

Role of platelets in blood–biomaterial interactions

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Abstract. Over 2 million cardiovascular procedures are performed annually in the United States. Every one of these procedures requires some period of contact with blood with several different biomaterials used in the manufacture of assist devices or implant devices. In view of the increasing importance of the biomaterials in clinical practice, it would be timely to review briefly physicochemical characterization as well as biological evaluations. Blood compatibility encompasses a variety of events associated with blood interaction with the biomaterials used in various procedures. Two separate coagulation mechanisms are involved (arterial and venous) depending upon the flow characteristics. At least three interacting factors modulate normal hemostasis and the pathogenesis of thromboembolic events. They are the state of activation of coagulation cascade, circulating levels of thrombin and fibrinogen and relative activity of platelets. In this overview we discuss the current concepts on the role of platelets in blood–biomaterial interactions.

When blood contacts a biomaterial surface a variety of blood components interact with the surface. Some of the key players in platelet activation on biomaterial surface include fibrinogen and von Willebrand factor. Currently available antiplatelet drugs effectively block aggregation and secretion induced by physiological agonists such as epinephrine, adenosine diphosphate and thromboxane in suspension. However, they do not prevent platelet interaction on biomaterial surfaces. Mechanisms involved in platelet activation in suspension and on surfaces as well as the pharmacology of newer antiplatelet drugs will be discussed.

Keywords. Platelet adhesion; protein adsorption; biomaterials; surface induced platelet activation; fibrinogen; platelet-surface receptors; antiplatelet drugs.

1. Introduction

The adhesion of circulating platelets at sites of injury on the vessel wall where subendothelium, in particular collagen, is exposed to the flowing blood, is known to be an important step in a sequence of events leading to the formation of a hemostatic plug (Mustard and Packham 1975). With the development of prosthetic devices and artificial organs, the study of platelet adhesion and thrombus formation on synthetic polymer surfaces has become very important in assessing the compatibility of biomaterials to blood. A clear understanding of the blood interactions with artificial surfaces would promote a better utilization of existing materials and the development of new materials with improved properties.

1.1 Contribution of platelets to thrombus formation

1.1a Platelet morphology, physiology and function: Platelets are the disc-shaped fragments of bone marrow megakaryocytes circulating in blood. They are about $250,000 \pm 80,000$ per μl . They have a life span of 8–10 days and play a critical role in the recognition of vascular injury, formation of effective hemostatic plugs, retraction of clots and wound healing. However, when hyperactive,

they can initiate events leading to clinical complications associated with cardiovascular and cerebrovascular diseases. Although completely nonsticky in the resting state, they become sticky with the slightest stimulation. The degree of activation depends on the strength of the stimulus and the type of signal generated by ligand–receptor interaction. Four well developed stages of activation are recognized: (i) development of stickiness, (ii) changes in cell shape, (iii) contraction and release of granule contents and (iv) irreversible aggregation.

Platelet plasma membranes contain transmembrane proteins as well as glycoproteins. Glycoproteins serve as the receptors for agonist/surface-mediated stimuli initiating platelet activation. Platelets contain integrin and nonintegrin domains in their plasma membranes. Integrins are transmembrane glycoproteins with α and β units coupled noncovalently (GPIIb–IIIa, GPIa–IIa, GPIc–IIa). They participate in both cell–cell and cell–matrix interactions. In addition, there are nonintegrin glycoprotein domains on platelets capable of interacting with acromolecules such as vWF and collagen (GPIV, GPIb).

