Mechanical properties of tissues - introduction

The mechanical properties of tissues are often described in two planes:

1. at the level of **structural** properties that characterize the properties of the tissue in its intact, *in vivo* form.
2. in terms of the '*mechanical* properties of the substances from which the given tissues are composed.

By the mechanical properties of substances, we understand those properties that are related to the **deformation *of a body made of a given substance under the action of external forces. If the body acquires flood properties (shape and volume) after the end of the action of these forces, we speak of ``elastic deformation*. If this does not happen, it is "plastic deformation".**

From a biophysical point of view, in addition to *strength*, i.e. the ability of a material to withstand an external or internal force without being broken, the following static properties are the most important[1]:

- **Elasticity** - the ability of a body to return to its original shape after an "elastic" deformation.
- **Distension** - flexibility of a substance to the action of a deforming force.
- **Plasticity** - the ability of a substance to permanently change its shape under the influence of an external force.
- **Viscosity** - a dynamic property that manifests itself as resistance to changing the shape of a substance.

Strength

In physics, a distinction is made between strength in "tension, bending, compression" and "rotation". It is evident that the values of the ``strength limit*, which indicates the maximum value of the conventional ``stress* that can be reached when the material is loaded until it breaks, will differ considerably for individual types of movements.

Between the strengths is different for different materials and is determined experimentally. It is denoted R_m and is given in **Pascals [Pa]**.

R_m = F/A
R_m - between strength [Pa]
F – force acting on the body [N]
A – cross-section of the body on which the given force acts [mm^2]

Among the strongest tissues in the human body is the bone marrow, whose strength corresponds to the strength of brass, cast iron or malleable iron - i.e. it is able to withstand mechanical stress of up to 100-200 MPa.[2]

Elasticity

Elastic substances exhibit a linear course of deformation below the *elastic limit* that corresponds to Hooke's law.

ε = σ / E
ε – relative deformation of the material
σ – tensile mechanical stress [Pa]
E – modulus of elasticity in tension [Pa]

Between the *limit of proportionality* and between elasticity, the linear course of deformation changes to *nonlinear*, but after the end of the stress, the material still returns to its original state. **Elastická** žlutá **vlákna** jsou shluky proteinu elastinu v extracelulárně matrix, které mají schopnost se elasticky prodloužit až na 150 % jejich původní délky. Toto umožňuje mnohým tkáním přizpůsobovat se a kompenzovat působení vnějších anebo vnitřních sil bez poškození.

Plasticity

Plastic materials show deformation only at a certain value of the applied stress. Even after the **removal *of the external force, they retain the*** *maximum reaching deformation.*

Viscosity

Viscous substances are liquids which, according to the dependence of the rate of deformation on the deforming force, are divided into two groups - ``Newtonian liquids*, in which the rate of deformation varies linearly with the applied stress, and ``non-Newtonian liquids*, in which this dependence is generally non-linear.

In the case of blood, this viscosity is a relatively significant property, because with its hyperviscosity, e.g. in the case of polycythemia, the risk of "cardiovascular incidents" increases rapidly.

Links

Related Articles

- Mechanical properties of tissues - Support and movement system
- Mechanical properties of tissues - Vascular system
- Mechanics of Breathing
- Mechanical properties of tissues - Digestive system
- Mechanical properties of tissues - Excretory system
- Mechanical properties of tissues - Human voice and human voice production

References

1. HRAZDIRA, Ivo – MORNSTEIN, Vojtěch. *Lékařská biofyzika a přístrojová technika.* 1. edition. Neptun, 2001. ISBN 80-902896-1-4.
2. ČIHÁK, Radomír. *Anatomie 1.* 3. edition. Grada, 2011. ISBN 978-80-247-3817-8.

External links

- Mechanické vlastnosti tuhých látok (https://fyzika.utc.sk/sk/zaklady/zaklady/08.pdf)

Used literature

- ČIHÁK, Radomír. *Anatomie 1.* 3. edition. Grada, 2011. ISBN 978-80-247-3817-8.
- HRAZDIRA, Ivo – MORNSTEIN, Vojtěch. *Lékařská biofyzika a přístrojová technika.* 1. edition. Neptun, 2001. ISBN 80-902896-1-4.