International Society on Aptamers

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EDITORIAL

Hi All,

Welcome to 2023. It feels like it came crashing in with a bang and hasn't really let up since! But what a time to be working with aptamers, eh? We've had more clinical trial results presented, and I've been engaged in a number of conversations about moving aptamers more into everyday use. I can't comment on those at the moment but do have a chat with me if you're in Oxford soon at the conference.

We have a few good updates in this issue, with the first look at our new aptamer database thanks to the excellent work of Benjamin Skubi. And we have our first article showcasing an interesting application of aptamers from Qurat ul aim Zahra, who you may remember from a previous issue of the newsletter. In good news, she has also received her doctorate! If you're still engrossed in the newsletter, you will also find an interview with me!

As we have our first showcase in this issue, we would like to continue adding interesting applications of aptamers so if you have published a research article recently and want to highlight it to members of the Society, please get in touch. You can find all the contact details in the newsletter. We aim to publish 3 issues a year so the deadlines to submit a short summary will be Feb 28th, **June 30th, and October 30th**. We will also have more to say on our ECR Arm of the Society in the new year and we will be chatting to all interested parties at the conference.

As a final note, have you liked our Facebook page? We are currently providing links to new aptamer research papers on a daily basis. Don't have time to keep up to date on current literature? Get our daily updates in your morning newsfeed at https://www.facebook.com/AptaSoc/. Please don't forget to also follow us on twitter (@Aptamer Society, @Japtamers).

Remember, If you see an article in mainstream science, send it to me or tag me on LinkedIn? I will sign off this editorial and let you read through our newsletter. As always, we hope that you are all healthy, happy, and successful with all your endeavours. And to those travelling to the Aptamer Symposium at the end of March, safe travels!

Associate Professor Sarah Shigdar
President

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Newsletter Contributors:

Prof Sarah Shigdar
Prof Maureen McKeague
Prof Prabodhika Mallikaratchy
Dr Muhammad Sohail
Dr Qurat ul aim Zahra
Dr Benjamin Skubi

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https://twitter.com/AptamerSociety
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Aptamer Symposium 2023 – Sarah Shigdar

I'm writing this just as the speaker list has been released, and I am so excited to be attending and hearing all our wonderful speakers, as well as co-chairing the flash talks! We're excited to announce that both Larry Gold and Ichiro Hirao are key note speakers for 2023. If you've heard either of them present at conferences previously, you'll know how enthusiastic they are when talking about their research. We have some new speakers presenting their work too so it's going to be a busy time for me taking notes to provide a summary for the next newsletter. Please, check out the website, http://libpubmedia.co.uk/aptamers-2023/ for more details. Also note that, for our 10th anniversary conference, we are back where it all began, at St Edmund Hall. For those that can't attend in person, we are having an online presence and there are still a few seats left for in person attendance! Finally, all attendees can **publish free of charge** in the Aptamers Journal this year! I'll leave this photo from the archives of all attendees at the first conference, in 2013! If you were there, see if you can find yourselves in the picture.

From the Editor

If you have anything you would like to see in the next issue of the INSOAP newsletter, send it directly to sarah.shigdar@deakin.edu.au.

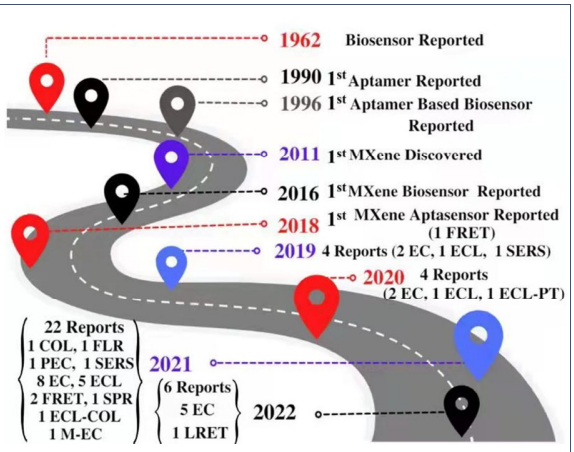
Aptamers Journal

We announced the official journal of INSOAP at Aptamers 2017. Please email us at aptasoc@gmail.com to express your interest in joining the editorial or reviewer team. Please see http://libpubmedia.co.uk/aptamers/ to submit your article.

