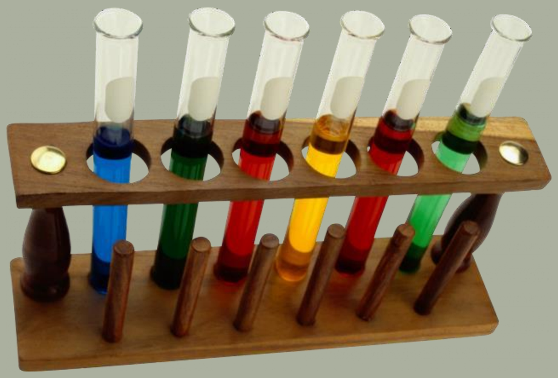
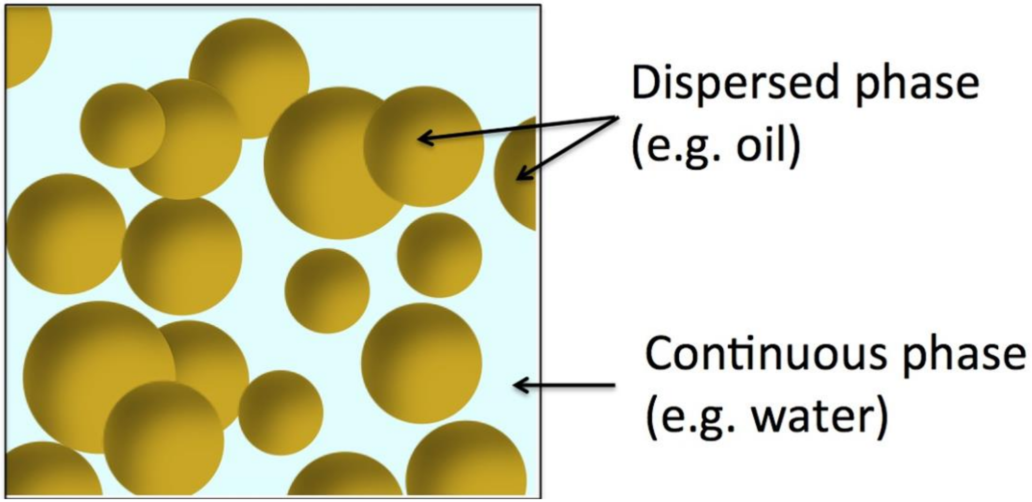
COLLOIDS

Lecture 6



THE CONCEPT OF DISPERSED SYSTEMS

Dispersed systems are heterogeneous (inhomogeneous) systems in which one substance, being in a finely divided state (dispersed phase), is evenly distributed in continuous phase (dispersed medium).



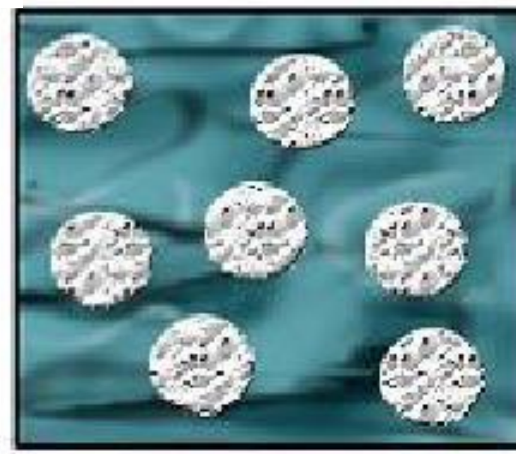
TYPES OF DISPERES SYSTEMS BY PARTICLE SIZE

TRUE SOLUTION

$D<10^{-9}$ cm

COLLOIDAL SYSTEM

$D = 10^{-7} – 10^{-9}$ cm



SUSPENSIONS

$D> 10^{-7}$ cm

COLLOIDAL AND TRUE SOLUTIONS

Colloidal solutions are solutions related to dispersed systems, where the particles of the dispersed phase are in the dispersion medium in the form of micelles.

