Modern Nano- and Bioelectroanalysis

HEAD:

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GROUP MEMBERS:

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RESEARCH PROFILE:

Nanomaterials, biomaterials, bioelectrochemistry, biosensors, medical diagnostic, drug carrier systems, targeted therapy

CURRENT RESEARCH ACTIVITIES:

Our scientific activity is focused on the preparation and characterisation of nanomaterial-based assemblies on electrodes that would effectively bind biological materials with the electrode surface, in appropriate orientation and conformation (see Figure 1), and allow the rapid transformation of chemical signals into electrical signal, which are directed to eventual application in catalysis, biofuel cells or as a biomolecular electrochemical devices.

We also focus on modern nano-electrochemistry of DNA and immuno-electrosensors used in POC diagnostics and modern nanomedicine. The developed by us modern electrochemical bioassays are mainly based on the antigen-antibody specific interactions, aptamer-protein interactions or hybridization processes between two complementary DNA fragments. To enhance the sensitivity of such novel devices, different nanomaterials including quantum dots, metal nanoparticles, dendrimers, polymer-metal nanoparticle composites, carbon-based nanomaterials are applied as a new

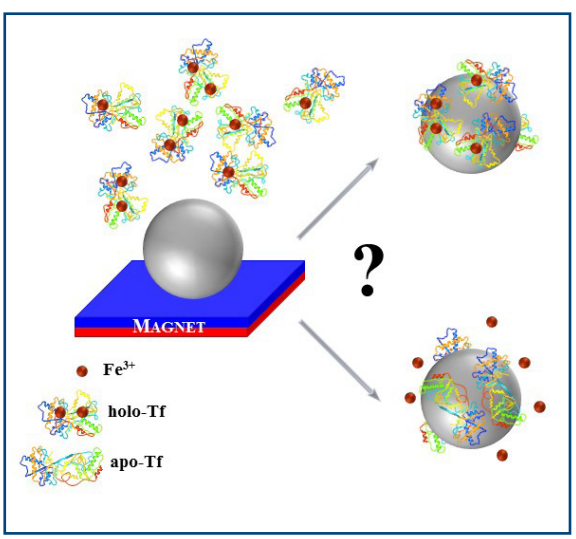

Fig. 1. Consequences of protein interaction with magnetic nanoparticles.

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carriers for immobilization of biomolecules or targeted signal molecules (see Figure 2).
One of the major challenges of medicine is effectively combating diseases of civilization. Despite the enormous technological and scientific progress, effective methods to combat cancer are still scarce and limited to particular forms of this disease. The difficulty issue of cancer treatment consists of a number of factors, however the biggest problem is the cytotoxic activity of the drug against both tumor and healthy cells. This fact is the main driving force of research aimed at reducing / elimination the cytotoxic activity of the anticancer drugs toward the healthy cells. One way to limit the negative effects of anti-tumor drugs on healthy cells is targeted therapy employing functionalized drug carriers. We also carry out research in the field of searching for and designing new drugs / drug carriers that will allow the active substance to be transported in a suitable concentration and time to the desired place (e.g. tumor tissue). Among our interests are multitarget drugs (MTD), which act simultaneously on more than one molecular target.

