PART 1:

Conclusions / Opportunities

- The interfacial properties of "simple" proteins at very simple interfaces are qualitatively understood
- A plea for theory!
- Complex, multi-domain proteins — especially at complex interfaces — is wide open
- Constraints:
  - structure of complex, relevant proteins
  - characterization/prediction of interface microheterogeneity in aqueous environments
- Surface dynamics of complex polymer surfaces — wide open
- Competitive Adsorption from complex protein mixtures — wide open
- Constraints:
  - quantitative, simultaneous measurement of 10–100 proteins
  - covalent changes — proteases, etc...
- Cells – Tissues – interface engineering; protein modification
- New paradigm – new view –
  Do there a simple way to predict/understand interfacial behavior of thousands of different molecular machines?

3/94 whitaker

Heterogeneity + Cooperativity + Dynamics + Environment

⟹

Responsiveness / Accomodation:

"Intelligence"?

Posters:

Fibrinogen – A Multi-Domain Biopolymer

Multi-Domain Polyether urethanes – Protein "Specificity"?

Micro-Domain Imaging of Polymer Surfaces: AFM Elasticity Mapping?

Luciferase – Behavior & Assembly of a Photoprotein at Interfaces

Enhancing Science Education by use of Unusual Bio-Phenomena: Bioluminescence

Thanks! ☺

Wollongong 12/93

"SIMPLE" SURFACE OR INTERFACE COMPLEXITY AXIS

Air/H_2O PDMSO PMMA SiO_2 PHEMA Block Copolymers Polyetherurethanes

Surface Dynamics

PROTEIN COMPLEXITY AXIS

Insulin Myoglobin Lysozyme	Small proteins whose 3-D structure and function are well-known.
Albumin IgG IgM Fibrinogen	Large complex proteins whose structures are approximately known.
Lipoproteins Fibronectin	Large complex proteins with dynamic structures--not well-known.
Multi-component Solutions Competitive Adsorption	Many proteins present at high concentration; "Vroman" effects are likely.
Plasma Tears Aqueous Humor	Actual biological fluids containing many competing proteins and other components.

"COMPLEX"

FIGURE 1: A Protein Adsorption Complexity Matrix. The upper left represents "simple" systems; the lower right shows highly complex systems. A solid surface complexity axis runs from left to right; the protein complexity axis goes from top to bottom. See text for abbreviations and details.

Ann NYAS (1987) in press 516

Tingey, PhD Thesis

MULTIDOMAIN INTERACTION HYPOTHESIS (3 OPTIONS)

TIME = 0 TIME > 0 participating properties

multi-domain protein

protein domain size
energetics
polymer domain size
γ-soft segment
γ-hard segent

Domains & energetics match @ impact

protein T-degradation ↓
flexibility
activation pot.
polymer T-glass trans ↑
g-hard segment

Protein conforms to polyurethane surface

multi-domain surface

protein T-degradation ↑
flexibility
activation pot.
polymer T-glass trans ↓
g-hard segment

Polyurethane surface conforms to protein

U. of Utah, SALT LAKE CITY

Center for Biopolymers at Interfaces (CBI)