MXene-based Aptasensors: Challenges and Future – Qurat ul aim Zahra

MXene-based aptasensors are biosensors that use oligonucleotide aptamers and nanomaterials made of MXene to detect target analytes in a specific way. MXene is a two-dimensional (2D) nanomaterial composed of transition metal carbides, nitrides, and carbonitrides. By coupling MXene nanomaterials with aptamer molecules, biosensors can detect various analytes, such as proteins, small molecules, and even whole cells. The use of MXene-coupled aptasensors offers several advantages over traditional biosensors. The high surface area of MXenes allows for high binding capacity and sensitivity. MXene, a newly emerging 2D material, has advanced at a rapid pace in recent years, serving as an important transducer for the fabrication of aptasensors. Since its discovery in 2011, MXene has captivated the interest of the scientific community due to its unique features, which include catalytic features, ease of functionalization, superior metallic conductivity, and layered morphology. MXenes exhibit superior electrochemical properties than other 2-D NMs such as Mo2S and graphene, etc., enabling label-free detection of analytes, resulting in rapid and cost-effective biosensing. Some of its features, such as the existence of ample functional groups and a good surface area, are critical for developing improved biosensors that integrate bio-receptors such as aptamers. As a result, the fabrication of an aptasensor using aptamers and MXenes results in increased sensitivity and selectivity. MXenes' non-covalent interactions with single-stranded DNA aptamers are considered to play a key role in the development of high-performance MXene-based aptasensors [1].

Aptasensing with MXene is a new topic, and most of the research articles on it (22 reports) came out in 2021. Some new combinations, e.g., MXene-based microfluidics or M-EC [2] and LRET [3], and SPR [4] aptasensors, clearly indicate that this type of aptasensor are likely to become the most popular in the future. It is found that Ti3C2TX is the dominant MXene involved in the field of aptasensing. Titanium carbide quantum dots (QDs) and nanosheets (NSs) exhibit remarkable optical and electrical characteristics that have been used in a variety of optical sensing devices. Additionally, by employing



The Story of the MXene-based aptasensors. A short journey from October 2018 to March 2022.
(COL = Colorimetric,FLR = Fluorescence,PEC = Photoelectrochemical, ECL = Electrogenerated chemiluminescence, SERS = Surface-enhanced Raman spectroscopy, EC = Electrochemical, PT = Photothermal, FRET = Fluorescence resonance energy transfer, SPR = Surface plasmon resonance, LRET = Luminescence resonance energy transfer, and M-EC = Microfluidic electrochemical).

desired surface functionalization and engineering strategies, it is possible to synthesize MXenes with desired features that might expand their optical uses beyond colorimetric, ECL, photo-thermal, fluorescence, PEC, SERS, and SPR-based aptasensing. Although considerable efforts have focused on constructing and implementing optical aptasensing strategies based on MXenes, the investigations are comparatively scarce compared to electrochemical aptasensors. While a small number of published studies focused on MXene QDs and NSs as fluorescence technologies, alternative optical sensing methods such as SERS, colorimetric, PEC, and SPR appear to be uncommon (each type has only one or two published reports yet). To enhance the reader's awareness, Figure sketches a historical perspective of MXene-based aptasensor development over time. It is obvious that the majority of the research works appeared recently. This is also worth noticing that most of the published aptasensing research studies are related to electrochemical aptasensors, whereas few are related to different types of optical aptasensors [1].