1.1b Role of platelets in thrombosis: Circulating platelets rapidly adhere to the subendothelial matrix, become activated, adhere, spread, release the contents of various storage organelles and become cohesive, leading to

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Role Of Platelets In Blood Biomaterial Interactions

Alan D. Michelson



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The Role of Platelets in Blood-Biomaterial Interactions E Missirlis, J-L. Wautier, 2012-12-06 Medicine and engineering work together towards solutions for biomedical problems The interactions of blood elements with artificial materials bags tubes artificial organs etc require many disciplines for its understanding Thus the effort presented in this book is the culmination of a genuine discussion on the problems arising in blood banks in hospitals in biomaterials development in experimental hemocompatibility testing when platelets interact with biomaterials Hematologists chemists biologists and engineers have tried to put their own point of view and to understand the point of view of the other disciplines The main themes that are presented in the discussion are Platelet collection storage and transfusion Hemostasis and anticoagulation Platelet and biomaterials extracorporeal circulation and implanted materials Hemorheological parameters Modulation of platelet function Biological tests for evaluating platelet biomaterial interactions LIST Manual of Blood Platelets: Morphology, Physiology and Pharmacology Gundu HR Rao, 2018-11-30 Platelets are tiny blood cells that help the body form clots to stop bleeding Antiplatelet medications such as aspirin and clopidogrel are commonly used to thin the blood which limits clotting and reduces the risk of heart attack This book is a comprehensive guide to blood platelets for haematologists Beginning with discussion on platelet structure morphology function and physiology the next chapters cover the role of calcium in platelet activation and calcium modulation by cyclic nucleotides The following sections explain the pharmacology of antiplatelet drugs antiplatelet therapies aspirin resistance and the association of diabetes mellitus with major platelet dysfunction The book concludes with chapters on acute coronary problems interaction between endothelial cells and platelets and blood biocompatibility studies Authored by a Minneapolis based expert in the field the text is further enhanced by clinical photographs diagrams and tables Key points Comprehensive guide to blood platelets for haematologists Extensive coverage of antiplatelet drugs and resistance Recognised author from University of Minnesota Highly illustrated with clinical photographs diagrams and tables *Hemocompatibility of Biomaterials for Clinical Applications* Christopher Siedlecki, 2018-03-05 Hemocompatibility of Biomaterials for Clinical Applications Blood Biomaterials Interactions summarizes the state of the art on this important subject The first part of the book reviews the latest research on blood composition and response mechanisms of coagulation test standards and methods Next the book assesses techniques for modifying biomaterial surfaces and developing coatings to improve hemocompatibility In the final sections users will find discussions on ways to improve the hemocompatibility of particular classes of biomaterials and a review of methods for improving medical devices Provides comprehensive information on the fundamentals of hemocompatibility and new technologies Combines research in the biomaterials field in a digestible format for clinical applications Provides a complete overview biomaterials in current use and test methods **An Introduction to Tissue-Biomaterial Interactions** Kay C. Dee, David A. Puleo, Rena Bizios, 2003-03-31 An Introduction to Tissue Biomaterial Interactions acquaints an undergraduate audience with the

fundamental biological processes that influence these sophisticated cutting edge procedures Chapters one through three provide more detail about the molecular level events that happen at the tissue implant interface while chapters four through ten explore selected material biological and physiological consequences of these events The importance of the body s wound healing response is emphasized throughout Specific topics covered include Structure and properties of biomaterials Proteins Protein surface interactions Blood biomaterial interactions Inflammation and infection The immune system Biomaterial responses to implantation Biomaterial surface engineering Intimal hyperplasia and osseointegration as examples of tissue biomaterial interactions The text also provides extensive coverage of the three pertinent interfaces between the body and the biomaterial between the body and the living cells and between the cells and the biomaterial that are critical in the development of tissue engineered products that incorporate living cells within a biomaterial matrix Ideal for a one semester biomedical engineering course An Introduction to Tissue Biomaterial Interactions provides a solid framework for understanding today s and tomorrow s implantable biomedical devices

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Role Of Platelets In Blood Biomaterial Interactions Book Review: Unveiling the Magic of Language

In an electronic era where connections and knowledge reign supreme, the enchanting power of language has become more apparent than ever. Its capability to stir emotions, provoke thought, and instigate transformation is actually remarkable. This extraordinary book, aptly titled "**Role Of Platelets In Blood Biomaterial Interactions**," published by a very acclaimed author, immerses readers in a captivating exploration of the significance of language and its profound effect on our existence. Throughout this critique, we shall delve into the book's central themes, evaluate its unique writing style, and assess its overall influence on its readership.

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