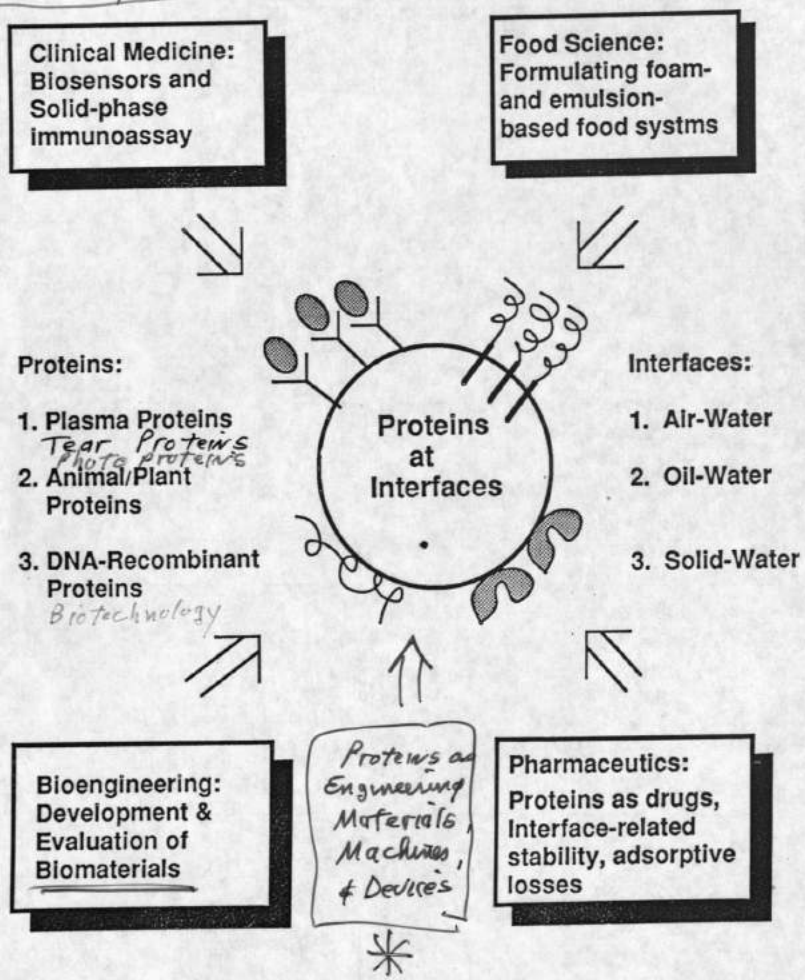


Fig. 1.1 Some of the applications that involve proteins at surfaces or interfaces.

