Five Challenge Topics

Topic 1: Hypercompetition for Resources

***Description*:** One of the most concerning aspects about being a scientist is raising funding for one's work. Government agencies and private foundations are the most common bodies funding scientific research. Resources are most often given to hot topics, and scientists often have a greater chance to receive funding when they have been funded previously, creating a hypercompetitive research environment where funding for basic science is diminished and big grant receivers tend to swallow up large parts of the funds available. Furthermore, foundations tend to give funds to topics within their field/scope of interest, which can lead to scientists overextending the relevance of their work or overselling their project.

What constitutes fair prioritization of public, foundation and industry funding? Within the prioritized areas, how can funds be distributed fairly? How can the system be redesigned to more fairly distribute funding? What actions can scientists take to reform the system? Would a more narrow specification of individual grants be a solution to diversify who receives funding? Or would an interesting alternative be letting the public have full or partial influence on the decision-making regarding prioritization of research funding, e.g., by public referendum? Such a mechanism would increase public awareness regarding research, but also risk subjective voting, where a disease in the family could be a decision trigger or where flying to Mars sounds more intriguing than understanding mitochondrial biology.

Your challenge: How should the priorities for public, foundation, and industrial funding be set? How should the funding be distributed? Who should decide? Should it be up to a public referendum and if so, to what extent? Discuss pros and cons of possible outcomes. What is the optimal solution?

***Suggested resources*:**

- Rescuing US biomedical research from its systemic flaws, Alberts, et al., *Proc. Natl. Acad. Sci.*, (2014), (https://www.pnas.org/content/111/16/5773)
- A kinder research culture is possible, Nature editorial, (2019) (https://www.nature.com/articles/d41586-019-02951-4)
- Science funding is a mess. Could grant lotteries make it better? (2019) (https://www.vox.com/future-perfect/2019/1/18/18183939/science-funding-grant-lotteries-research)
- Public ballot voting, Museum of Extraordinary Objects, Royal Society, UK (2018) (https://royalsociety.org/topics-policy/projects/research-culture/changing-expectations/museum-of-extraordinary-objects/)

Topic 2: Open science/open access

Description: In addition to theory and experimentation, a third aspect of science, namely the vast amount of data being produced and available to researchers especially for collaboration, has significantly changed the way science is done in recent years. You may have heard and thought carefully about open access publication, but have you thought about the more comprehensive concepts in open science, the "movement to make scientific research, data and their dissemination available to any member of an inquiring society, from professionals to citizens." Despite the conspicuous benefits of open science, such as creating trust in the scientific community, sharing of resources and increasing data re-usability, many scientists are still reluctant to open up their knowledge and discoveries to the community, especially at an early stage. Major challenges to open science are restrictions such as data ownership, intellectual right properties, other political and economic reasons as well as lack of a clear reward system that promotes open science practices. In the most recent decade, novel communication technologies and platforms have emerged to facilitate information sharing, such as ResearchGate

Q&A (to share lab experiences and help fellow scientists with specific protocols), BioArchives (to pre-publish your manuscripts), Addgene (for sharing detailed information about genetic constructs), Open Science Framework (OSF; to share your unpublished research concepts and enable collaborations) - to mention a few. However, there is still a wide range of opportunities to support and ease researchers' workflows to transit to a culture of openness.

Indeed, sharing information about recent discoveries can be viewed as risky for researchers, as the fear of 'being scooped' is tangible, jeopardising a publication in a high impact journal or falling short on securing further funding. Therefore, scientists often prefer to follow the traditional path and wait until their research/protocols are published in peer-reviewed journals. However, the road from manuscript submission to a publication is a long and tedious one that often leads to delays in contributing one's discoveries to the body of scientific knowledge and making use of new discoveries in applied, translational and clinical science.

***Your challenge*:** How do we make open science more appealing to scientists? List innovative ways to facilitate the culture of open science and information sharing; outline positive influence it might have on progress in science.

***Suggested resources*:**

- Learn about open science through the FOSTER e-learning platform (https://www.fosteropenscience.eu/resources)
- What is open science? The Orion Open Science Project: https://www.orion-openscience.eu/resources/open-science
- Heavyweight funders back central site for life-sciences preprints, Callaway, *Nature*, (2017) (https://www.nature.com/news/heavyweight-funders-back-central-site-for-life-sciences-preprints-1.21466)
- Addgene: The Non-profit Plasmid Repository: http://www.addgene.org/
- ResearchGate Professional Network for Scientists and Researchers: https://www.researchgate.net/
- bioRxiv: The Pre-Print Server for Biology (Cold Spring Harbor Laboratory) https://www.biorxiv.org/
- Young's Translator, Museum of Extraordinary Objects, Royal Society, UK (2018) (https://royalsociety.org/topics-policy/projects/research-culture/changing-expectations/museum-of-extraordinary-objects/)

Topic 3: Positive influence of failure

***Description**:* Studies with successfully proven hypotheses are considered worthy of publication and are greatly represented in scientific literature (85% of data papers on pubmed are 'positive-data-biased'; Mlinaric *et al.*, 2017). This publication trend is in stark contrast to unexpected results that 'failed' to prove the hypothesis, delivering so called 'negative data'. Negative or less-than-dramatic findings are currently viewed as boring for editors, a costly waste of resources, and a culprit of 'ruining one's career', collectively causing an enormous demotivation among junior scientists. Under-reporting and filing away of negative results significantly impacts science and research culture by skewing the view of reality, as well as by affecting our career paths. Surely, pursuing risky hypotheses costs resources and time; however, would publishing negative data help the scientific community increase data reproducibility and optimize the current measures of our productivity?