Some MXenes other than Ti3C2Tx or Ti3C2, e.g., Nb2C [4] and Nb4C3Tx [5], have been recently used to construct MXene-based aptasensors. It shows the growing interest of the scientific community in exploring the benefits of a variety of MXenes in aptasensing in the upcoming years. Although the aptasensors reported for food/water safety might be extended for environmental monitoring, aptasensor with Nb4C3Tx as a transducer [5] have recently started finding applications in environmental monitoring to detect the traces of heavy metals in environmental samples as well (the first MXene-based aptasensors to detect Pb2+). It may necessitate large-scale commercialization in the future owing to its broad-ranging application potential. Considerable attention is required to explore various emerging optical biosensing platforms such as ECL, SERS, colorimetric, SPR, and certain coupling approaches based on MXene QDs and NSs. Because Ti3C2Tx has garnered considerable attention, its stability needs to be improved, and it is suggested that various other MXenes be investigated for the development of novel aptasensors. Due to the electromagnetic interference shielding characteristics of MXenes, magnetic-field stimuli, and activated optical sensing platforms might also find significant applications in biological systems and biomedicine. Further research should be conducted to understand the correlation between the optical properties of MXene and their composition or structure, along with their edges. Computer-aided engineering of MXenes in relation to adjustable surface terminations, morphology, and appropriate size could be another approach to enhance our understanding of how to promote MXene development for their sensing applications and optical features. A more comprehensive understanding of aptamer immobilization strategies on various MXenes is required for multiplex sensing of biomolecules in a cost-effective and facile setting, particularly for point-of-care diagnostics. The exceptional electrical and mechanical features of Ti3C2Tx MXene make it an excellent platform for wearable technology. Wearable MXene-based biosensors are playing substantial roles in the continuous and non-invasive tracking of a wearer's health and physiology in the human body, including disease diagnostics and therapy. Aptasensors based on wearable technology have also been commonly reported, e.g., wearable cortisol aptasensors [6]. Yet there is not even a single report describing the use of MXene-based aptasensors in wearable technology, for an unknown reason.

MXene-based wearable biosensors may be efficiently converted into MXene-based aptasensors to broaden their potential application range.

MXene-based aptasensors appear to be very useful since their detection sensitivity ranges from picomolar to femtomolar, which is much higher than that of traditional approaches like spectroscopy and chromatography. Despite these advancements, MXene-based aptasensors are still in their infancy in comparison to most of the other biosensing techniques. Still, MXene-based aptasensors could be useful in the future for a wide range of applications once some problems are solved. Aptamer's shorter half-lives are a serious obstacle for the aptasensor industry. Further, the literature shows a lack of familiarity with aptamer surface immobilization approaches and a scarcity of aptamer varieties. The use of MXenes in aptasensors is associated with various other challenges, e.g., MXene oxidation may affect the stability of biosensors in humid and hot environments; non-uniform surface terminations could affect its proper functioning, and the expensive MAX precursor may hinder the development of MXene aptasensors, etc. The published MXene-based aptasensors for genuine foodborne pathogens and mycotoxins detection in food safety still have significant limitations, which need to be seriously considered.

For commercialization to work, the given methods need to be improved so that they can be used regularly. Continued advancements in all these aptasensing strategies are conceivable by combining multiple approaches, thereby overcoming the challenges of each method mutually. Moreover, future efforts should be directed toward the construction of less sophisticated technologies that can be easily utilized by non-professional individuals. The evaluation of representative MXene-related aptasensors and future trends in this area are anticipated to further explore MXene's prospects for biomedical sensing advancements. Current research demonstrating the use of innovative MXene nanomaterials in combination with aptamers tailored to identify a variety of targets of biological significance has opened up new opportunities in the food industry and healthcare. The situation has improved significantly over the current year, and recent breakthroughs in the field of MXene aptasensing well surpass the limitations outlined previously. While the majority of these aptasensors are still in the initial phase of development, attempts are being made to commercialize these devices in the future. Due to the increased interest and unwavering efforts from both the scientific and industrial communities, the existing constraints of MXene-based aptasensors are projected to be overcome shortly.