Heterogeneous mixture

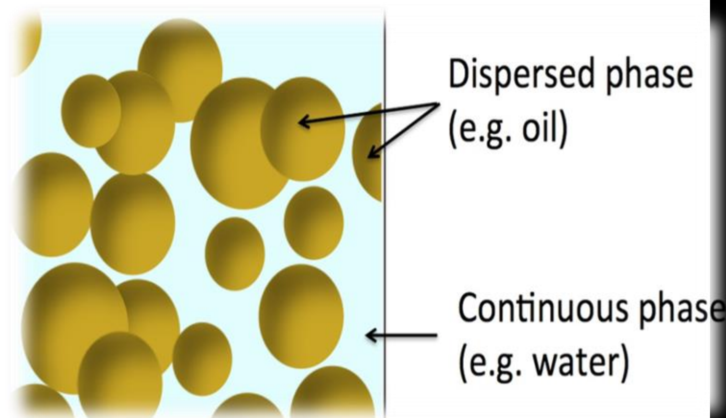
True Solution is solution in which particles of a solute are in water or other solvent in the form of molecules, atoms or ions. For example solutions of low-molecular weight compounds (salts, acids, alkalis).

Homogeneous mixture

BASIC DEFINITIONS

- **Colloidal solutions are** dispersed systems with a particle size of the dispersed phase exceeding the molecular size (10^{-9} - 10^{-7} m).

- **A dispersed system is** a heterogeneous system in which one of the phases is represented by small particles evenly distributed in the volume of another homogeneous phase.
- **A phase is** a homogeneous part of the system.
- **Dispersed phase is** finely divided particles, evenly distributed in the dispersion medium.
- **Dispersion medium (continuous phase) is** a homogeneous continuous phase, in which the particles of the dispersed phase are distributed.



CLASSIFICATION

Dispersed systems		**Type of dispersed system, its designation**	**Examples of dispersed systems**
Dispersion phase	***Dispersion medium***		
Solid	Gas (g)	Aerosol (s/g)	Dust, smoke, snow flakes
	Liquid (l)	Suspensions (s/l) Colloidal solutions (s/l) ***True solutions (s/l)***	Clay, toothpaste, lipstick. Egg white solution, blood plasma, chlorophyll alcohol extract, silicic acid. **Solutions of salts, alkalis, sugar.**
	Solid (s)	Solid solutions (s/s)	Alloys, minerals, colored glasses.
Liquid	Gas (g)	Spray can (l/g)	Fog, clouds, drizzling rain, spray from an aerosol can.
	Liquid (l)	Emulsion (l/l) ***True solutions (l/l)***	Milk, butter, mayonnaise, cream, ointments, emulsion paints. **Lower alcohols+water, acetone + water, acid solutions.**
	Solid (s)	Solid emulsion (l/s)	Pearls, opal.
Gas	Gas (g)	No dispersed system is formed	-
	Liquid (l)	Foam (g/l)	Soda water foam, lather, whipped cream, whipped cream, candy.
	Solid (s)	Solid foam (g/s)	Styrofoam, foam concrete, foam glass, pumice, lava.

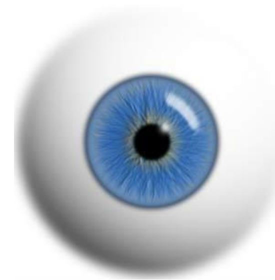
EXAMPLES OF DISPERSED SYSTEMS AMONG MEAL

s/s	Sausages, sweets (gel)  	s/l	Fruits, juices (sols, suspensions) 
l/s	Vegetable oil in dough (gel) 	l/l	Milk (emulsion), food creams, sauces (emulsions) 
g/s	Bread, cheese (solid foams) 	g/l	Carbonated drinks (foams) 

EXAMPLES OF DISPERSED SYSTEMS IN A BODY

- **Sols are blood, lymph, spinal liquid, saliva, cytosol**

- **Gels are skin, brain, eyeball**



COLLOID FORMATION CONDITIONS ARE …

1) Mutual insolubility of the substances forming the system;
2) The presence of a stabilizer;
3) Very small particle sizes 10^{-9}-10^{-6}m.

