3.034- Final (2005) closed book and notes

Place answers to questions (1/2) and (3) in separate exam books

Using only the molecules on the following pages (and related reagents if needed), show a suitable materials-based design for the following systems. In each case, show the chemistry and processing needed to create the final system, the structure of the final system and **briefly explain the function of all key design elements**. State all important assumptions.

1a) Design an injectable "stealth" system for drug delivery of the water soluble anti-cancer drug – doxorubicin.

Your drug delivery system should.....

a) be protected from the body's immune system
b) provide a slow drug release capability
c) be able to attach to cells in the body

1b) Show how you could make a system similar to the above, but with the ability to release the drug more quickly.

2) Design an implantable device that could be used to monitor glucose levels in the body.

Your device should.....

a) not invoke an inflammatory response from the body
b) be selective to glucose
c) prevent adsorption of proteins that could cause the device to fail.

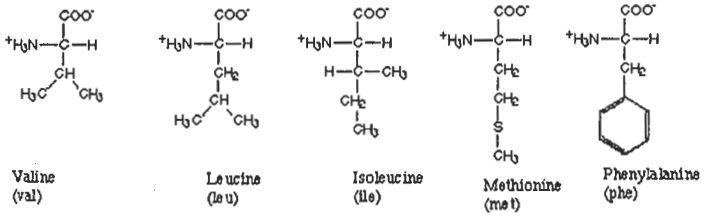
3) Specific antibodies are often selected from a mixture of molecules in solution by passing this solution through tightly packed, solid beads (5 micron-diameter) coated with antigens. After binding, the antibody is released from the bead via chemical disruption of the antigen/antibody binding.

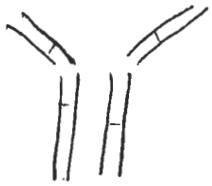
You have designed a drug delivery device made of M13 bacteriophage fibers. The phage is naturally cysteine-rich at the head and tail, and has been genetically engineered to exhibit a histidine-rich polypeptide drug presented on the body. You need to determine whether human blood plasma contains antibodies for these M13 phages.

(a) Design a bead which you could use to selectively bind these phage and test for antibodies in plasma. Draw and specify the base material and polymers / polypeptides / lipids used to functionalize the surface to which the phage will bind.

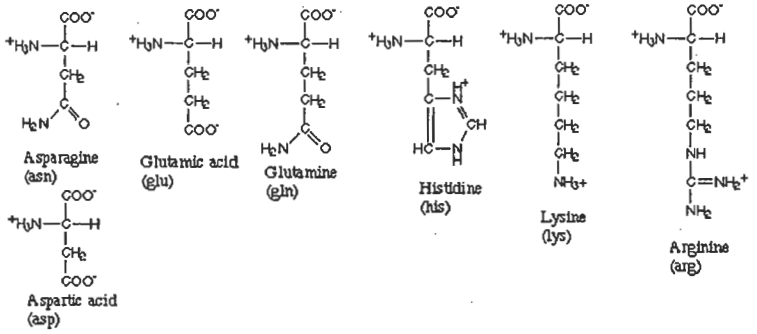
(b) Once bound, how will you elute the anti-M13 phage antibody from the phage-functionalized bead?

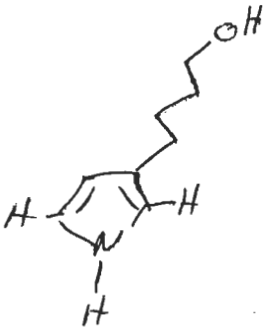
(c) How will you assess whether the antibodies are binding to the histidine-rich drug or to the cysteine-rich phage head/tail?

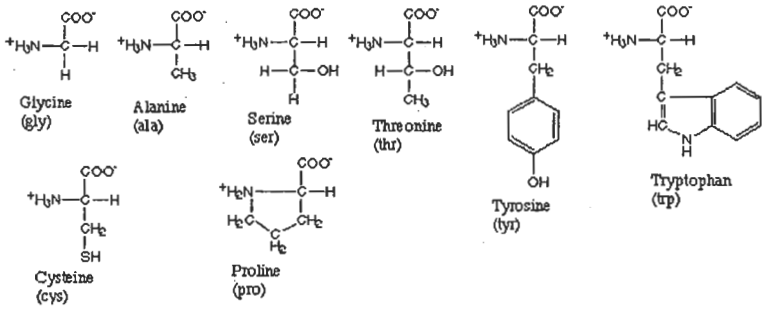


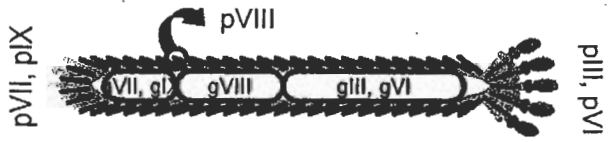


IgG antibody









$(NBu_4)^{\oplus}Cl^{\ominus}$

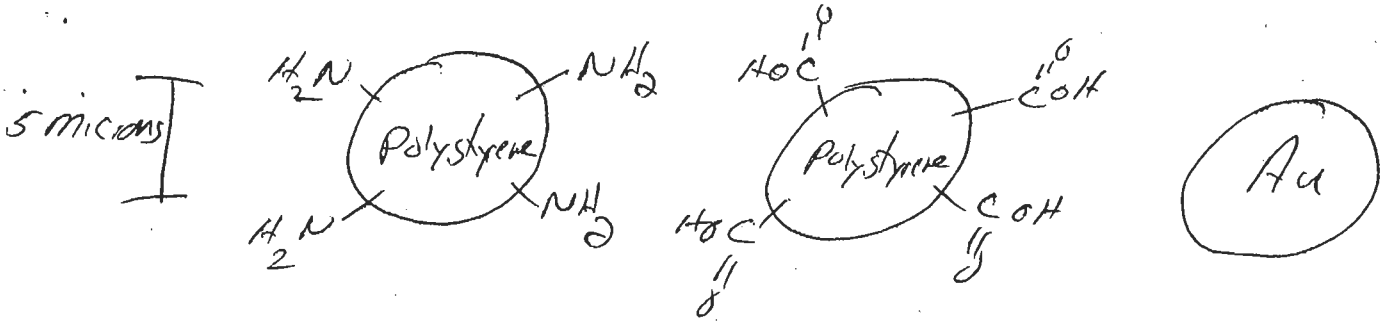
$HO\left(CH_2CH_2O\right)_{100}H$

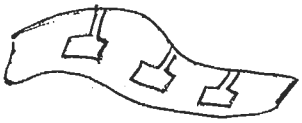
$\left(CH_2-\underset{\underset{O}{\|}}{\overset{|}{C}}OH\right)_x$

$CH_3-(CH_2)_{16}-\underset{\underset{O}{\|}}{C}OH$

$\left(CH_2-\underset{\underset{O}{\|}}{\overset{|}{C}}NH_2\right)_x$

$HO-CH_2CH_2CH_2O-\underset{\underset{O^{\ominus}}{|}}{\overset{\overset{O}{\|}}{P}}-OCH_2CH_2-\overset{\overset{CH_3}{|}}{\underset{\underset{CH_3}{|}}{N^{\oplus}}}-CH_3$





flexible plastic substrate patterned with gold electrodes (you specify size)