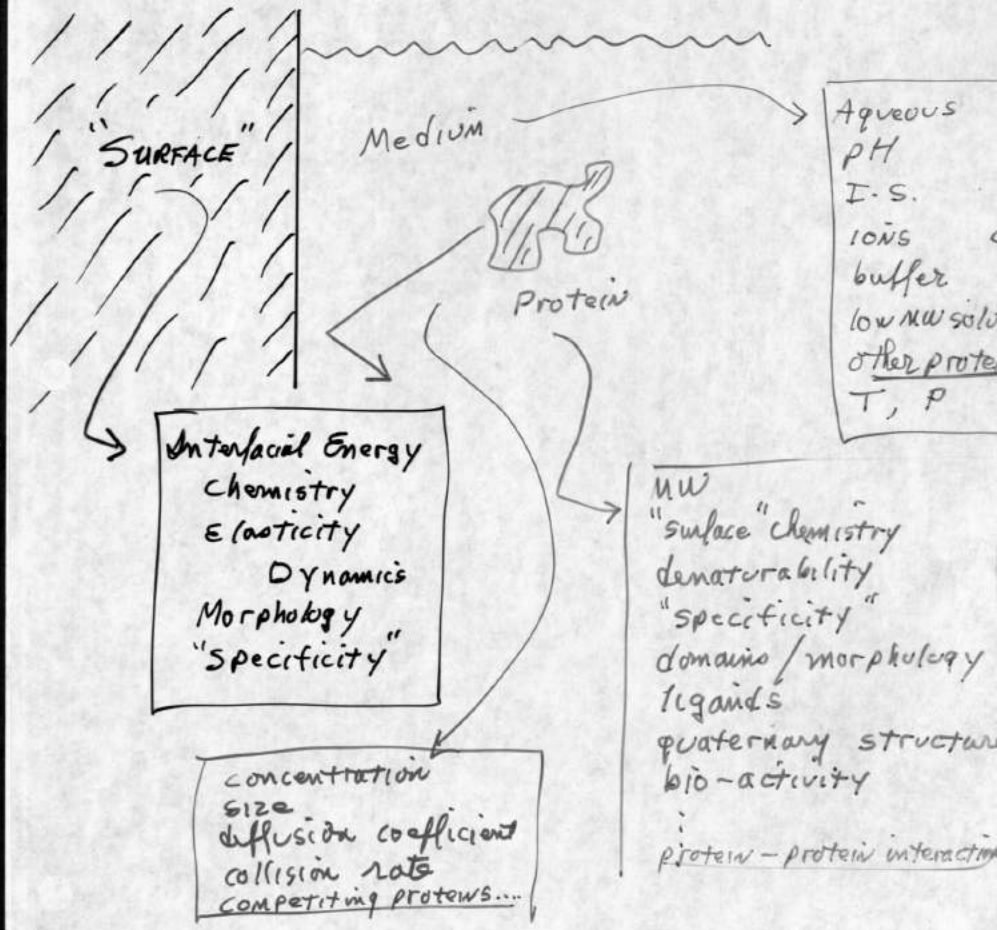
A-P Wei MSc thesis, U of Utah 2/90

Thanks Tom & John – 8 yrs ago!

S/V ratios + concentratio

PROTEIN ADSORPTION:

Defining the Problem – the Variables:

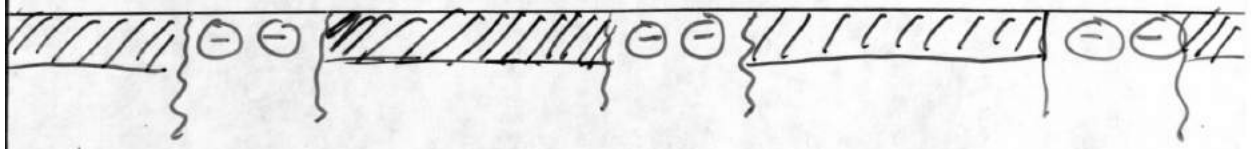


Compiegne 7/91

Cooperatin

△ DSC ?

△ IR ?



Ionomer?

Dirty Glass ?

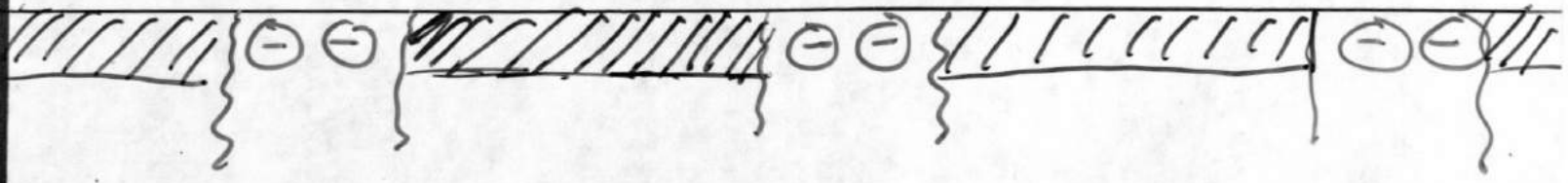
Silanized Glass ?

RFGD polymer ?

Cooperativity

△ DSC ?

△ IR ?



Ionomer?

Dirty Glass ?

Silanized Glass ?

RFGD polymer ?

"SIMPLEST" MODEL SYSTEM

"Simple" Proteins

Aqueous Solution:
3-D Structure
[XRD
Raman
NMR]
Molecular Graphics

Denaturation
pH
[Urea]
[GdmCl]
T

ΔG ~ 5–15 kcal/mole

slides

Model Interface

Air

WATER

short time → long time

Surface Tension
Dynamics,

Adsorption

A/W ⇒ Hydrophobic Interactions

Lin, whitesides et al

Theoritical Modeling & Simulation
Jaan, de Gennes, Lin, Horton

J. Colloid Interface Sci. 142 (1991) 149, 159

Gradient Model Surfaces
Healy, Lin

Adv. Appl. Chem. Soc., 4/91

Protein-Resistant Surfaces

Practical PEO Surfaces
Lee, Zhang

T. H. Lee, et al., J. Biomed. Mat. Res. 23 (1989) 351;
Biomaterials 11 (1990) 455

PEO Tethers – Immunosensors, Non-specific Binding
Lin, Napolitano

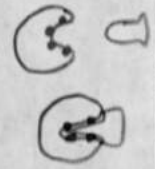
J. Chromatog. 542 (1991)
New Polymeric Materials 2 (1990) 287

Nagaoka / Mori
Hydrogen Peroxide
Merrill
Golander

Heterogeniety + Cooperativity

+ Dynamics =

"Specificity"



4. Statistical Specificity

Functional Groups: Chromatography: ion-exchange, hydrophobic, charge-transfer

+ H+C+D : Marcel + Jacqueline Effect.

