Last time
- linear elasticity
- stress / strain tensors (deformations ≠ rigid body rotation)
- constitutive laws

• Newtonian fluids — constitutive law $\sigma \sim \dot{\varepsilon}$ — "moduli" μ (1) — force balance $\frac{\partial \sigma_{ij}}{\partial x_j} = 0$ — Stokes equation

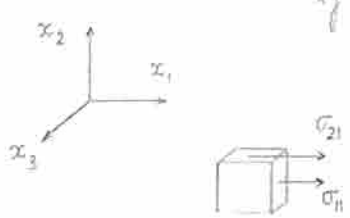
• Hookean solid — $\sigma \propto \varepsilon$ — λ, G — Equilibrium (no inertia)

{ continuum (ignore microfracture)
isotropic
homogeneous
linearly elastic

G ↓ shear modulus
2nd Lamé constant
or (μ, E, ν, K) only two independent

$$\sigma_{ij} = \lambda \varepsilon_{kk} \delta_{ij} + 2G \varepsilon_{ij}$$
$$\varepsilon_{ij} = \frac{1+\nu}{E} \sigma_{ij} - \frac{\nu}{E} \sigma_{kk} \delta_{ij}$$
ν = Poisson's ratio
E = Young's modulus

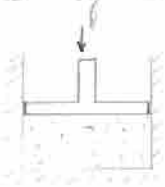
with notations σ_{ij} { i direction of surface normal; j direction of stress; $i = j$ normal stress; $i \neq j$ shear stress

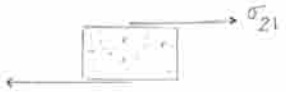


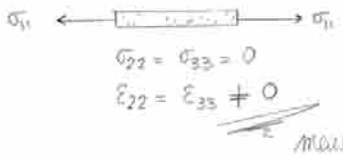
▷ also $\varepsilon_{kk} = \varepsilon_{11} + \varepsilon_{22} + \varepsilon_{33} = \frac{V_f - V_i}{V_i}$ (volume expansion)
$\frac{1}{3}\sigma_{kk}$ (mean normal stress) $= -p$ (hydrostatic pressure)

○ A Hookean material is characterized by any two of λ, G, E, ν, μ, K
↳ need 2 independent experiments to determine

e.g.
- confined compression
- unconfined compression
- pure shear (*)
- pure extension



(*)




$$\left.\begin{aligned} \varepsilon_{11} &= \frac{1+\nu}{E}\sigma_{11} - \frac{\nu}{E}(\sigma_{11} + 0 + 0) = \frac{\sigma_{11}}{E} \\ \varepsilon_{22} &= \frac{1+\nu}{E} 0 - \frac{\nu}{E}(\sigma_{11} + 0 + 0) = -\frac{\nu}{E} E \varepsilon_{11} \end{aligned}\right\} \quad \boxed{\nu = \frac{-\varepsilon_{22}}{\varepsilon_{11}}}$$

TISSUE MECHANICS
1. Molecular structure & composition of extracellular matrix
2. Elastic behavior of tissues
3. Viscoelastic (time-dependent) behavior - creep / strain relaxation
4. Poroelastic behavior (fluid can move around)
5. Electromechanical behavior
6. Mechanobiology (muscle - stress adaptation - mechanotransduction)

Today:
• connective tissues
- loose, irregular (basement membrane)
- dense, irregular (dermis, fascia)
- adipose tissue (fat)

- dense, regular (tendon, ligament, cornea)
- skeletal (bone, cartilage, dentin)

- primary constituents
  - collagen superfamily (strong)
  - elastin (flexible)
  - proteoglycans (compressive)
  - adhesion proteins