TECHNOTE 306

Magnetic beads as versatile tools for DNA and protein biosensing

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Magnetic beads (MBs) are versatile tools in the separation of nucleic acids, proteins and other biomacromolecules, their complexes and cells. Recent application of MBs in **biosensing** and particularly in the development of **DNA hybridization sensors** is reviewed. In these sensors MBs serve not only for separation but also as a platform for optimized DNA hybridization.

At present alternative methods, based on DNA binding to solid surface offering faster and less time-consuming procedures, are available. Among them magnetic separation has gained renewed interest over the last decade because of its advantages over traditional nonmagnetic methods. This method uses magnetism for efficient separation of cells, cell organelles as well as specific biomolecules, such as nucleic acids (NAs) and proteins (Fig. 1).

Magnetic methods rely on efficient separation of micrometer-sized paramagnetic or ferromagnetic particles from biological or chemical media. Superparamagnetic particles become magnetic under a strong magnetic field but retain no residual magnetism in the absence of magnetic field. The diameter of the particles is usually between 0.1 and 10 μm. Monodisperse spherical particles (beads) with hydrophilic surfaces are particularly convenient for NAs, providing reproducible magnetic separation. Magnetic beads (MBs) can be prepared in various ways. Usually particles susceptible to magnetism, such as iron oxide, are coated with biological or synthetic polymers.

A number of companies offer MBs and kits optimally adjusted for the desired application. The matrices of the magnetic particles are usually composed of agarose, cellulose, silica, silane, porous glass, mica, or polystyrene. Magnetic separators enabling **automated handling** of the beads are commercially available. With the use of such systems a **rapid diagnosis** of viral infections, separation of specific RNAs and extraction of DNA and RNA from various media is possible. New magnetic particles with improved properties, suitable for diagnostics in microbiology, cell isolation and other purposes, were developed. Recently, it can be expected that materials with more

specific binding properties and better separation will soon be developed. Both scale-up procedures for the purification of large volumes of biomacromolecules and miniaturization for sensors and lab-on-a-chip techniques can be foreseen.

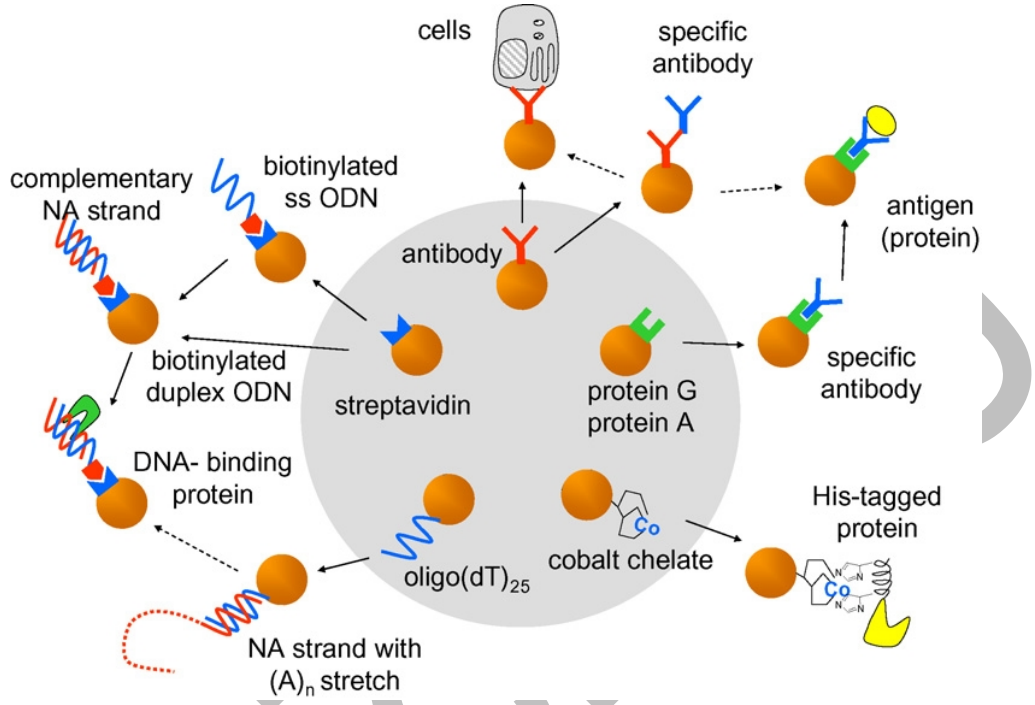

Fig. 1. Magnetic beads (MBs) as versatile tools for bioassays.

(From Emil Paleˇcek ∗, Miroslav Fojta's literature)

Fig. 1. Magnetic beads (MBs) as versatile tools for bioassays. Beads modified with various recognition elements (examples of commercially available MBs shown on the gray background) can be used for specific bioaffinity capture of different molecules. For example, beads bearing covalently attached oligo(dT)25 chains can bind nucleic acid involving (A) stretches, including natural eukaryotic mRNAs or tDNAs tagged with (A) adaptors. Streptavidin-coated beads are suitable for capturing any biotinylated molecules, including ss or ds nucleic acids, aptamers, peptides, proteins, etc. Antibodies can be attached to the beads either via a direct covalent linkage, or via specific antibody binding proteins such as protein A or protein G (beads functionalized with the latter proteins can be further modified with various antibodies on demand). Other affinity ligands attached to MBs are suitable for specific capture of tagged recombinant proteins (such as metal-affinity cobalt chelate for histidine tags). Biomolecules captured at the MB surface can serve as a biorecognition layer for interaction with other molecules. For example, a biotinylated ssODN immobilized at streptavidin-coated beads features a hybridization probe for complementary sequence,

the dsDNA can represent a target for a DNA-binding protein, antibody can bind a specific antigen (including antigens exposed at surfaces of whole cells), immobilized protein (e.g., via antibody, his-tag or biotin–streptavidin linkage) can interact with a specific nucleic acid or another protein, etc.

References

[1] J. Marmur, D. Lane, Proc. Natl. Acad. Sci. U.S.A. 46 (1960) 453–461.
[2] J. Marmur, R. Rownd, C.L. Schildkraut, in: J.N. Davidson, W.E. Cohn (Eds.), Progress in Nucleic Acid Research, vol. 1, Academic Press, London, 1963, pp. 231–300.
[3] J. Marmur, J. Mol. Biol. 3 (1961) 208–218.
[4] S. Berensmeier, N. Theilacker, BioTech (2007) 6–10.
[5] A.L. Hei, J.P. Cai, DNA Cell Biol. 24 (2005) 479–484.
[6] D. Horak, B. Rittich, A. Spanova, M.J. Benes, Polymer 46 (2005) 1245–1255.
[7] E. Paleˇcek, M. Fojta, Talanta, 74(2007)