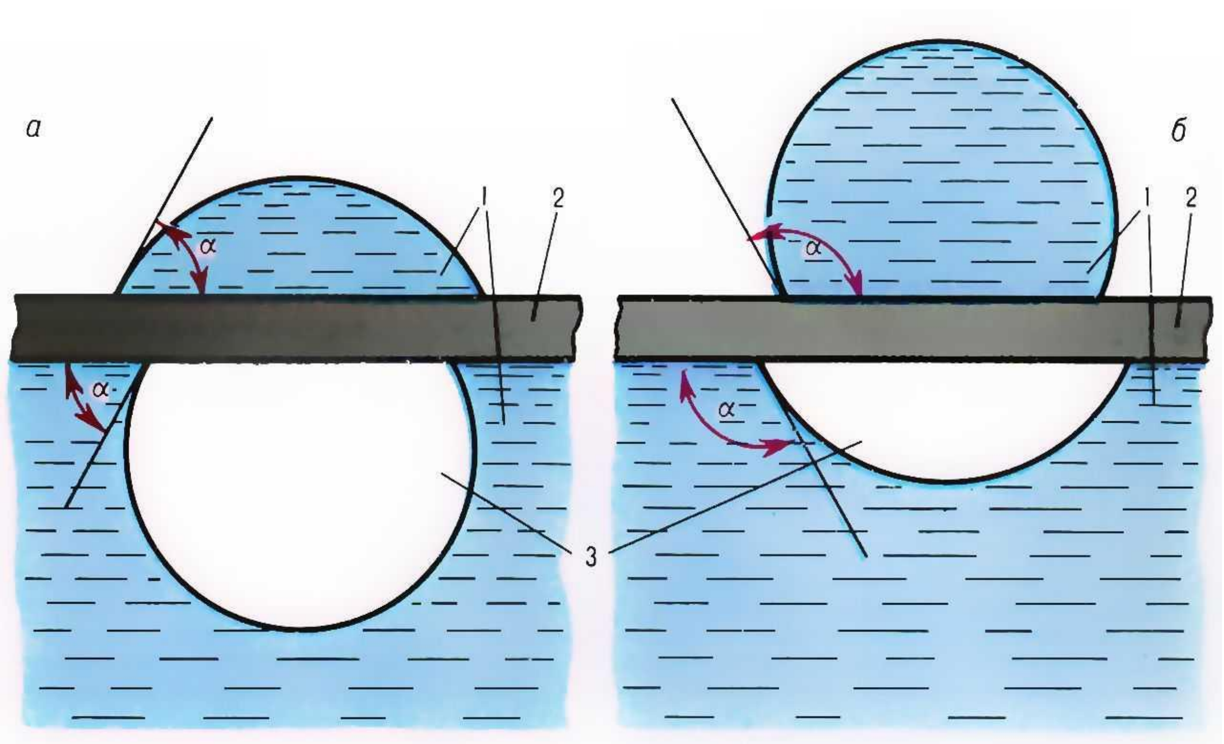
But even if these conditions are met, colloidal solutions, in contrast to true ones, are ***thermodynamically unstable.***

The reasons for low stability are **small particle size, large specific surface area.**

Classification by degree of interaction dispersion phase with the dispersion medium

Lyophilic - a systems, where interaction of the particles of the dispersed phase with the solvent is highly expressed.

Lyophobic - dispersion phase interacts weakly with the dispersion medium.



Hydrophilic (a) and hydrophobic (b) surface in a three phase system - water - solid - air; 1 - Water 2; - Solid; 3 - air; a - wetting angle.

STRUCTURE OF COLLOID MICELLES

According to the standard theory of micellar sol consists of 2 parts:

• **Micella** is a colloidal structural unit, surrounded by an electric double layer.