Your challenge: How do we introduce a positive influence of failure and make negative results valued/easier to publish for the scientific community?

***Suggested resources*:**

- 'Dealing with the positive publication bias: Why you should really publish your negative results' Mlinaric *et al.*, (2017) https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5696751/
- Smart Science Career: https://smartsciencecareer.com/negative-results/

- Enago Academy, Scientific Transcapancy: https://www.enago.com/academy/why-it-is-important-to-publish-negative-results/
- Memorial to 2027 Mars Mission, Museum of Extraordinary Objects, Royal Society, UK (2018) (https://royalsociety.org/topics-policy/projects/research-culture/changing-expectations/museum-of-extraordinary-objects/)

Topic 4: Team science & research assessment

Description: Teamwork and collaboration in science happen both within a research group as well as among groups with different scientific expertise. It has long been shown that decision-making by teams rather than individuals most often results in improved, creative solutions. The positive effects of teamwork are also evident in interdisciplinary research or large "grand challenge" science where it is often necessary to publish findings in high impact journals.

While team science and interdisciplinary collaboration can be a golden road to scientific discovery, awarding credit in a traditional system that more often rewards individuals than teams, can cause a significant amount of friction. Authorship is a key currency in researcher assessment, and the order of authorship is one of the most important ways that a researcher gains recognition, funding and further publication in high impact journals. Interestingly, signs of change are afoot, e.g., at CERN where authors are listed alphabetically on publications to avoid giving too much or too little credit to individuals.

Your challenge: How should researchers be assessed? How can we reward groups and collaborative efforts, instead of selected individuals? Or should individual names be on publications and if so why and in what order? What does authorship mean and what responsibilities does it carry?

***Suggested resources*:**

- Institutional culture is the key to team science, Lee & Jabloner, *Nature Biotechnology* (2017) (https://www.nature.com/articles/nbt.4026)
- Genetics consortia are often credited on publications by their consortium name rather than consortium members' names: eQTLGen Consortium (https://www.eqtlgen.org); BIOS Consortium (https://www.bbmri.nl/acquisition-use-analyze/bios)
- Collaboration and Team Science: From Theory to Practice, *J. Invest. Med.* (2013) https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3652225/
- Diversity and decision-making – pain and gain, U. Firth (2018) https://blogs.royalsociety.org/in-verba/2018/07/16/diversity-and-decision-making-pain-and-gain/
- Improving recognition of team science contributions in biomedical research careers, *The Academy of Medical Science (*2016) https://acmedsci.ac.uk/file-download/38721-56defebabba91.pdf
- Who's on first, Amber Dance, *Nature* (2012) https://www.nature.com/articles/nj7417-591a.pdf
- Authorship and Team Science, Fontanarosa et al. (2017) https://jamanetwork.com/journals/jama/fullarticle/2667044
- The Noble Award for Team Science, Museum of Extraordinary Objects, Royal Society, UK (https://royalsociety.org/topics-policy/projects/research-culture/changing-expectations/museum-of-extraordinary-objects/)

Topic 5: Public trust and perception of science

Description: We are currently in an era where there is increasing distrust in the public debate about science. A survey made for the Ministry of Education and Research in Denmark revealed that two out of three people that responded have a high or very high degree of trust to the researchers; however, 82% only vaguely (or not at all) trust that the media report scientific findings truthfully! In general, they believe that the public debate is not

supported sufficiently by facts from research. Denmark is not alone in painting this picture. Other countries, such as the USA, face an uphill battle for the public validation of science. Examples abound in climate science, regenerative medicine, and the uprising of anti-vaccination campaigns. Too often, miscommunication and the need for sensational news leads to this outcome.

***Your challenge**:* How do you as a scientist gain the public's trust in science and prevent media misinterpretation?

Suggested resources:

- The public mostly trusts science. So why are scientists worried? (2018) https://www.sciencemag.org/news/2018/02/public-mostly-trusts-science-so-why-are-scientists-worried
- Trust in science and health professionals (2018) https://wellcome.ac.uk/reports/wellcome-global-monitor/2018/chapter-3-trust-science-and-health-professionals
- Scientists who selfie garner more public trust. (2019) https://phys.org/news/2019-05-scientists-selfie-garner.html
- Ethics to Hype: How Media Frames Regenerative Medicine (2017) https://www.eurostemcell.org/ethics-hype-how-media-frames-regenerative-medicine
- Stem cell hype: Media portrayal of therapy translation (2015) https://stm.sciencemag.org/content/7/278/278ps4.short
- The Ministry of Education and Research in Denmark (In Danish) (2017) https://ufm.dk/aktuelt/pressemeddelelser/2017/danskerne-har-storst-tillid-til-forskere
- Factank news in the numbers, USA (2019) https://www.pewresearch.org/fact-tank/2019/03/22/public-confidence-in-scientists-has-remained-stable-for-decades/