FUNDING PROGRAM FOR NEXT GENERATION WORLD-LEADING RESEARCHERS

Project Title: Design of biocompatible polymers for medical devices	
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1. Background of research

The design of biocompatible surfaces to control cell adhesion has a variety of potential applications in medical devices and tissue engineering. Many attempts to modify surfaces have been made in order to avoid the activation of the body's defense mechanisms through exposure of cells to foreign materials. A number of biomaterials have been proposed, including hydrophilic surfaces, phase-separated microdomain surfaces, and bioinspired biomembrane-like surfaces. It has not been clearly elucidated which mechanism(s) is responsible for biocompatibility on a molecular level, although many theoretical and experimental efforts have been devoted to this mechanism.

2. Research objectives

Water interactions have been recognized as a fundamental part of the biological response to contact with bio/medical materials. Here we will study the dynamics and structure of water and hydrated polymers at biointerfaces encompasses a wide range of techniques. We also highlight that the reasons that polymers exerted a strong influence on cell behavior under physiological condition.

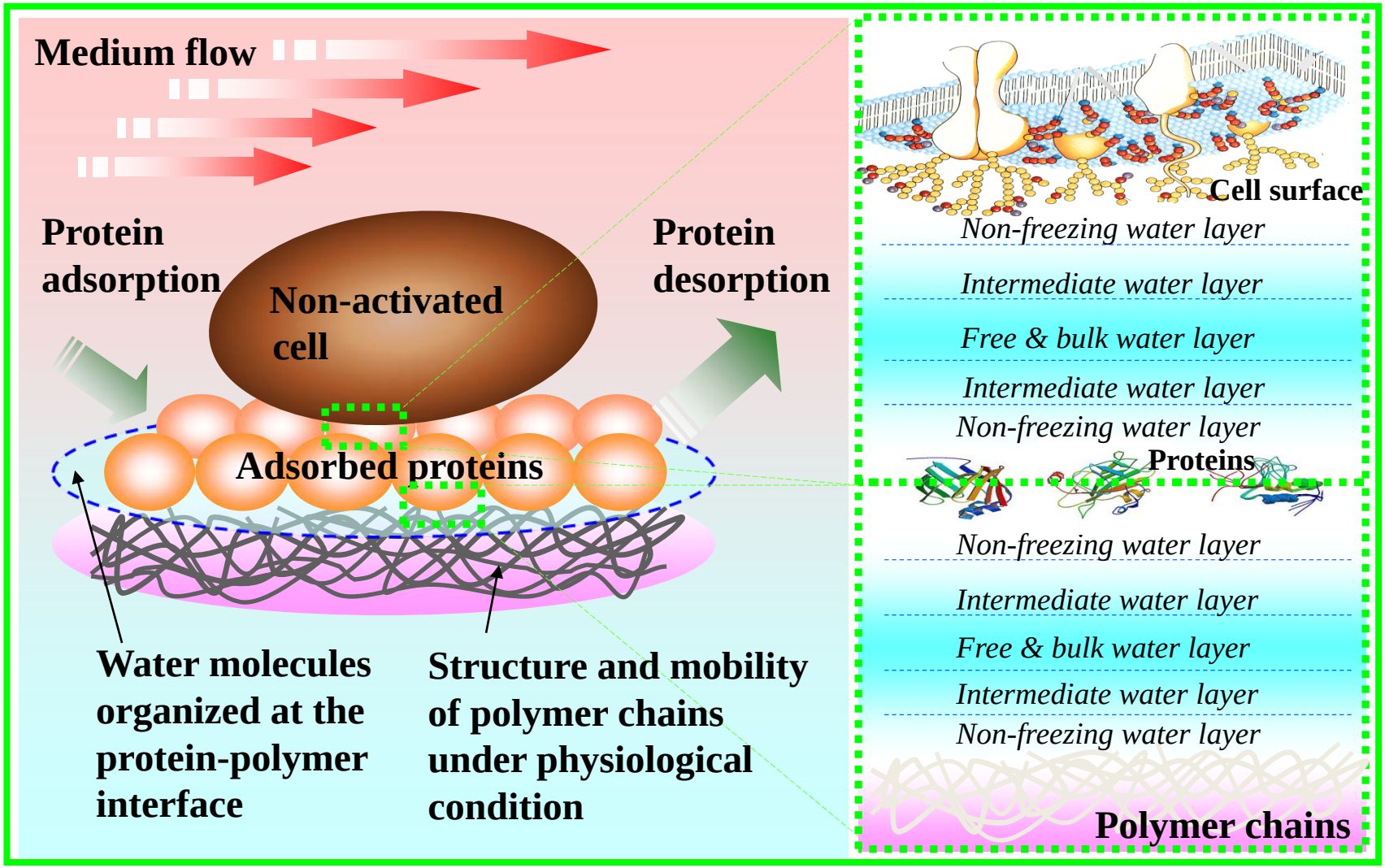
3. Research characteristics (incl. originality and creativity)

We focus on the relationships between water structure and normal, cancer and stem cell adhesion, morphology, proliferation, differentiation, cytoskeleton, focal adhesion, as well as functions including matrix production profiles. This study will be to give an idea of the polymer design in the quantitative description of mechanism of biocompatibility driven by novel approaches.

4. Anticipated effects and future applications of research

New designed biocompatible polymers are available to apply for medical devices, such as artificial blood vessel with small diameter, and cancer therapy systems. It is also expected that the designed surfaces will have great potentials as polymers for tissue regeneration in a growth factor free proliferation and selective adhesion process of stem cells.

The roles of water molecules in the biointerface - clarification of the biocompatibility mechanism -



Schematic representation of the polymer and cell interface at the biointerface. The hydrated water in polymer can be classified into 3 types: *non-freezing water*, *intermediate water*, and *free water* on the basis of the equilibrium water content and the enthalpy changes due to the phase transition. In addition, it is well known that proteins and blood cells have hydration shells composed of *non-freezing*, *intermediate*, and *free waters*, and the shells keep the blood components stable. The biocomponents will get activated when the structures of the proteins and/or the cell membranes are changed due to contact with the *non-freezing water* on the polymer surface and/or with the polymer surface. We first hypothesized that *intermediate water* which prevents the bio-components from directly contacting the polymer surface or *non-freezing water* on the polymer surface was an important factor in determining the compatibility.