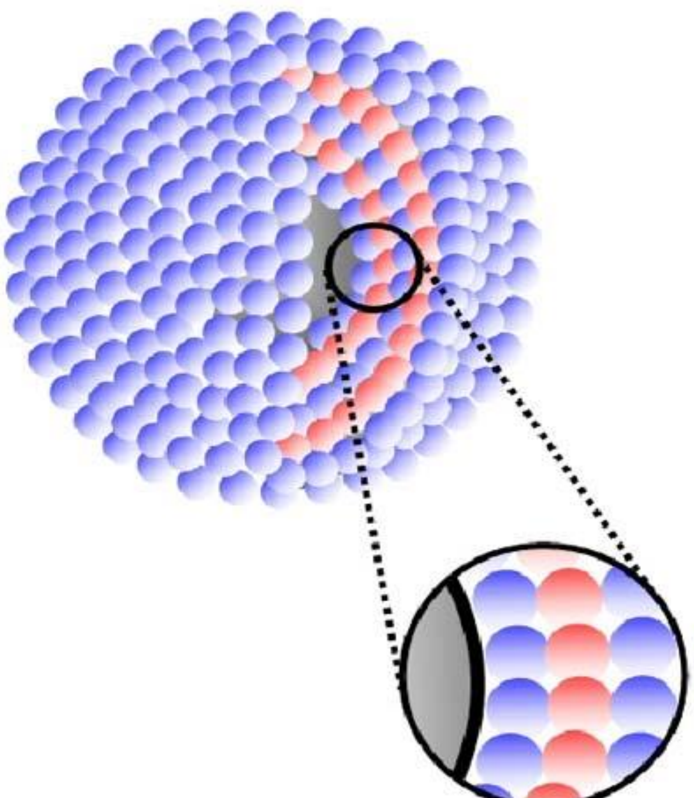
• **Intermicellar fluid** is the dispersion medium, separating the micelles, where the electrolytes, non-electrolytes and surfactants are soluted.

STRUCTURE COLLOID MICELLES

Micelle structure can be considered only as a first approximation, because it has no specific composition

$$KI + AgNO_3(\text{ex.}) = AgI\downarrow + KNO_3$$

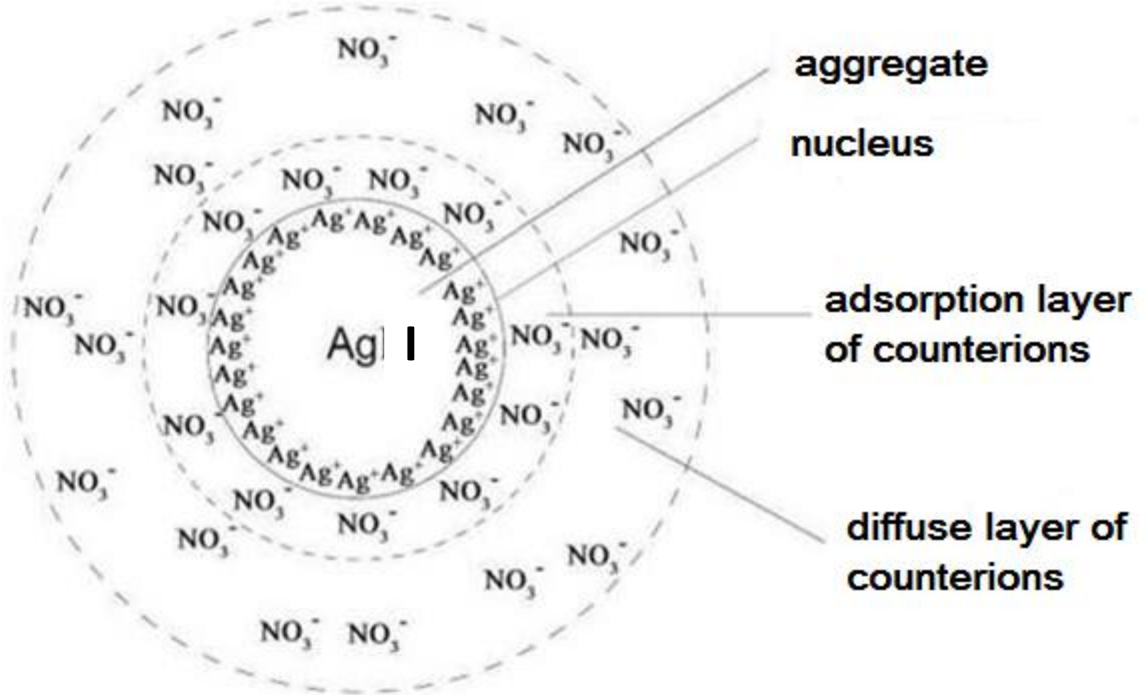
$$mKI + (m + n)AgNO_3 \rightarrow mAgI \cdot nAg^+ + nNO_3^- + mKNO_3$$



$$\{m[AgI]nAg^+(n-x)NO_3^-\}^{x+}xNO_3^-$$

$$\underbrace{\underbrace{\underbrace{\{m[AgI]}_{\text{aggregate}}\underbrace{nAg^+(n-x)NO_3^-\}^{x+}}_{\text{adsorption layer}}}_{\text{colloid particle}}\underbrace{xNO_3^-}_{\text{diffuse layer}}}_{\text{Micella}}$$

With an excess of one reactant microchip adsorbs its ions, which do not form a precipitate.
As a result of this microchip acquires a charge, ions, informing him that the charge potential-called, and he charged crystal - core micelles.



