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The Fundamental Characteristics of a Translational Scientist

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ABSTRACT: Translational science is defined as the field of investigation focused on understanding the scientific and operational principles underlying each step of the translational process. Further development of the field is advanced by describing the key desirable characteristics of individuals who seek to uncover these principles to increase the efficiency and efficacy of translation. The members of Translation Together, a newly launched international collaborative effort to advance translational innovation, present here a consensus representation of the fundamental characteristics of a translational scientist. We invite all stakeholders to contribute in the ongoing efforts to develop the field and educate the next generation of translational scientists.

KEYWORDS: *translation, translational science, Translation Together, innovation*

Translational science for benefiting human health requires the convergence of a diverse array of disciplines, including biology, chemistry, informatics, computer science, engineering, medicine and public health, into a united effort to uncover the scientific and operational principles leading to efficient and effective translation. The fundamental characteristics and attributes required to be a successful translational scientist go beyond the competencies of existing individual disciplines and include a broad understanding of the translational spectrum, the full embrace of a team science approach to research, and a focus on developing innovative solutions to persistent problems in translation, among others.

Translation: the process of turning observations in the laboratory, clinic, and community into interventions that improve the health of individuals and the public—ranging from therapeutics and diagnostics to medical procedures and behavioral medicine

The members of Translation Together[1] (www.TranslationTogether.org) recognized the lack of an engaging and informative resource that communicates and disseminates those fundamental characteristics to aspiring translational scientists, established practitioners, and other stakeholders wanting to learn more about the discipline. Other groups have sought to extensively list dozens of competencies for use in designing educational curricula in training clinician-scientists in translational science,[2] or have developed a more concise competency profile that trainees can use to chart their progress over time.[3] These resources, and others, provided a foundation upon which the members of Translation Together sought to take a different yet complementary approach to describing and defining the essential characteristics of a translational scientist.

Translational Science: the field of investigation focused on understanding the scientific and operational principles underlying each step of the translational process

Herein we present an illustrated resource (Figure 1) that provides a global vision of the ideal translational scientist in a manner that is visually engaging and broadly understandable, in order to (i) encourage the recognition of translational scientists as unique practitioners of an independent scientific discipline; (ii) inspire young scientists to pursue a career in translational science; and (iii) educate stakeholders about the characteristics of scientists who work in this field.

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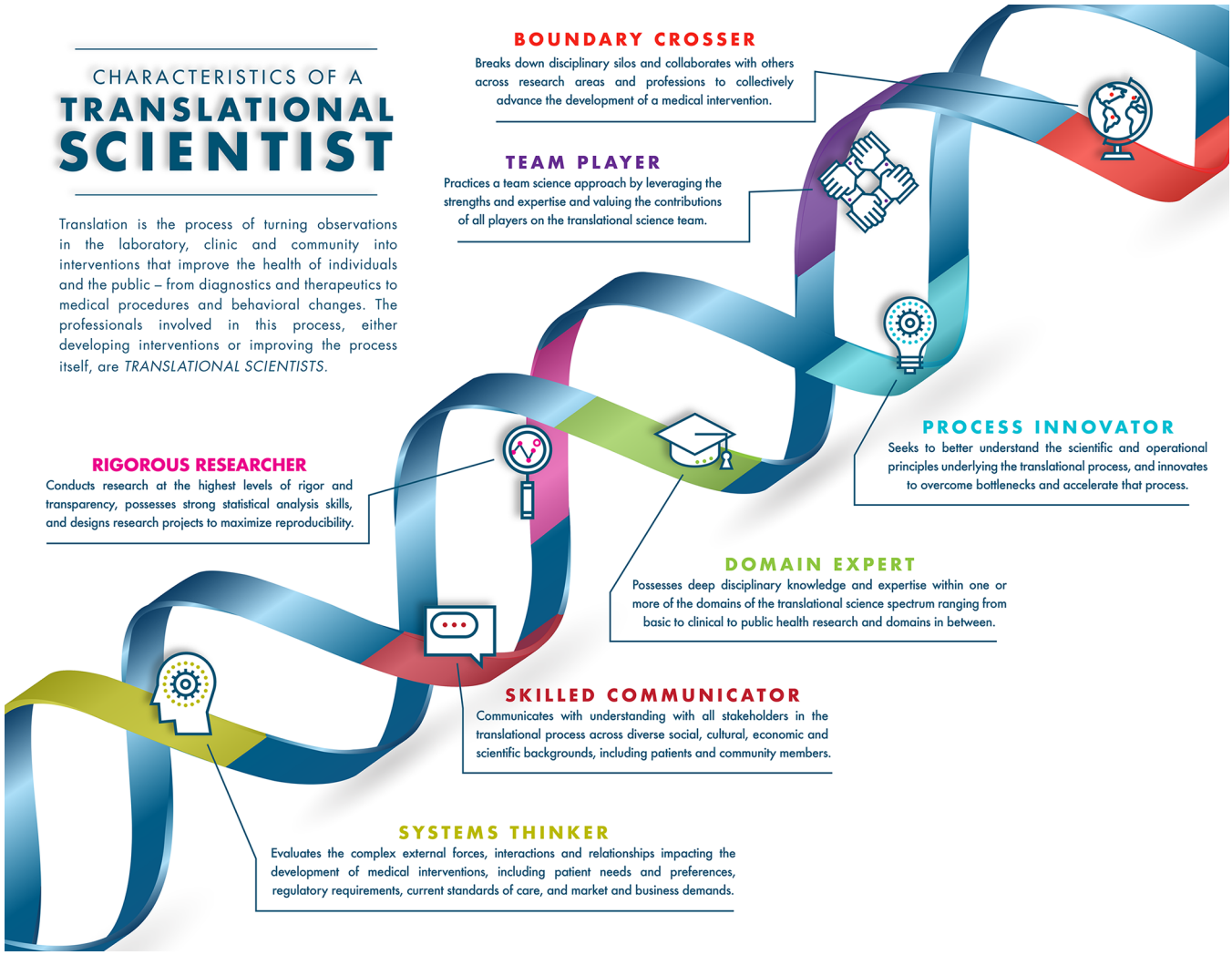

