The AptaReport™
Newsletter
Summer 2025

Kinetic and Affinity Profiling Rare Earth Metals Using a DNA Aptamer

Rare earth elements (REEs) consist of the 15 lanthanides in addition to scandium (Sc) and yttrium (Y). While these elements have found use in increasingly important applications due to their unique properties, their pollution in water and soil has created health and environmental concerns. REEs are currently detected with inductively coupled plasma atomic emission spectroscopy (high cost, low turnaround time), leading to a need for cost-effective biosensors capable of on-site detection.

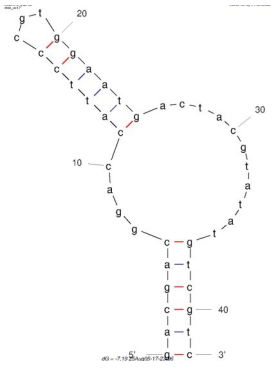

Figure 1. Predicted structure of aptamer Sc-1. Note that secondary structure may be inaccurate due to changes resulting from interactions with the target.

In 2024, Wang et al. used library-immobilized SELEX to identify an aptamer called Sc-1 with scandium as the target (Kd=192 nM). However, testing showed that Sc-1 recognized all REEs (except promethium, omitted due to radioactivity). Moreover, in an experiment where fluorescent signal drops when Sc-1 binds to an REE and displaces fluorophore, it was found that adding EDTA would pull different REEs off Sc-1 at different rates, leading to a difference in the speed of recovery of fluorescence. This difference in kinetics allows for detecting REEs and categorizing them into one of three groups:

Group 1 (instant): La^{3+}, Ce^{3+}, Pr^{3+}, Nd^{3+}, Sm^{3+}, Eu^{3+}, Gd^{3+}
Group 2 (slow): Tb^{3+}, Dy^{3+}, Ho^{3+}, Er^{3+}, Tm^{3+}, Yb^{3+}, Lu^{3+}, Y^{3+}
Group 3 (almost no recovery): Sc^{3+}

Sc-1 used in a structure-switching strand displacement aptasensor and tested against REE ions at low (10 nM) and high (500 nM) concentrations. Responses responded similarly to fluorescence groupings: Group 2 ions were detectable at low concentration, Group 1 ions had fluorescence responses at high concentrations (increasing with size), Group 3 responded somewhere in-between and other metal ions showed no response.

*Reference: Apta-Index™ ID# 9394 P.H.K.

A novel CD44-targeting aptamer recognizes chemo-resistant TNBC cells and inhibits tumor growth

Triple-negative breast cancer (TNBC) is associated with high tumor heterogeneity and poses a significant clinical challenge. Cerchia and colleagues reported the development of a nuclease resistant 2'Fluoro-pyrimidines (2'F-Pys) RNA aptamer, namely sTN58, which selectively targets TNBC cells. sTN58 efficiently inhibits the proliferation and EMT capabilities of mesenchymal-like (MES) chemo resistant TNBC cells by binding to cytomembrane proteins on these cells.

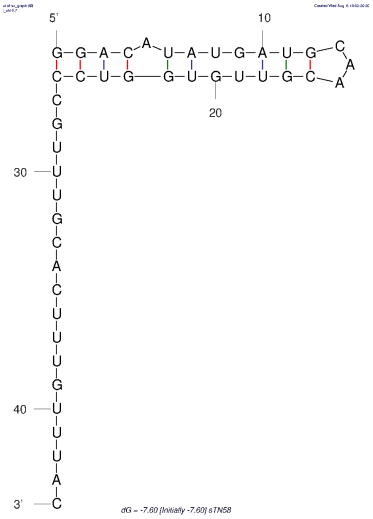

Figure 1. Predicted structure of aptamer sTN58. Note that secondary structure may be inaccurate due to changes resulting from interactions with the target.