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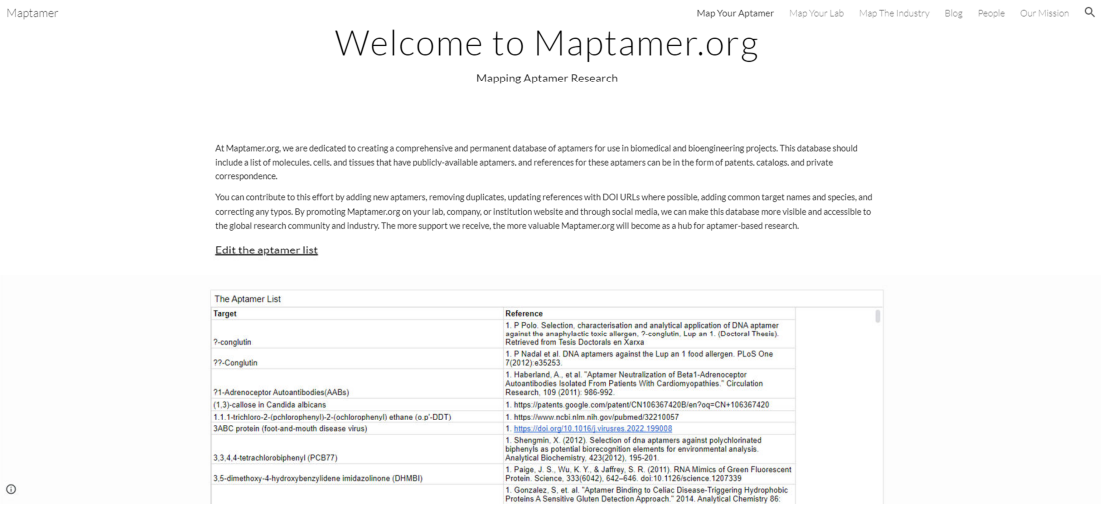
Maptamer.org – Benjamin Skubi

Maptamer.org is a new database of chemical and cellular targets with a corresponding aptamer. It's designed to be comprehensive and permanent, and Maptamer.org is already the largest database of aptamer targets on the web! By coordinating SELEX efforts and facilitating use of aptamers as off-the-shelf components in exciting new bioengineering projects, Maptamer.org meets the needs of scientists and engineers for a convenient way to discover these incredible technological resources.

Our next growth step is to use machine learning to extract hundreds to thousands of additional aptamer targets, never before collected in one place, from our corpus of over 20,000 aptamer-related academic abstracts. You can also add your aptamer directly to our website in a matter of seconds, because Maptamer.org is built on the simplest and most familiar cloud technology there is: embedded and community-editable Google Sheets. I have also started an editable list of academic labs and companies that work with aptamer technology. In the future, we will also include a database of SELEX experiments that faced challenges or failures, which can be an incredibly valuable resource that too often is lost due to the difficulty of publishing negative results in academic journals.



In our database, I include only the aptamer's target and a reference where an interested person can learn more. That reference is typically an academic article, but it can also be a corporate catalog, or even a name and email address. I keep our database this simple because it minimizes the barrier to adding additional entries while vastly simplifying the search-and-discovery phase of finding out whether an aptamer exists for a given target. To ensure Maptamer.org's longevity, I built the site using simple, proven technologies, minimized the maintenance requirement, and purchased the domain for 10 years. Maptamer.org is going to last.

We are recruiting writers for our blog, which will focus on SELEX education and the journey of aptamer technologies to the clinic, particularly in global health and low-resource settings where their advantages over antibodies are particularly important. Entries can be as short as a single paragraph and informal, as long as they contain useful information. We are looking for contributions by aptamer researchers, diagnostics engineers, clinicians, administrators, and anyone else with experience and interest in translating aptamers to underserved clinical settings.

You can help Maptamer.org grow by adding your aptamer, lab or company to our lists, and by writing for our blog. Please feel free to reach out to me with questions, submissions and ideas. To best serve

the aptamer community, Maptamer.org needs to be maximally visible on the web. You can assist by linking to us from your lab or company website, as well as from tweets and other social media. Spread the word!

