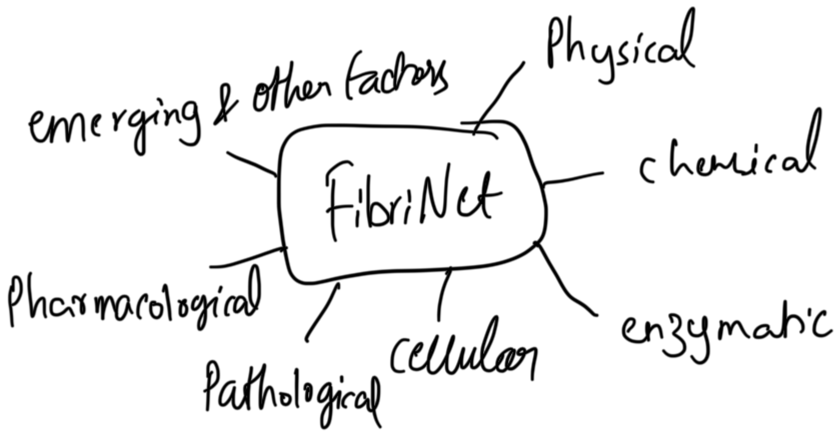
Factors affecting fibrin network



Proportionality (fibrinolysis vs factors)

F

- $F \propto \dfrac{1}{\text{Tensile strain}}$ (Source :- Strain tunes proteolytic degradation and diffusion transport in fibrin)

- $F \propto$ Prestrain & Tension (source :- physical Determinants of fibrinolysis in single Fibrin fibers)

- F $\begin{cases} \text{Moderate - promotes F} \\ \text{(Non Linear) - shear deformation} \end{cases}$ (shear - induced Densification of

fibrin Micro-
- structure)

Extreme - inhibits F

- $F \propto \dfrac{1}{\text{compression \& contraction}}$ (Hindered Dissolution of fibrin Under Mechanical Stress)

- $F \propto \dfrac{1}{\text{Molecular unfolding}}$ (Effect of shear and Tensile Loading on fibrin Molecular structure)

- $F \propto$ fiber diameter & Stiffness (fibrin fiber stiffness and Diameter Relationship)

<u>Build to break:</u>

<u>Building on physical parameters</u> :-

(i) <u>Assign the edge weights</u>

edge weights $\approx$ fiber thickness

Diameter D_i (in nm)

→ random Assignment

→ varies from 100 - 500 nm

(100 to 250 in range)

Realistic

(2) Modulus (or) (stiffness) - Depends on D_i

Experimentally validated formula for stiffness, Y

$$\boxed{Y_i = \underline{Y_0}\, D_i^{-1.6}}$$

$$\boxed{Y \propto D^{-1.6}}$$

Y_i = Youngs modulus of edge i

D_i = thickness/diameter of edge i

Y_0 = reference modulus constant

(from experiment)

(3) Spring constant for individual edge (fiber)

* Assuming edge is cylindrical fiber

$$\boxed{A_i = \frac{\pi}{4} D_i^2}$$

$$K_i = Y_i \frac{A_i}{L_i}$$

where:-

K_i :- spring constant for each fiber (edge)

A_i :- cross-sectional area of the fiber

L_i :- original Length of fiber i

(4) Edge Tension under Deformation

$$\varepsilon_i = \frac{l_i - L_i}{L_i}$$

- l_i :- current Length (after deformation)
- L_i :- original Length

Tension in the fiber :-

$$\boxed{T_i :- Y_i \, \varepsilon_i \, A_i = K_i (l_i - L_i)}$$

This gives a good link between thickness to the maximum | instantaneous tension that an edge can support (or) bear

Table of Track :- Phyical constraints

① Diameter :- input (100-500nm) ✓

② Modulus (stiffness) :- $Y_i = Y_0 D_i^{-1.6}$ ✓

③ Area :- $A_i = \frac{\pi}{4} D_i^2$ (since its cylindrical) ✓

④ spring constant for individual edge :- $K_i = Y_i \frac{A_i}{L_i}$ ✓

(5) strain:- $\varepsilon_i = \dfrac{l_i - L_i}{L_i}$ ✓

☆ (6) Instantaneous :-
Tension

$$T_i = Y_i \varepsilon_i A_i$$
or
$$= K_i(l_i - L_i)$$

force in fiber at any given Point of time ✓

Resources

Major research Paper:-

"fibrin fiber stiffness is strongly affected by fiber Diameter, but Not by fibrinogen Glycation"

Supporting

("The elasticity of an individual Fibrin Fiber in a clot") 2005

" Non-Uniform internal structure of fibrin fibers:- Protein Density and Bond Distribution"

("Biophysical Mechanisms Mediating Fibrin Fiber Lysis" 2005)

chemical - constraints

→ tpa - Rate of degradation

↓

→ fibrin con.c

→ thrombin conc

→ tpa conc

→ plasmin

→ plasminogen

→ ionic con.c

→ Chemical vs physical

→ Rate of degradation

→ $\boxed{\text{Density of fibrin}}$