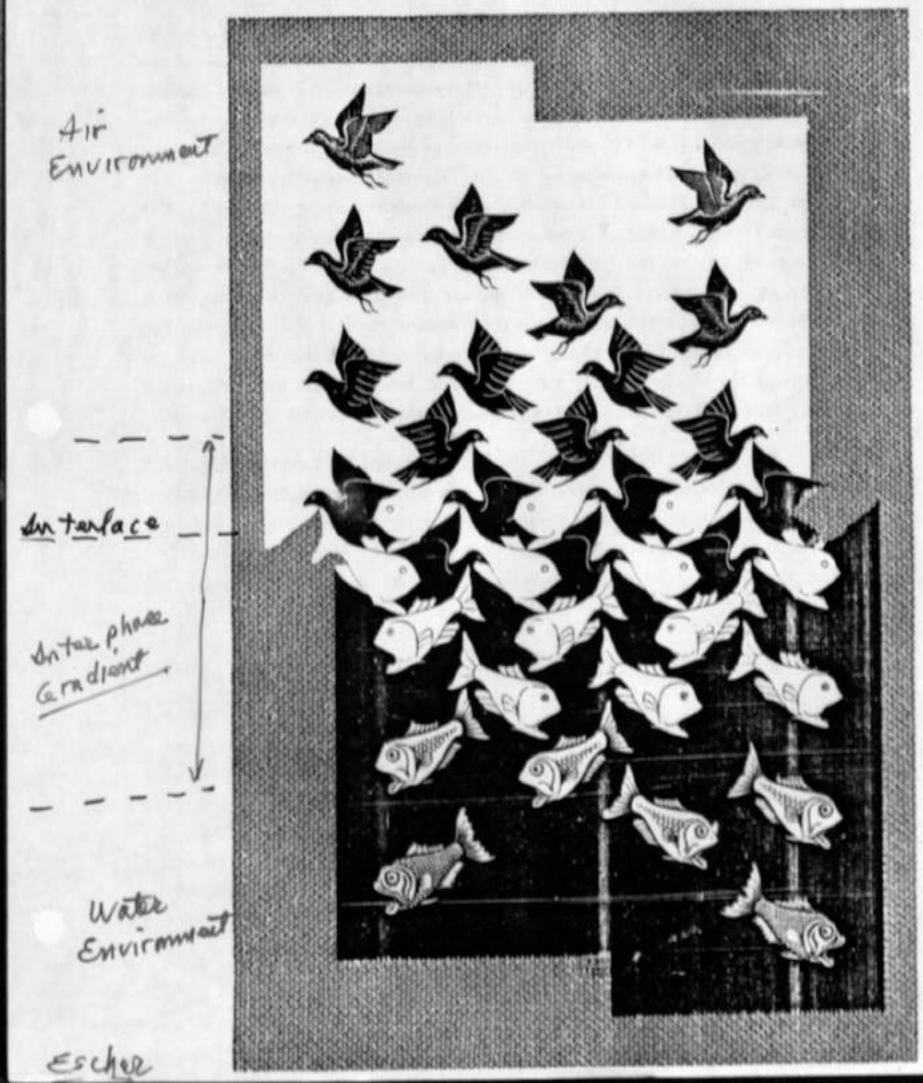
Protein Domains: "vitro"nectin, Heparin-Binding Proteins

Two Phase Polymers: Phase "Specificity" — Surface Phase/Morphology, Hydrothermo — Okano, Cooper

