAase proteases, look for loss of function. Try amino acid sequencing, DNA sequencing of the transforming principle.

5. Design a system that would allow you to self-assemble and template an inorganic material above and below an organic layer. Yellow is inorganic, red is organic



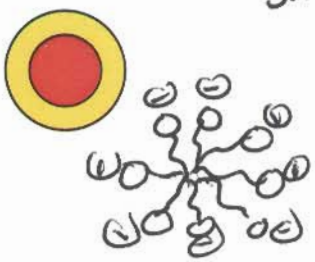
Use a lipid with hydrocarbon tails and a polar head.

a glycerophospholipid



a postive charged ion like Ca^{+2}, or Cd^{+2} will bind the negative head group.

6. Design an experiment to self-assemble in inorganic sphere with an organic interior.

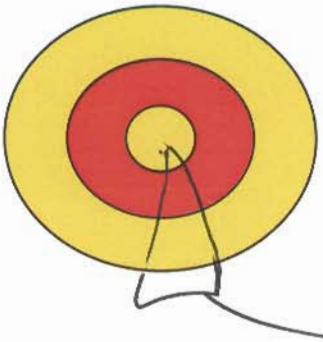


Single chain lipids form micelles. Use a single chain lipid with polar head group

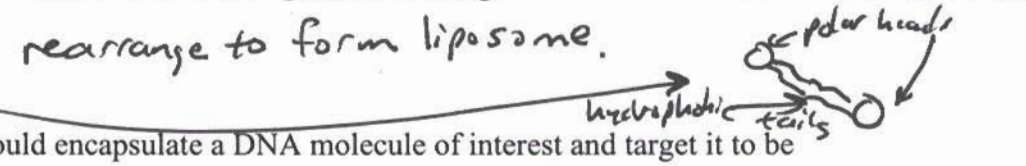
7. Design an experiment to assemble an organic outer layer with an interior inorganic material.

make a reverse micelle, use the same single chain lipid in question 6, but use an organic solvent.

8.Design an experiment to assemble a sphere with an inorganic exterior an organic middle and an inorganic interior.



make a liposome. A suspension of phospholipids with two hydrocarbon tails will form an onionlike arrangement of lipid bilayers. Upon agitation by ultrasonic vibrations (sonication) the structures rearrange to form liposome.

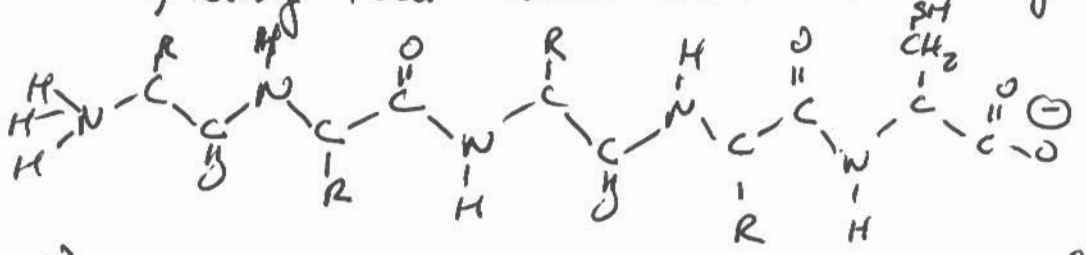


8. Design a material that could encapsulate a DNA molecule of interest and target it to be delivered to a tumor cell.

Use a positively charged biocompatible lipid to form a liposome, use lipid with 2 tails. positive charged lipid will complex with negative DNA. Use chemistry you have learned to functionalize the outer part of the liposome with an antibody or Fab fragment that binds to specific cell of interest. A positively charged amino on the lipid could complex with an amino acid with a carboxyl group to form a amide bond.

9. Give an example of a 5 amino acid peptide that could only bind one gold particle.
Give an example of a 5 amino acid peptide that could bind two gold particles.

a) any four amino acid with 1 cysteine



b) cys-a.a-a.a-a.a-a.a-cys

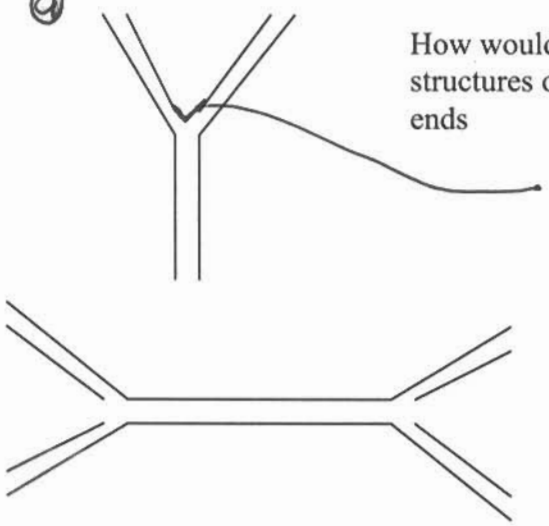
a.a = any amino acids

the two cysteins do not have to be on ends, but would probably work best

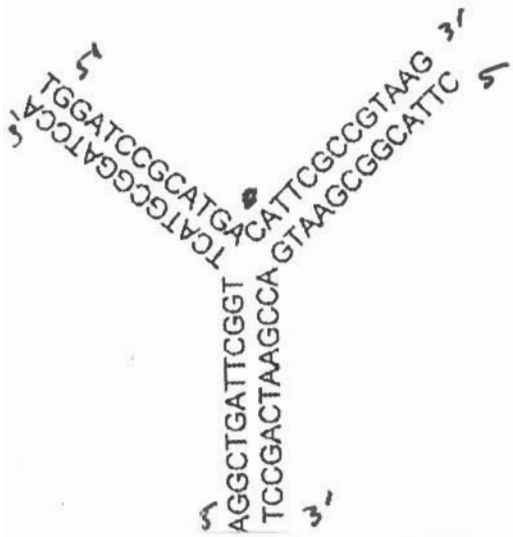
(4)

10. (9)

How would you design the follow structures out of DNA, label the ends

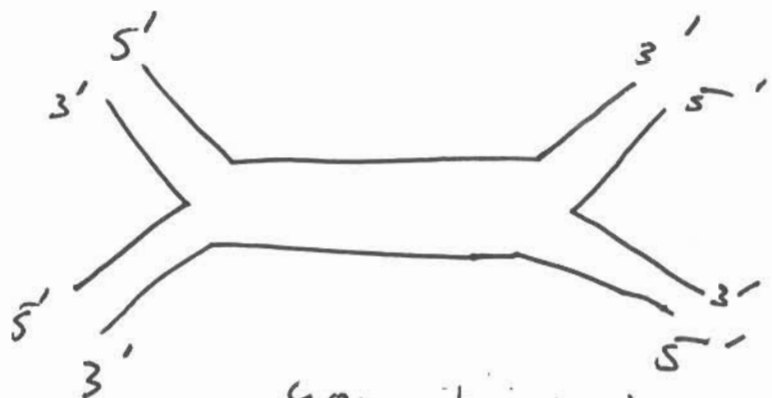


can fill in center of Y or not



→ this is an example you have to match A-T & G-C but not in this exact order

(b) for part b



you do not have to write out complete sequence