— Benjamin Skubi, University of Michigan/OHSU Biomedical Engineering
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Interview with a researcher: Associate Professor Sarah Shigdar

We've had a pretty amazing list of interviewees in the newsletters over the past years, but Prabodhika and I thought it was time for us to hear from our President, Sarah. It is truly thanks to Sarah that we have these newsletters so often. She has been great at getting different people involved. But most impressively, she works hard to think of new content ideas and write them out for all of us to enjoy! We are all busy but Sarah always finds a way to put new content together, really encouraging the aptamer field to stay current and connected. We are so lucky to have her leading this society and it is a great opportunity to know more from her in this interview below.

Associate Professor Sarah Shigdar is the President of the International Society on Aptamers and is currently employed at Deakin University. She is the Head of the Laboratory of Aptamer Theranostics and leads a large research group that focuses on the development of aptamers that can be used for both diagnostic and therapeutic applications. Diagnostically, these include medical imaging and companion diagnostics, point of care devices, and rapid diagnostics. Therapeutically, these novel molecules have shown efficacy in a number of cancers, both in vitro and in vivo and her current interest is in developing effective treatments for brain metastases and brain cancers. While As/Prof Shigdar's research focus is on cancer theranostics, she champions the use of aptamers and is collaborating on a number of projects worldwide to aid researchers to switch to aptamers for their applications and assays.

Q1) How did you become interested in the field of aptamers?
I was finishing my PhD when I was introduced to them by a new laboratory head, Professor Wei Duan, in the School of Medicine, and it was love at first sight. Here were these tiny little chains of nucleic acids that could be used for diagnostics and therapeutics? I'd previously worked with antibodies diagnostically and could see so many applications for aptamers and immediately jumped in to develop them for cancer related targets.

Q2) From your point of view, what is unique about aptamers?
One is that with the right knowledge, anyone can develop aptamers with the most basic of molecular biology tools. If you have a PCR machine, then you can start to generate some. Another point is their stability. I send aptamers around the country using normal post and they still work. There's no extra cost for using cold storage. Another thing is that, especially in my field, the same aptamer can be used in both diagnostics and therapeutics. And their lack of batch to batch variability. I could probably wax lyrically about them for pages, but I'll leave it there for now.

Q3) What do you think is the future of aptamers?
What a time to be working with aptamers. I could direct you to the last edition of the newsletter where I talk about the current clinical trials and the successes there have been. Or I could point to the global market view that the aptamer market is predicted to be $4.1 billion by 2025, which is an almost 20% increase in the compound annual growth rate (CAGR) since 2018. I could also point to the adoption of non-animal derived reagents, of which aptamers are a source. Aptamers will break into the market for the unique applications that only aptamers can accomplish, before breaking through in other areas. And the fact that aptamers are reusable will help them with that breakthrough as it presents a very economical solution, in addition to the cost benefits of using aptamers in the first place.

Q4) What are the major challenges that need to be solved?
There are some in terms of therapeutic delivery, but those are being solved and optimized, as seen from the clinical trials that have been run over the last few years. I think the main one is getting them to become an everyday term for people to talk about, but even here in Australia, when we talk about aptamers, more and more people have heard of them and understand what they can be used for.

Q5) Tell us about your research.
I first started working with aptamers for targeted delivery of drugs to solid cancers that were epithelial in nature. When I started my own research group, the focus shifted to targeting any cancer that spread to or originated in the brain. We have since developed other aptamers that target other cell surface receptors over-expressed on cancer cells. What we've seen so far is that these aptamers reduce systemic burden of disease and can get into the brain and reduce tumour burden there as well. So while we are working on developing treatment for brain cancers, like glioma and medulloblastoma, and have a platform technology to get into the brain, we are also focusing on delivering a treatment for metastatic disease, still at the preclinical level, but moving closer to clinical trials.

Q6) How did you know about the INSOAP?
I was lucky enough to be at the inaugural Aptamers Symposium in 2013 and was involved in discussions with Said Ismail, who was the first President, and he announced INSOAP and I joined and became Secretary. Then when Said was seconded to another role, I stepped up and became President.