This study identified CD44 as the target of sTN58. CD44 is the main surface receptor for hyaluronic acid (HA) and is abundantly expressed in cancer stem cells (CSC). sTN58 aptamer targeting chemoresistant TNBC cells inhibited invasive growth and HA-induced tube formation in three-dimensional (3D) culture conditions. in vivo and ex vivo studies also demonstrated that sTN58 selectively targets TNBC implanted in mice, strongly interfering with tumor growth and lung metastases. Chemotherapy usually fails to eradicate CSCs, which results in therapeutic resistance and recurrence. Therefore, using aptamer to directly target tumor stem cell populations represents a promising therapeutic approach.

*Reference: Apta-Index™ ID# 9385 -H.P.

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High-affinity ssDNA aptamer and chemiluminescent aptasensor for TIMP-1 detection in human serum

In this study, Wang et al. developed a high-affinity single-stranded DNA aptamer for the detection of human TIMP-1 (Tissue Inhibitor of Metalloproteinases-1), a protein associated with cancer progression, metastasis, and fibrosis. Using seven rounds of magnetic bead-based SELEX followed by high-throughput sequencing, the researchers identified Apt-4 as the most effective aptamer. Binding analysis showed that Apt-4 interacts strongly and specifically with TIMP-1, with a dissociation constant of around 0.41 nM. The aptamer also exhibited high specificity, showing minimal binding to other common serum proteins, including AFP, CA199, CEA, and BSA.

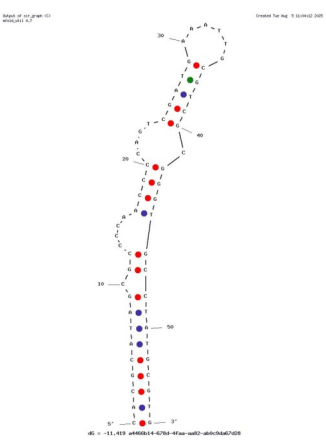


Figure 1. Predicted structure of aptamer Apt-4. Note that secondary structure may be inaccurate due to changes resulting from interactions with the target.

To explore its potential for diagnostic use, the team created a chemiluminescent aptasensor by immobilizing biotin-labeled Apt-4 on streptavidin-coated magnetic beads. An acridinium-ester-labeled TIMP-1 antibody was used as the detection element in a sandwich assay. The sensor demonstrated a linear detection range of 1–500 ng/mL when tested in human serum. However, when applied to 40 clinical serum samples, the aptasensor's results showed poor correlation with standard ELISA measurements (R^2 = 0.1446). This discrepancy is likely due to the different molecular forms or epitopes of TIMP-1 recognized by aptamers versus antibodies—suggesting that Apt-4 may selectively bind free TIMP-1, while ELISAs might detect TIMP-1 in protein complexes. Overall, this work introduces a novel and highly specific TIMP-1 aptamer and underscores the potential of aptamers as stable, selective, and cost-effective alternatives or complements to antibodies in clinical diagnostic platforms.

*Reference: Apta-Index™ ID# 9399 -F.L.T.

Nucleocapsid protein binding DNA aptamers for detection of SARS-COV-2

The coronavirus has proven to be a burden on the welfare of the world for almost half a decade at this point, and it continues to be a serious health issue to this day. While there have been breakthroughs in methods to detect the severe acute respiratory syndrome coronavirus (SARS-COV-2), namely reverse transcription-polymerase chain reactions, these methods have limitations that could negatively impact some patients. DNA aptamers against the virus's Nucleocapsid protein were made to better detect the virus and its variants due to the abundance of Nucleocapsid protein in positive patient samples.