Figure 1. Seven fundamental character traits of a translational scientist.

Rather than try to list the specific learning competencies for a field of investigation that encompasses a myriad of disciplines running the gamut of biomedical science and human health, we share here a more high-level view of the basic traits of a translational scientist independent of his or her particular area(s) of expertise. Additionally, we recognize that some of these characteristics may be found in practitioners of other scientific disciplines; however, the full complement as described here is arguably unique to translational science.

A fundamental distinguishing characteristic of a translational scientist is multiplex outlook. In most sciences, emphasis is placed on mastery of a specialized domain of expertise, with relevance or application to other disciplines in a larger scientific ecosystem deemphasized or absent. While this atomistic approach has enormous value in unravelling the complexities of particular fields, it predictably produces scientists who lack holistic, system-level understanding, and is largely responsible for the "silo" dominated scientific culture so decried today. In contrast, translational scientists possess both deep scientific domain expertise and systems understanding, and their research is designed to produce discoveries that are simultaneously important for their discipline(s) and contribute to other disciplines, thus intentionally advancing the translational process as a whole.

The illustration depicts the following seven fundamental characteristics of a translational scientist:

Boundary Crosser: *Breaks down disciplinary silos and collaborates with others across research areas and professions to collectively advance the development of a medical intervention.*

Being a translational scientist requires venturing beyond one's own research discipline or professional domain to gain an understanding of the fundamental knowledge, methodologies, and priorities of all other disciplines and domains involved in a translational research project. The institutional strictures and incentive structures within academia and other large scientific organizations often deincentivize data sharing, multidisciplinarity, and trans-disciplinary collaboration. An effective translational scientist seeks to break down those barriers and push the historical boundaries between disciplines.

As with the more commonly understood meaning of translation among the general public, one must also be able to speak and comprehend the native language of those disparate domains and translate one's own disciplinary jargon into a language that can be understood by others. An effective translational scientist should be an interpreter of the multiple languages of biomedical, clinical, and public health research for those translational team members caught up in their silos. With this broad knowledge, a translational scientist can most effectively design their research program to align with the

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interests and requirements of the researchers up- and downstream, to enable a seamless transition between translational phases.