Q7) How will you support the INSOAP?
I curate the social media sites. The Facebook page releases three abstracts per day so you can stay in touch with publications. I add other information through the LinkedIn groups. And working with my fantastic team within the Society, we release newsletters 3 times per year. For any of the links to these, you can find them on the first page. I also answer every email about aptamers, whether it is from a researcher, a company, or somewhere in between. Aptamers are my favourite topic so I am happy to talk about them to whomever will listen, and I'm happy to help anyone looking at getting into using aptamers, or troubleshooting with someone to help their aptamer applications work. My disclosures list is getting longer.

Q8) What kind of advice can you give to the young researchers about aptamers?
They are quirky if you're used to working with antibodies, and through various manuscripts we've tried to take each of these and explain how to work with aptamers. Also, don't be afraid to ask any question. And as Maria said in the last edition, the aptamer community is such a great group of people, that it is easy to reach out and ask questions. We need to work together to raise awareness of aptamers, and it is through the simple connections we make at conferences or through emails that that can happen.

Q9) What is your personal philosophy on life and science?
For life, it is looking at the simplest things and appreciating them. I'd say that applies to science as well. A small band on a gel that means the experiment has worked. But part of both is also learning and I love taking on new information and learning new skills. It's what I try and teach to my students.

Q10) What is your favorite part about research?
When it works! And when it works really well. There have been many happy tears over the years. The first were when we saw that we had got our drug across the blood brain barrier and specifically into the cancer cells. Another moment sticks out, when I explained to a student that what she was seeing was the aptamer-drug entering the cancer cells, and the drug then able to move into the nucleus, and that her experiment had worked, and she started crying happy tears and laughing at the same time. It's moments like those that gets you through the failed experiments.

Q11) What do you like to do in your free time?
Hello streaming services! I watch TV with one of the cats sitting on my lap and scream abuse at the tv whenever they get something sciencey wrong, much to the bemusement of my partner. I also love finding the time to watch the NFL, but with timezones, it can be pretty much impossible.

Q12) Any other fun facts/tidbits you'd like us to know!
Our house has become an ode to star wars Lego! Though we were recently gifted another Lego piece from a conference which will be put together soon and will go on my Twitter account! And during the pandemic, while working at home for so long, I rescued a cat, a rabbit, and a frog in the back garden, interacted with a crow so much that he trusted me to be within a few feet of him, and enjoyed playing with the neighbour's dogs when they escaped into our garden.

INSOAP updated list of recently published aptamers – Maureen McKeague

Here are newly reported aptamers since our last issue to 12th December. We focus on aptamers that have been characterized with a dissociation constant (Table 1). Typically, we make use of Pubmed to identify newly published aptamers with the keywords "aptamer" and "SELEX". If we have missed any newly reported aptamers, please let us know (maureen.mckeague@mcgill.ca). Readers should consult the literature (link provided) for verification and further information.

Table 1: Newly-reported aptamers published since our last issue.

Link	Target(s)
https://pubmed.ncbi.nlm.nih.gov/36519741/	Geobacillus stearothermophilus
https://pubmed.ncbi.nlm.nih.gov/36594741/	Receptor Tyrosine Protein Phosphatase F
https://pubmed.ncbi.nlm.nih.gov/36657878/	Methyl parathion
https://pubmed.ncbi.nlm.nih.gov/36657012/	T4 DNA Ligase
https://pubmed.ncbi.nlm.nih.gov/36672400/	Human Epididymis Protein 4
https://pubmed.ncbi.nlm.nih.gov/36700646/	Sialyllactose
https://pubmed.ncbi.nlm.nih.gov/36716100/	Microglial Transmembrane Protein CD64
https://pubmed.ncbi.nlm.nih.gov/36769156/	thrombin
https://pubmed.ncbi.nlm.nih.gov/36812415/	Uveal Melanoma
https://pubmed.ncbi.nlm.nih.gov/36812779/	LipL32 in pathogenic Leptospira
https://pubmed.ncbi.nlm.nih.gov/36816615/	SARS-CoV-2 nucleocapsid (N) protein
https://pubmed.ncbi.nlm.nih.gov/36831921/	thiamethoxam
https://pubmed.ncbi.nlm.nih.gov/36838669/	Fibroblast Activation Protein
https://pubmed.ncbi.nlm.nih.gov/36882911/	sulfameter
https://pubmed.ncbi.nlm.nih.gov/36868770/	Cronobacter spp.
https://pubmed.ncbi.nlm.nih.gov/36920371/	nucleated red blood cells
https://pubmed.ncbi.nlm.nih.gov/36940632/	SARS-CoV-2 spike protein
https://pubmed.ncbi.nlm.nih.gov/36935137/	nitrofurazone
https://pubmed.ncbi.nlm.nih.gov/36937170/	immunoglobulin E

