

Aptamer Applications



APTAMERS

Functional Nucleic Acids

Aptamers, from the Latin aptus (fit), are short, single-stranded DNA- and RNA-molecules that can bind a target molecule very specifically and with high affinity thanks to their specific, three-dimensional structure. A combination of electrostatic interactions, hydrogen bonds and the nucleic acid sequence-dependent structure account for the »lock and key model« of both binding partners.

The broad selection of successfully applied target molecules underscores the great potential of aptamers, as it was possible to develop aptamers with binding constants in the picomolar range against nearly all types of analytes (viruses, bacteria, cells, polysaccharides, proteins, low-molecular substances, ions, etc.).

Aptamers are primarily generated using the SELEX (Systematic Evolution of Ligands by Exponential Enrichment) procedure, in which aptamers are isolated from a random library of at least 10^{14} different nucleic acids using a targeted *in vitro* evolution.

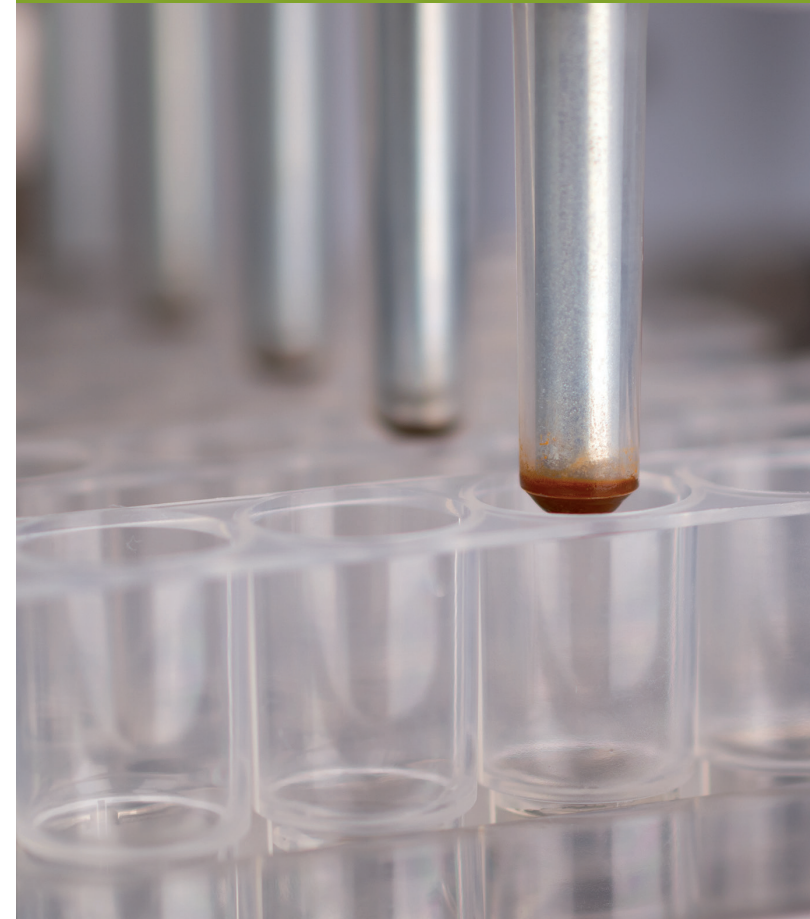
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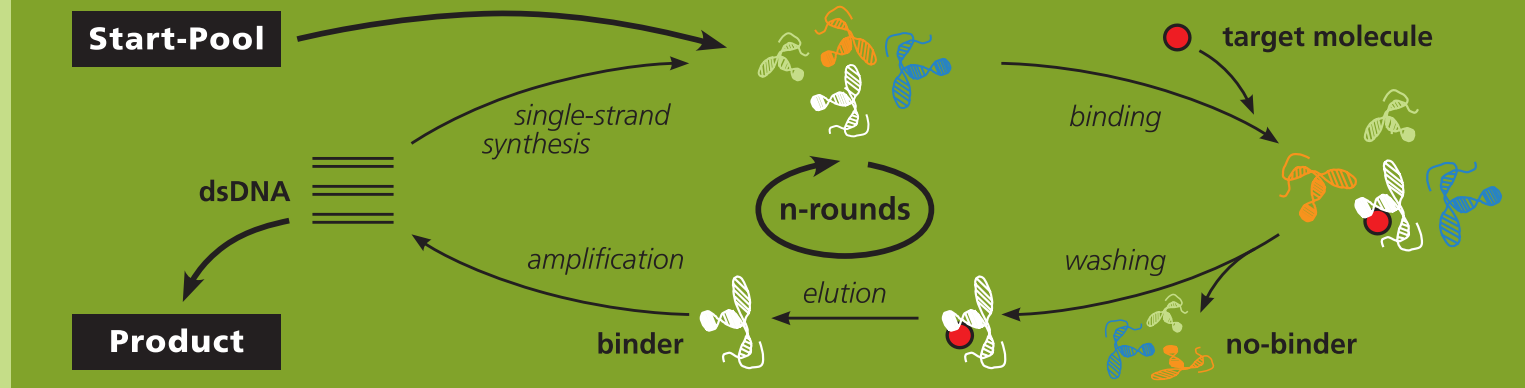
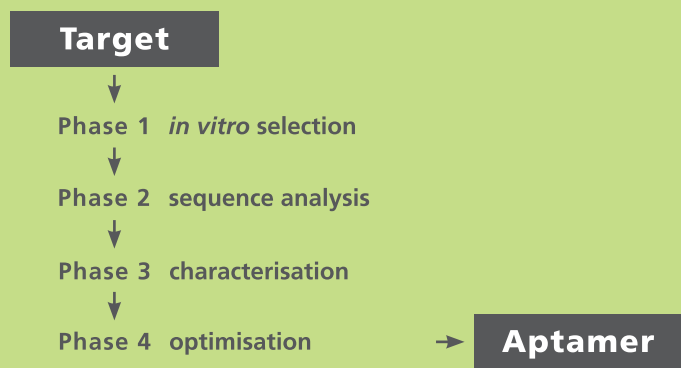
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FUNCTIONAL NUCLEIC ACIDS APTAMERS