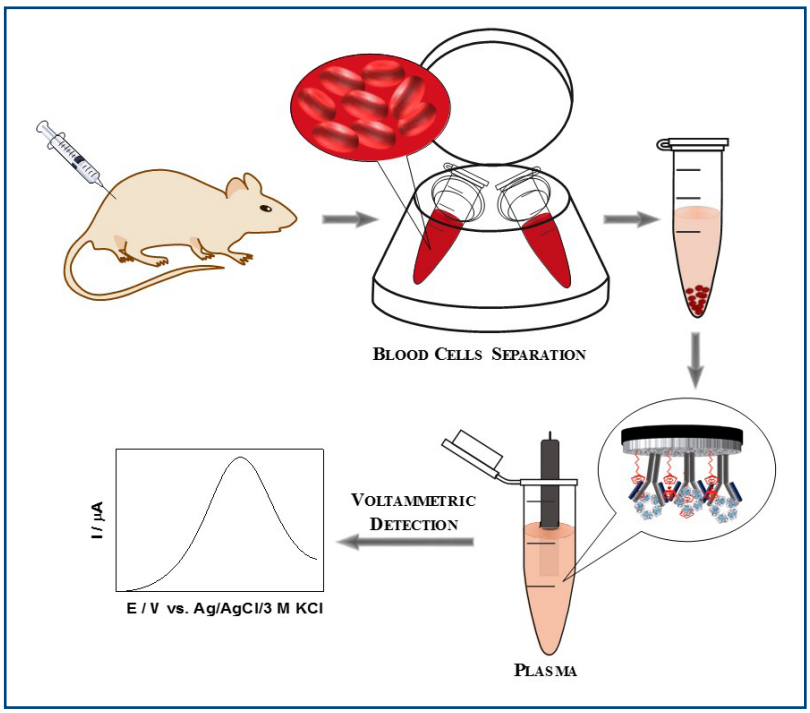

Fig. 2. Immunosensor for C-reactive protein detection

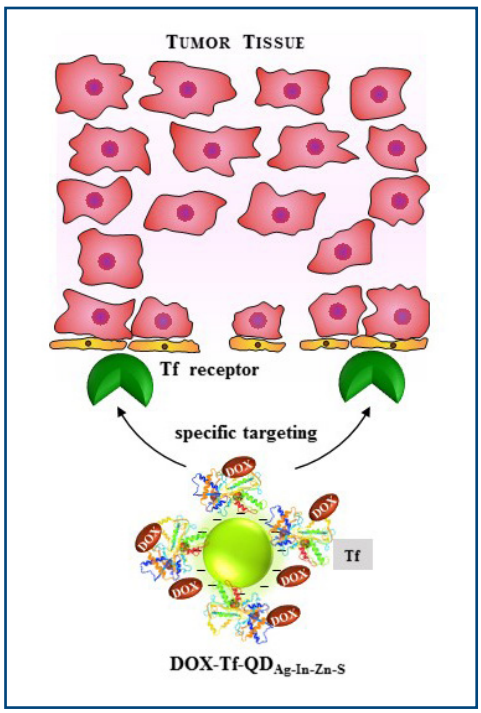

Fig. 3. Drug delivery system.

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2. W. Kiciński, J.P. Sęk , E. Matysiak-Brynda, K. Miecznikowski, M. Donten, B. Budner, A.M. Nowicka, Enhancement of PGM-free oxygen reduction electrocatalyst performance for conventional and enzymatic fuel cells: the influence of an external magnetic field, Appl. Catal. B-Environ. 258 (2019) 117955.
3. J.P. Sęk, A. Kasprzak, M. Bystrzejewski, M. Popławska, W. Kaszuwara, Z. Stojek, A.M. Nowicka, Nanoconjugates of ferrocene and carbon-encapsulated iron nanoparticles as sensing platforms for voltammetric determination of ceruloplasmin in blood, Biosens. Bioelectron. 102 (2018) 490-496.
4. E. Matysiak-Brynda, P. Bujak, E. Augustin, A. Kowalczyk, Z. Mazerska, A. Proń, A.M. Nowicka, Stable nanoconjugate of transferrin with alloyed quaternary nanocrystals Ag-In-Zn-S as biological entity for tumor recognition, Nanoscale. 10 (2018) 1286-1296.
5. A. Kowalczyk, J.P. Sęk, A. Kasprzak, M. Popławska, I.P. Grudziński, A.M. Nowicka, Occlusion phenomenon of redox probe by protein as a way of voltammetric detection of non-electroactive C-reactive protein, Biosens. Bioelectron. 117 (2018) 232-239.
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8. A.M. Nowicka, A. Kowalczyk, A. Jarzębińska, M. Donten, P. Krysiński, Z. Stojek, E. Augustin, Z. Mazerska, Progress in targeting tumor cell by using drug-magnetic nanoparticles conjugate, Biomacromolecules. 14 (2013) 828-833.
9. A. Kowalczyk, A.M. Nowicka, R. Jurczakowski, M. Fau, A. Królikowska, Z. Stojek, Construction of DNA biosensor at glassy carbon surface modified with 4-aminoethyl-benzenediazonium salt, Biosens. Bioelectron. 26 (2011) 2506-2512.
10. A.M. Nowicka, U. Hasse, M. Hermes, F. Scholz, Hydroxyl radicals attack metallic gold, Angew. Chem. Int. Edit. 49 (2010) 1061-1063.