BME341 Biomaterials

Lecture #9
Protein Interactions with Biomaterials

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Objectives of this course

- To understand basic thermodynamic equations for protein-substrate systems.
- To understand basic protein chemistry and hieraracy of organization.
- To understand how structure of proteins affects folding and adsorption.
- To compare and contrast reversible and irreversible protein binding, molecular reasons behind these phenomena.

Gibbs Free Energy and Protein Adsorption

For a reaction to spontaneously occur, the change in Gibbs free energy, ΔG, must be <0

$$\Delta G = \Delta H - T\Delta S$$

$$\Delta G_{ads} = \Delta G_{prot} + \Delta G_{sol} + \Delta G_{Surf}$$

G = Gibbs free energy

H = enthalpy

S = entropy

System Properties Governing Protein Adsorption

The factors that have the largest impact on protein adsorption are:

- Hydrophobicity
- Charge
- Size
- Structure

Protein Structure

Proteins are diverse and one of most abundant functional molecules in nature.

They perform a number of functions such as,

- Catalytic functions
- Receptor
- Structural function
- Transport
- Protective functions

Amino acids

Amino acids building block of proteins and are molecules containing an amine group, a carboxylic acid group and a side chain that varies between different amino acids.

- Amino acids are monomers that can be polymerized to form proteins.
- The bonds between a.a. are called peptide bonds, therefore proteins also called polypeptides.

Protein Structure

- A protein's primary structure is linear order of its amino acids as dictated by the codons.
- While the primary structure addresses only the linear order of the a.a., the secondary structure is caused by localized interactions between these a.a. residues.
- Tertiary structure is the 3D arrangement of an entire polypeptide chain (how the secondary structural elements are folded).
- Many proteins contain 2 or more different polypeptide chains that are held in association by the same non-covalent forces that stabilize the tertiary structures of proteins.

Surface-Protein Interactions

As bonds between the adsorbed molecule and the surface are periodically broken, new protein molecules can occupy the binding sites. The first molecule is released from the surface when all of its contacts with the substrate become occupied by the new molecule. Exchange proceeds until the surface is populated with proteins having strong interaction with the substrate. This hierarchical series of collision, adsorption, and exchange processes has been termed ‘‘the Vroman effect’’

Techniques: Assays for Protein Type and Amount

- HPLC: Affinity chromatography
- Colorimetric assays
- Fluorescent assays
- ELISA
- Western blot