Syllabus

1. Introduction

2. Fluids

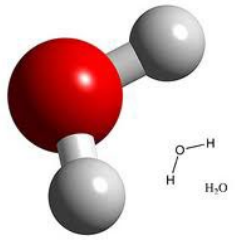
1. General Characteristics
2. **Dispersions**
3. Thermodynamics
4. Transport Phenomena
5. Solutions
6. Surface Tension
7. Electrical Properties
8. Optical Properties
9. Biological Fluids

Physics of Microfluidic Systems

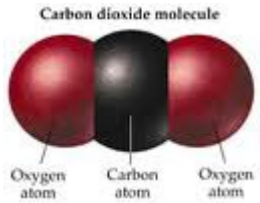
1. Navier-Stokes Equation
2. Laminar and Turbulent Flow
3. Fluid Dynamics
4. Fluid Networks
5. Transport of Heat
6. Interfacial Surface Tension
7. Electrokinetics

2.2. Dispersions

- Distinction of substances



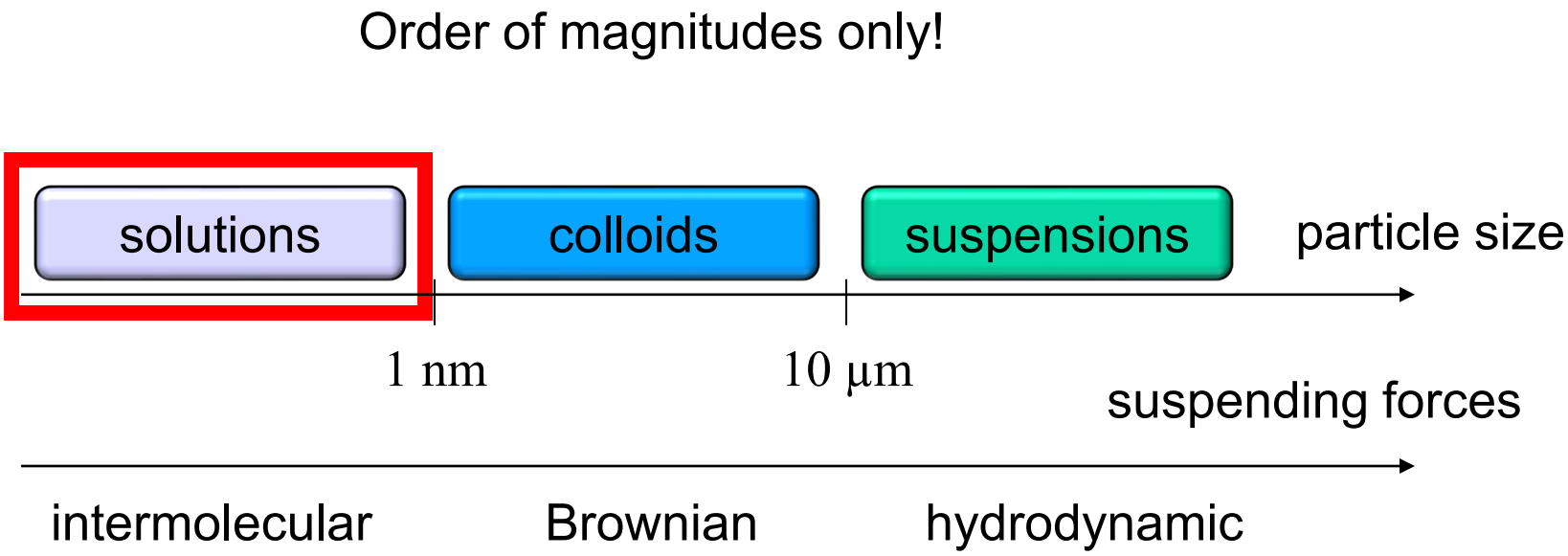
  - Pure substances
    - Atoms or molecules with strict stoichiometric ratio
    - Physical manipulation
      - Only alters state of matter
      - Chemical identity preserved