Charged core attracts ions from the solution with the opposite charge - counterions; interfacial electrical double layer is formed.

Some part of counterions adsorbed on the surface of the nucleus, forming a so-called adsorption layer counterions; nucleus together with adsorbed thereon are called counterions colloidal particles or granules. The remaining counter, the number of which is determined on the basis of the rules of electrical micelles constitute a diffuse layer of counterions; counterions adsorption and diffusion layers are in a state of dynamic equilibrium adsorption - desorption.

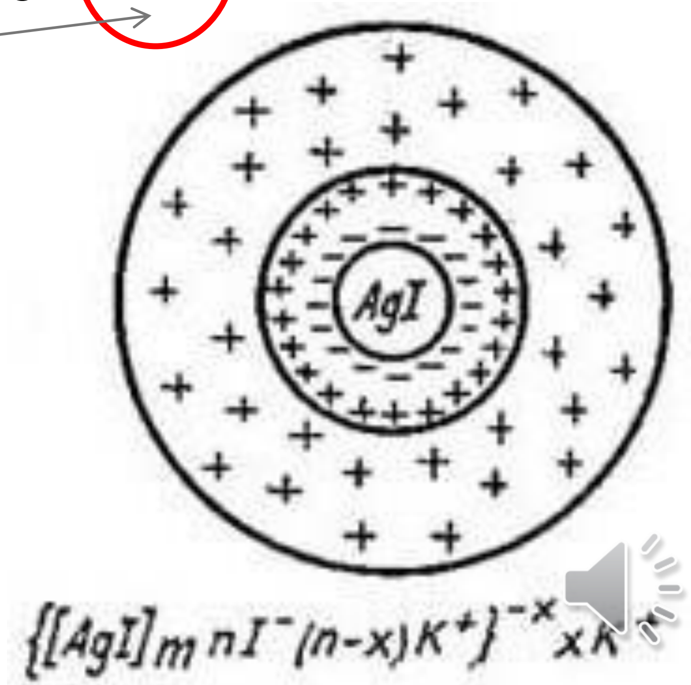
RULE PANETH-FAJANS

"On the surface of the solid assembly is primarily adsorbed ions which:

- **included in the assembly;**
- **<u>able to complete construction of the crystal lattice of the unit</u>;**
- **form compounds with ions of the unit;**
- **are isomorphic with the ions of the unit. "**

$$mAgNO_3 + (m+n)KI \rightarrow mAgI + mKNO_3 + nKI$$

KI is stabilizer



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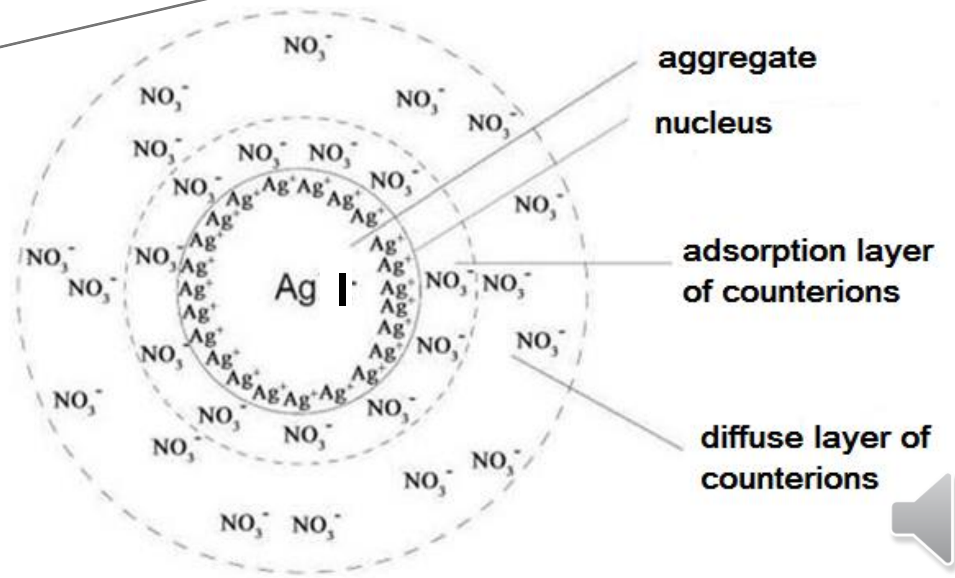
$$(m+n)AgNO_3 + mKI \rightarrow mAgI + mKNO_3 + nAgNO_3$$