Aptamers Journal

The Aptamers journal is the official journal of the International Society on Aptamers and will publish studies on all aspects of aptamer research. The Aptamers journal, launched at the end of 2017, is the first-ever peer-reviewed journal aimed to publishing all aspects of aptamer research. The journal is specifically open-access to help make aptamer research accessible to scientists all over the world. Moreover, the journal will consider "negative" data, as we all know that this can be very valuable information when performing aptamer research.

The landscape of published articles in the Aptamers journal to-date is very diverse. For example, topics of the presentations include selection methods, aptamer characterization, chemical modification of aptamers, applications in drug delivery and biomaterials. Furthermore, the publications have been received by authors from all over the world: specifically, USA, Germany, Russia, Australia, Canada, South Korea, Switzerland, Uruguay, Japan, Italy, China, Spain, UK, and Jordan. Finally, the journal accepts several forms of publications, and indeed each of the publication formats have included. In particular, we received three full Research Articles, three Research Reports, five Reviews/Mini-Reviews, one Protocol/Method, and three Meeting Reports/News Articles.

We would like to thank our very diverse and international Editorial Council team and reviewers for helping make the publications of these articles a reality. We look forward to many more aptamer articles in 2023! Please submit your articles for peer-review to the Aptamers journal. All symposium delegates can submit an article before 30th September 2023 **for free**. So if you'd like to publish your work in the first Aptamers journal, please follow this link http://www.JAptamers.co.uk

Nominations for INSOAP committee

We are currently asking for expressions of interest for membership of the management committee of INSOAP. If you would like to be an integral part of our Society as it moves forward, please contact me at sarah.shigdar@deakin.edu.au.

Updates to the website

We have been working on updating the website (http://aptamersociety.org/aptamer-laboratories/) for INSOAP and you will now see that we have a listing of all aptamer companies throughout the world, as well as a listing of all the aptamer laboratories to date. If we haven't got you listed, please email me at sarah.shigdar@deakin.edu.au. and we will add you to our growing list. We are also providing a careers page so please get in touch with any vacancies you wish to be listed. Finally, if there are any suggestions for improvements to the website, please contact us and we will make the changes.

Aptamer Consortium – Sarah Shigdar

One of issues that we've watched develop over the last few years is the reproducibility crisis that we first discussed in the June 2017 newsletter. At the time we suggested that aptamers could fix some of the issues of reproducibility by providing a more reliable tool for applications. To that end, within the Society, we have been discussing the need for a small group of researchers to come together from both Academia and Industry to work on these guidelines. Our Mission Statement, while still a work in progress, states:

'*The Aptamer Consortium supports researchers, academic institutions, and partners, to promote best practice for aptamer techniques in both diagnostics and therapeutics, to provide guidance for basic and applied research as well as development and commercialisation, and facilitate discussion and interchange of ideas*.'

We have published our first paper from the Consortium in the *Aptamer* Journal in 2022, which will tackle the minimum standards for publishing novel aptamers. If you are interested in sharing your views on the Consortium, please email me (sarah.shigdar@deakin.edu.au)