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Interactions of Graphene Oxide with Blood-Related Entities and Their Implications for Hematological Disorders

Blood-related disorders represent one of the most fundamental and complex abnormalities as they can cause critical health conditions, such as heart attack, stroke, and cancer [1, 2]. While nanomaterials have been widely explored for various biomedical applications [3-6], they have not been actively investigated for hematological applications. Of all classes of nanomaterials explored for biomedicine, the two-dimensional (2D) graphene oxide (GO) nanosheets stand out due to their unique and versatile physicochemical properties [7, 8], which may be beneficial for hematological applications [9-12]. Herein, we investigated the interactions of GO nanosheets with different blood-related entities, particularly plasma proteins, blood cells, and blood-borne parasites, to elucidate the biophysicochemical activities of GO nanosheets for hematological applications. We first assessed the GO-protein associations, particularly the adsorption, equilibrium binding, and conformational stability of plasma proteins upon interacting with GO nanosheets [9, 10]. The interactions of GO nanosheets with whole blood under flow condition, and with *Plasmodium falciparum* malaria parasites, were then probed to evaluate the antithrombotic and antimalarial properties of GO nanosheets [11, 12]. We observed that GO nanosheets possessed high loading capacity for major blood plasma proteins and the nanosheets did not induce protein denaturation. These interactions were protein-specific and might be significantly influenced by the lateral size distribution and concentration of GO nanosheets. We further noted that functionalized GO nanosheets exhibited antithrombotic characteristic under flow condition. Additionally, pristine GO nanosheets, regardless of their size distribution, displayed antimalarial activity by inhibiting the invasion of malaria parasites on red blood cells and delaying the maturation of these parasites. Overall, with their high biomolecule loading capacity and unique antithrombotic and antimalarial characteristics, GO nanosheets are highly promising for hematological applications. This study will offer a broad perspective on nanomaterial-blood interactions and potentially facilitate further exploration into the development of nanotechnology-based strategies for biomedical applications.

References

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Figure

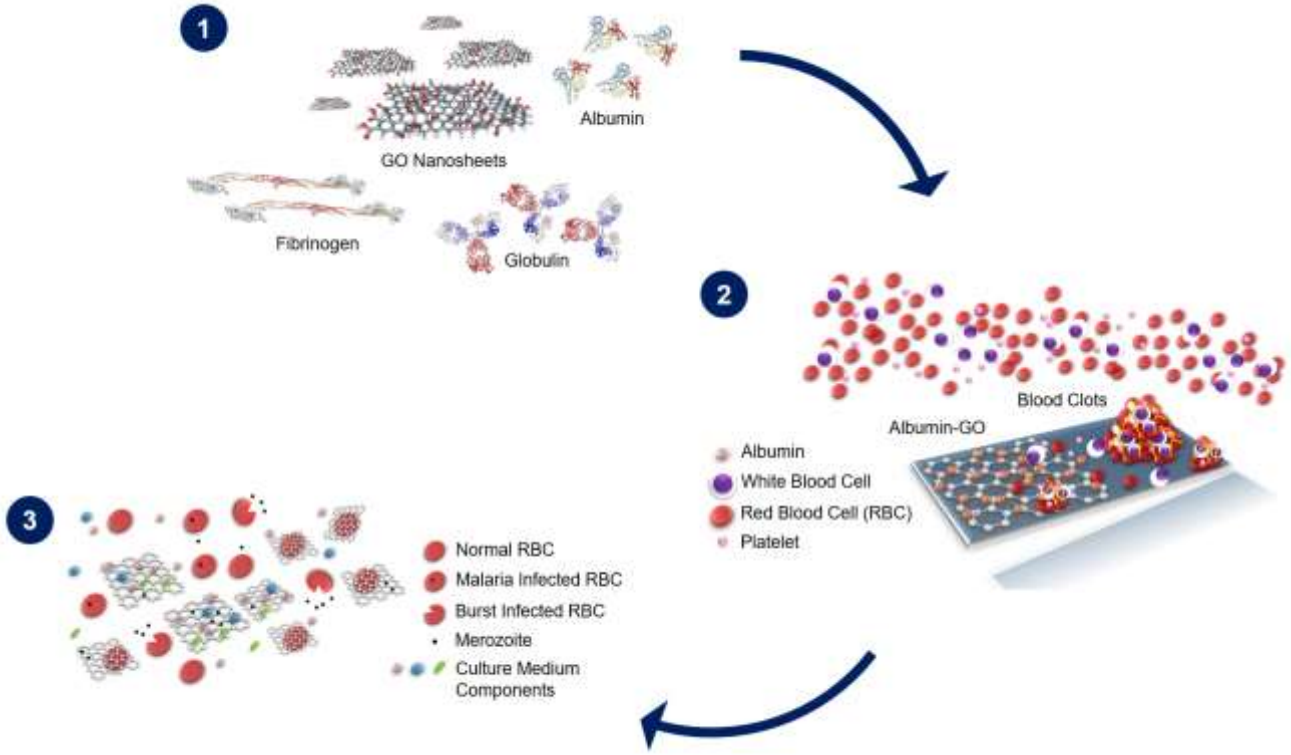

Figure 1: Schematic illustrating the overview of the study, i.e., 1) evaluation of the interactions of GO nanosheets with blood plasma proteins, 2) evaluation of the interactions of large GO nanosheets with human whole blood under flow, and 3) evaluation of the interactions of GO nanosheets with blood-borne malaria parasites.