MOTIVATION

Aptamers are functional nucleic acid molecules that can be used as tools for environmental analysis and food safety as well as for diagnostic and therapeutic approaches.

Therefore, the development of new innovative products on the basis of aptamers is a highly promising area of research. It includes the generation, synthesis & functionalisation of aptamers and the integration of aptamers in diverse applications.

APTAMERS VERSUS ANTIBODIES

Aptamers have a wide range of advantages compared to antibodies:

- target affinities in the same range (up to pM)
- higher target specificity based on the specific three-dimensional structure
- small size (< 25 kDa)
- thermal stability (reverse folding)
- *in vitro* selection methods (no animals)
- chemical synthesis by oligo synthesiser:
 - high reproducibility
 - low manufacturing cost and time
 - easy chemical modification
- no metabolism or toxicity issues
- no significant immune response

APTAMER GENERATION

The development process consists of a 4-phase approach:

1 *in vitro* selection

- semi-automated *in vitro* selection by using a robotic workstation
- effective monitoring by the use of independent affinity and diversity assays
- optimised nucleic acid start libraries

2 Sequence analysis

- by next generation sequencing (NGS)
- by bioinformatics

3 Aptamer characterisation

- high throughput screening of affinity and specificity
- determination of dissociation constants (K_D) and reaction rate constants (k_{on} and k_{off})

4 Aptamer optimisation

- truncation and mutagenesis

Advantages of this process

- fast development of aptamers
- parallelised development is feasible
- active process management
- scientific report to every phase
- milestone-dependent payments
- maximum control by the customer
- high success rate for specific aptamers

FURTHER USE OF APTAMERS

Stabilisation and functionalisation of RNA- and DNA-aptamers

- synthesis of RNA- and DNA-aptamers including functional quality control
- integration and labelling of almost all kinds of chemical modifications for stabilisation and functionalisation such as
 - nucleotide analogues
 - dyes or enzymes for detection
 - linker for surface immobilisation

Development of aptamer-based applications

- aptamer-based biosensors (aptasensors) by different ways of signal transduction:
 - optical
 - electrochemical
 - mass sensitive
- lateral flow devices (LFD)
- microtiter plate (MTP) assays