  - Mixtures
    - Two or more substances
    - Dispersions
      - Mixtures with one substance scattered throughout another substance
      - Further differentiation by size of particles
        - Solutions
        - Colloids
        - Suspensions

2.2. Dispersions

1. **Solutions**
2. Colloids
3. Suspensions



2.2.1. Solutions

- Also: homogeneous mixture
- Dispersion with dissolved particles of ionic or molecular size
- Homogeneous distribution of particles throughout volume
- Commonly liquid, but also gas and solid

- Molar concentration (molarity)

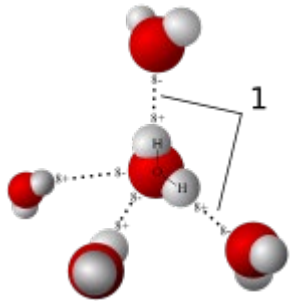
$$c = \frac{N}{N_A V} = \frac{n}{V}$$

N = number of solved molecules
V = carrier volume

- Molality

$$c_m = \frac{n}{m}$$

n = moles of solute
m = solvent mass

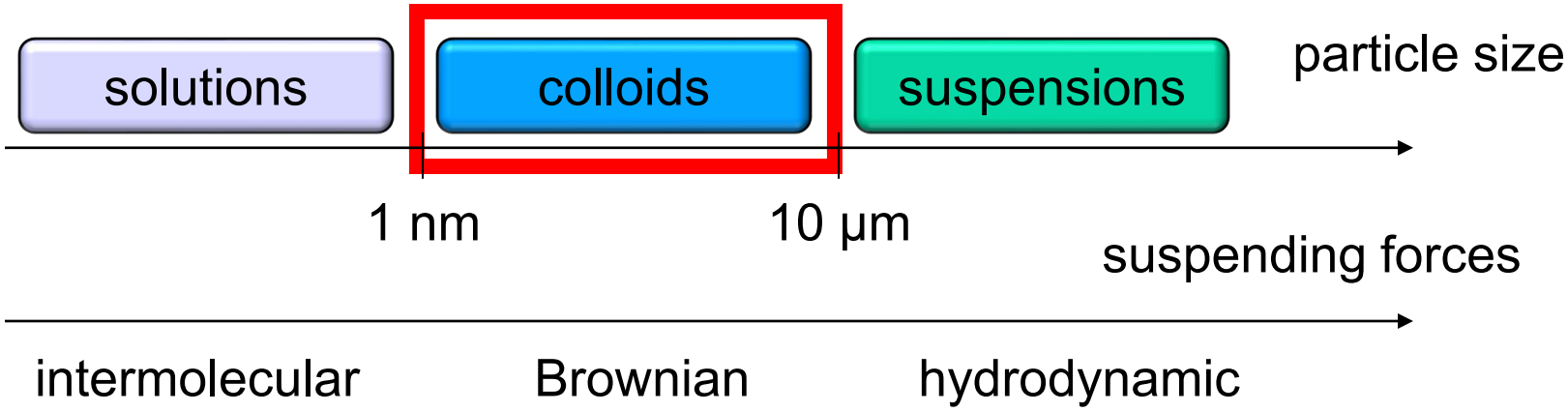


water

- Example: air
  - Solution of oxygen and nitrogen

2.2. Dispersions

1. Solutions
2. **Colloids**
3. Suspensions



2.2.2. Colloids

- Also: colloidal system, colloidal solution, colloidal dispersion
- Dispersion properties
  - Tiny dispersed (not solved) particles (nm -10 μm)
- Colloidal particles pass through
  - Filters
  - Not through semi-permeable membranes
    - Original definition by Thomas Graham
- Heterogeneous mixture
- Typically, two-phase
- Both phases
  - Solid or liquid
  - Only one gaseous
- Incessant bombardment of molecules sufficient to keep colloidal particles in suspension
  - Brownian motion (↦ Section: Thermodynamics)

Milk: emulsified colloid of liquid butterfat globules dispersed within a water-based solution