Domain-Domain Interactions: Morphology Specificity

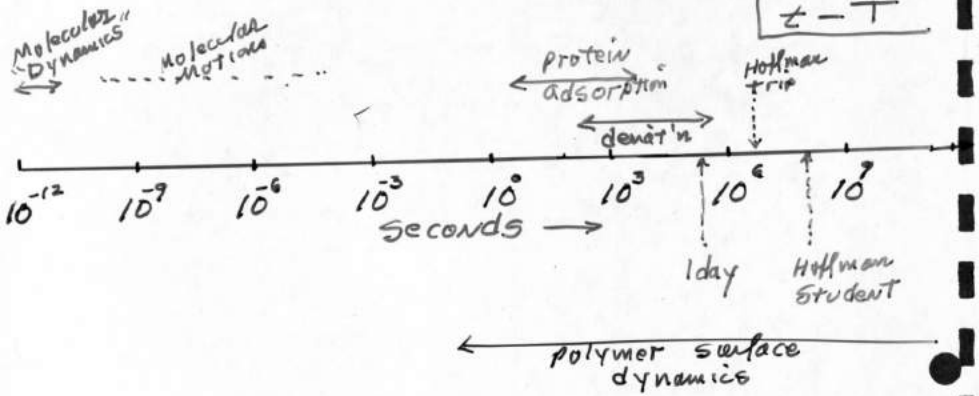
The REAL World: Σ All of the above!!

next q/a

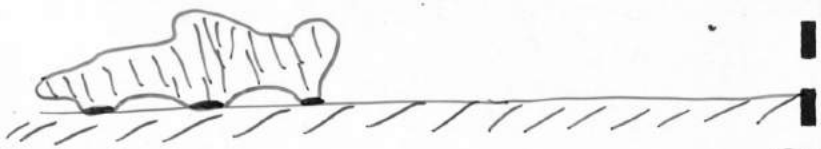


2. Dynamics: Everything is a function of time — if you look quickly enough or wait long enough

Polymers: $t - T$



3. Cooperativity: The phenomena we attempt to study and understand involve multiple, cooperative interactions ($\sim kT$) and multiple sites — of different dimensions

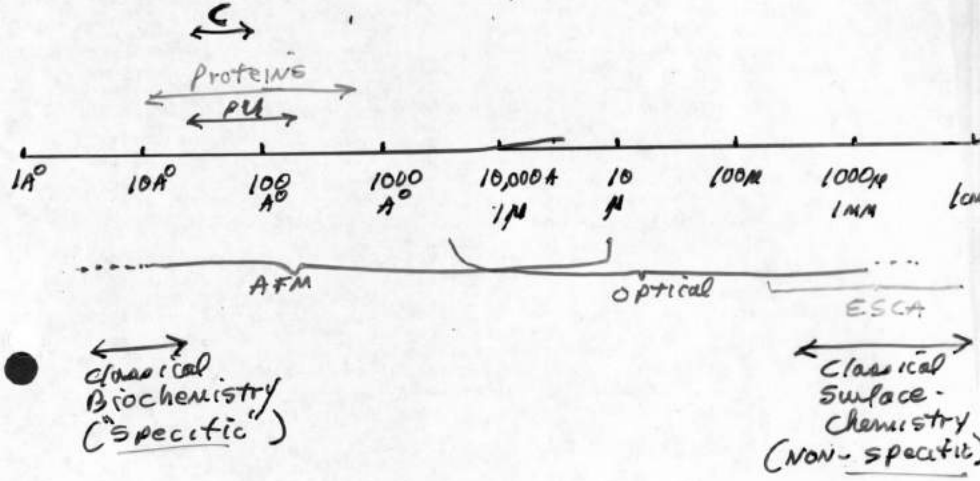


Polymer Adsorption Theory
Enzyme - substrate
Ag - Ab

Mavi 12/82

Four Perspectives

1. Heterogeniety: There are no homogeneous systems — simply different degrees of heterogeniety



Conclusion: Sizes / Dimensions are important

Mavi 12/82