1. What is the mechanical regulation of cell differentiation during bone regeneration?

   The mechanical regulation of cell differentiation is based on the model created by Prendergast et al. [1]. The model proposes that a combination of shear strain (γ) and fluid velocity (v) results in a mechanical stimulus, S, that directs which type of cells mesenchymal stem cells differentiate during bone regeneration. The model follows the equation:

$$S = \frac{\gamma}{a} + \frac{v}{b},$$

   where a = 0.0375, b = 3 µm/s
   - High mechanical stimulus (S>3): mesenchymal stem cells differentiate in fibroblasts
   - Medium mechanical stimulus (1<S<3): supports chondrogenic differentiation
   - Low mechanical stimulus (S<1): stimulate MSCs differentiation into osteoblasts.

2. What mechanical (poroelastic) characteristics of tissue enter the main parameter of mechano-regulation?

The octahedral shear strain and fluid/solid velocity are two characteristics used to compute the main parameter of mechano-regulation: the mechanical stimulus S.

3. What is the effect of this parameter on the growth rate of capillaries during tissue vascularization?

- As the mechanical stimulus, S, rises towards the threshold S_{max}, the growth rate of capillaries decreases linearly, reaching zero at S = $S_{max.}$ A high combination of shear strain and fluid flow (S high) will prevent capillary vessel formation.
- When the mechanical stimulus is zero, the rate of capillary growth is maximum: low or negligible stimulus permits rapid vascular growth.

Reference

Prendergast, P. J., R. Huiskes, and K. Søballe. Biophysical stimuli on cells during tissue differentiation at implants interfaces. J. Biomech. 30:539–548, 1997. doi:10.1016/S0021-9290(96)00140-6