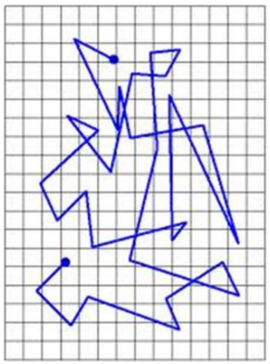
$AgNO_3$ is stabilizer



PROPERTIES OF COLLOIDS

Molecular kinetic properties:

Brownian motion (the collision of particles is an exchange of energy and as a result the average kinetic energy is set, same for all particles)



Diffusion

Osmosis

Optical properties:

ability to scatter light (this phenomenon was observed Faraday (1857) in the study of gold sol. The phenomenon Tyndall in 1868.

Coagulation

Peptization

STABILITY OF DISPERSED SYSTEMS

- Sedimentation stability characterizes the ability of particles dispersed phase be in suspension and do not settle under the influence of gravity

- Aggregate stability characterizes the ability of particles of the dispersed phase oppose them adhesion to each other and thereby maintain unchanged their sizes

The stability of dispersed systems is characterized by the ability of the dispersed phase to maintain the state of uniform distribution of particles of the dispersed phase in the entire volume of the dispersion medium

STABILITY OF DISPERSED SYSTEMS

1) Coarsely dispersed systems are heterogeneous and unstable, spontaneously stratified.
2) True solutions are homogeneous and indefinitely stable.
3) Colloidal solutions occupy an intermediate position on stability.

COAGULATION IS THE PROCESS OF ADHESION OF COLLOIDAL PARTICLES TO FORM LARGER AGGREGATES DUE TO THE LOSS OF AGGREGATE STABILITY.

THE CONSEQUENCE OF COAGULATION IS A DECREASE SEDIMENTATION STABILITY

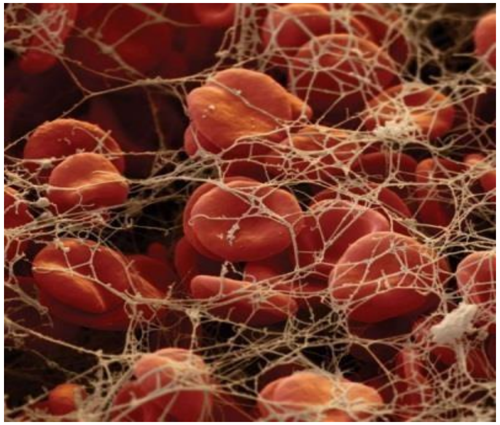
Coagulation in the body:

1) Sclerotic changes

vessels as a result of coagulation of colloidal solution

cholesterol

2) Blood clotting process



THE COAGULATION THRESHOLD IS THE MINIMUM AMOUNT OF ELECTROLYTE THAT MUST BE ADDED TO THE COLLOIDAL SOLUTION TO INDUCE COAGULATION (CLOUDINESS OR DISCOLORATION OF THE SOLUTION)

$$C_{пк} = \frac{c_{эл} V_{эл}}{V_{кр} + V_{эл}}$$

- $C_{пк}$ – coagulation threshold
- $C_{эл}$ – initial concentration of electrolyte solution
- $V_{эл}$ – the volume of electrolyte solution added to the colloidal solution
- $V_{кр}$ – colloidal solution volume

COLLOIDAL PROTECTION

- When added to the sols of some high-molecular compounds (as well as surfactants), their resistance to the action of electrolytes increases significantly.

- This phenomenon is called colloidal protection.

- The protected sol can be concentrated and even evaporated to dryness (and becomes thermodynamically stable, as if acquiring the properties of high-molecular compounds).

FOR EXAMPLE

Have a protective effect:

- Proteins
- Carbohydrates:

starch

cellulose

hyaluronic acid

- Heparin
- mixed biopolymers.