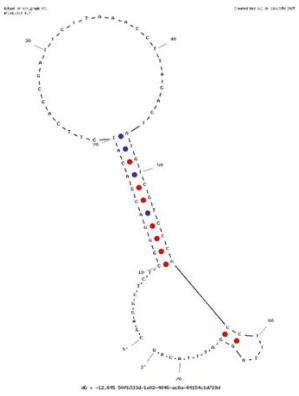
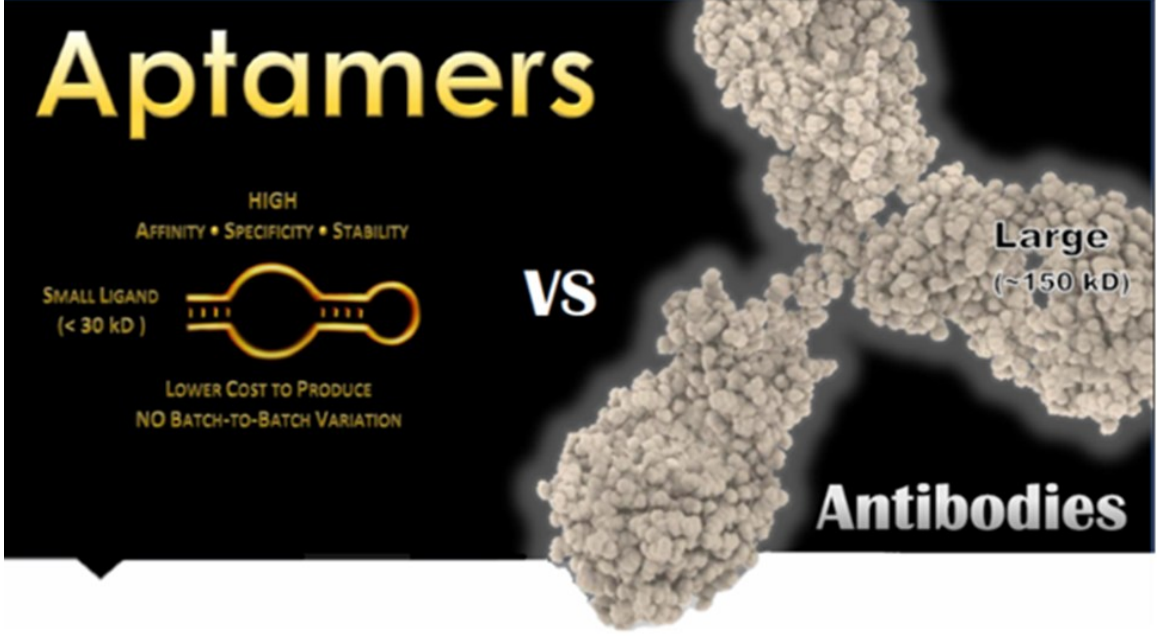


Figure 1. Predicted structure of aptamer Ap25. Note that secondary structure may be inaccurate due to other modifications and/or changes resulting from interactions with the target.

When used as detection agents in ELISA-like assays, many of the aptamers identified via SELEX were shown to have yielded a significant binding affinity to the alpha variant of HCoV. The aptamers were then reselected against the Omicron variant of the virus, as that was the newest and most problematic variant at the time, and two sequences were found to have yielded a higher signal than the other aptamers that were tested against the alpha variant.

Overall, the use of these DNA aptamers as detection reagents against different variants of SARS-COV-2 have proven to be very promising and could potentially and hopefully be used to better detect and diagnose both the coronavirus and other viruses to slow the spread of such deadly diseases.

*Reference: Apta-Index™ ID# 9375 -L.R.



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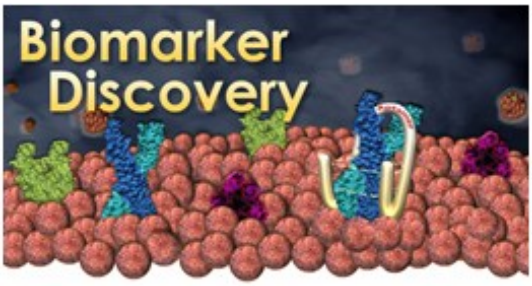

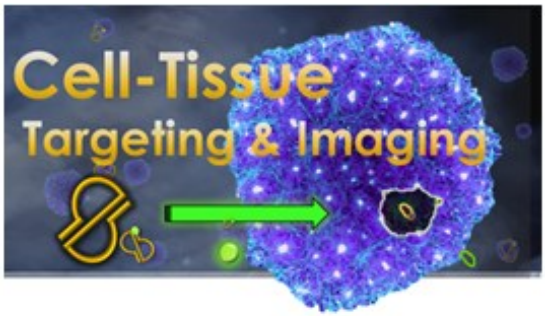

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