Laboratoire LÃ©on Brillouin
SÉMINAIRE

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Mardi 20/03/2018, 14h30

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Animal blood suspensions

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We investigate the in-vitro behaviour of blood from mammalian species in simple and oscillating flow. Comparative studies give insights to basic structure-function relationships, and healthy individuals of different species can compose fairly coherent study groups. The red blood cell (RBC) membrane composition is not uniform among mammals including man. This affects size, shape, and mechanical properties of the cell if e.g. specific membrane proteins are lacking or are unable to rotate. Species differences are identified by means of the shear dynamic modulus, apparent YoungÂ´s modulus or adhesion force (AFM). But also the lipid composition of the bilayer and the cytoplasmic viscosity vary, which influences the ability of the membrane to undergo dynamic motions during flow. Flow curves and shear moduli in linear mode are related to these properties, but they also rely on the interplay between RBCs and blood plasma. The situation gains further complexity when platelets come into play. This is the case when there is a high number of platelets present in blood (in rat) or when platelets have a comparable size to RBCs (in goat, sheep, and cat) 1-3.

To compare the species, we generated blood samples of different haematocrit (HCT), and tested them at various temperatures. Camel that experiences nychthemeral amplitudes of body temperatures up to 5-6Â°C, shows the lowest temperature dependency of blood viscosity among a series of six mammalian species (man, horse, rat, sheep, pig, camel). This reduces the need of the vascular endothelium to adapt intracellular signal transduction pathways to periodically changing shear forces and conserves energy. At physiological HCT, camel blood viscosity is lower than in other species. Increasing the HCT does not change this behavior, which is very untypical for the mammalian class. At high HCT (60

The Newtonian behavior of camel blood and the profound shear thinning (associated with thixotropy) of horse blood offer two contrasting blood properties (with human blood being in-between). To our great surprise, apparent YoungÂ´s modulus and adhesion force of camel and horse RBCs are equal. The answer may lie in the RBC shape and the viscosity contrast between RBC cytoplasm and blood plasma in the two species. We hypothesize that the membrane fortification at the cell poles to maintain the elliptic shape of camelid red cells play a key role. We further assume that a significant viscosity contrast circumvents coherence between RBCs and plasma. The relevance of viscosity contrast for the flow behavior was surprising. Camel RBCs possess a high amount of sialic acid domains on the membrane surface and the adhesion force to a SiO2 cantilever is comparable to horse. The electrochemical surface property should generate a significant double layer in autologous plasma. However, camel blood at temperatures between 42 and 12Â°C keeps surprisingly a Newtonian behavior...

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