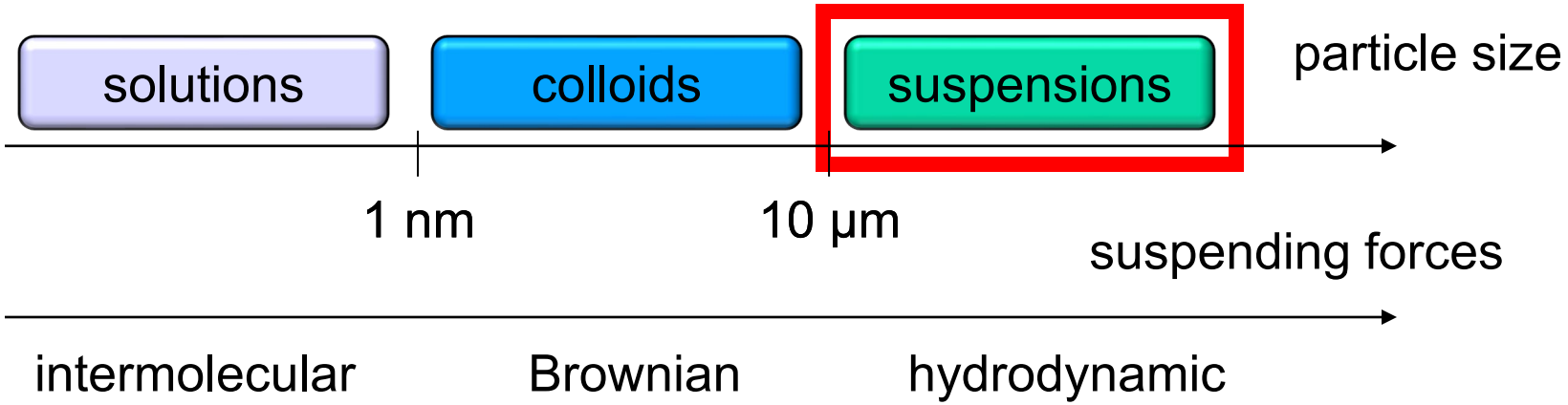
2.2.2. Colloids

- Process
  - Reversible
    - Generation and dissociation of colloidal particles
  - Irreversible
    - Suspended material is stable
- Types
  - Aerosols
    - Either solid or liquid suspended in gas
    - E.g., smoke, fog and smog
  - Emulsions
    - Heterogeneous liquid-liquid mixture
    - E.g., milk: fat droplets in aqueous solution
  - Sols
    - Solid particles in liquid
  - Gels
    - Liquid with particles dispersed or arranged in network throughout gel
    - Viscous enough to somewhat behave like solid

Milk: emulsified colloid of liquid butterfat globules dispersed within a water-based solution

2.2. Dispersions

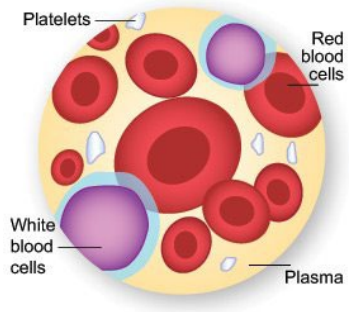
1. Solutions
2. Colloids
3. **Suspensions**

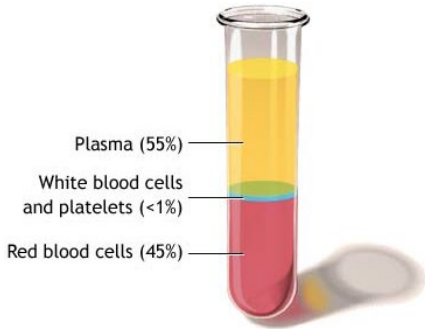


2.2.3. Suspensions

- Particles larger than those of colloids ($> 10\ \mu m$)
- Suspension particles observable with ordinary microscope
- Can be purified by filters
- Precipitation of particles
  - If solution remains (hydrodynamically) undisturbed

blood





Summary

Molar concentration: $$c = \frac{N}{N_A V} = \frac{n}{V}$$

Mass concentration: $$c_m = \frac{n}{m}$$