Domain Expert: *Possesses deep disciplinary knowledge and expertise within one or more of the domains of the translational science spectrum ranging from basic to clinical to public health research and domains in between.*

While breadth of foundational knowledge across the translational spectrum is critical, one must also possess depth in one or more domains. It is not sufficient to be "a mile wide and an inch deep" as the adage says. A translational scientist should attain expertise in one or ideally more translational domains to be able to contribute novel solutions to complex problems. This is perhaps best modeled by the concept of a "T"-shaped professional, with deep disciplinary knowledge combined with the ability to communicate across disciplines (see Boundary Crosser).[4]

The predominant focus of most graduate-level science and engineering education and training programs is to produce such disciplinary experts with a substantial depth of knowledge within a relatively focused intellectual pursuit. Being a specialist entails intimate understanding of the intricate workings of a specific system, whether it be at the atomic, cellular, organismal, or community level, and drilling down to fully grasp the nuances associated with it. This specialization of scientific research and knowledge generation continues to be instrumental to developing innovative solutions to some of the greatest challenges in biology and medicine.

Team Player: *Practices a team science approach by leveraging the strengths and expertise and valuing the contributions of all players on the translational science team.*

Translation can be thought of as an engineering challenge wherein each member with different skills works in order to advance the project to completion. A well-executed project requires a team to have clearly defined their goals, agreed upon a precise strategy, and maintained open communication before and during the project. For example, just as a relay race or building a submarine requires multiple people working together toward a common goal in exquisite harmony, so too does translation; an individual working in isolation or a team that does not collaborate would (and does) fail spectacularly.

Translational scientists must embrace a team science approach and learn to recognize and value what every member brings to the team. This necessitates a certain amount of humility and recognition that one cannot "go it alone". One must take into account the objectives and requirements of the person to whom they will handoff a promising biomedical intervention. If one only considers their immediate self-interests in a team setting, the baton will be dropped and patients will be left waiting at the finish line.

Process Innovator: *Seeks to better understand the scientific and operational principles underlying the translational process, and innovates to overcome bottlenecks and accelerate that process.*

Being a process innovator is perhaps one of the characteristics that most distinguishes a translational scientist from other researchers in the biomedical and health sciences. Translational scientists seek to understand the fundamental scientific and operational principles of each step of the translational process, with the goal of developing novel medical interventions that drastically improve their efficiency and efficacy. Rather than accept the weaknesses of the prevailing methodologies of the times, a translational scientist adopts a disease-agnostic approach to the process of translation and relentlessly hunts for inefficiencies that prevent new treatments and cures from reaching patients.

Processes such as preclinical toxicology prediction and testing, clinical trial recruitment and design, and physician implementation of new therapeutics are areas ripe for disruption and innovation, regardless of the particular disease or condition under study. What motivates and drives the translational scientist is not just to develop a single drug for a single disease, but to also develop solutions (platforms) that make it easier for anyone to develop any drug for any disease.

Skilled Communicator: *Communicates clearly with all stakeholders in the translational process across diverse social, cultural, economic and scientific backgrounds, including patients and community members.*

This is another meaning of the term "translational scientist": someone who is able to linguistically communicate their science so that it is comprehensible to stakeholders with a range of scientific and nonscientific backgrounds.

Biomedical translation suffers from a lack of understanding[5] among nonpractitioners who may understandably conflate the burgeoning discipline with the classical study of linguistics, among numerous other misconceptions. Translational scientists skilled in the art and practice of communication are urgently needed to connect with and engage the diverse set of stakeholders in biomedical innovation, ranging from patients and community members to funders and policy makers. Being a skilled communicator requires that one not only be able to speak and write in a language and manner that is comprehended by the audience, but that one also listens with understanding to the needs and desires of the audience.

Systems Thinker: *Evaluates the complex external forces, interactions, and relationships impacting the development of medical interventions, including patient needs and preferences, regulatory requirements, current standards of care, and market and business demands.*

The Systems Thinker is another quality of a translational scientist that sets them apart from other biomedical and health researchers. The ideal translational scientist, at whatever phase of the translational spectrum they work in, must consider the complex forces and influences that enable, as well as stagnate, the efficient and effective flow of therapeutic innovation.

Far too often, preclinical discoveries made in academic laboratories do not account for the rigorous regulatory requirements for an investigational new drug (IND) application, leading to a false perception of how quickly and easily one can advance a promising new compound into the clinic for human testing. Additionally, failure to factor in the requirements of health technology assessment agencies into the design of one's research can also hinder the results from being successfully handed off to practitioners in the next phase of translation. In other words, if one does not design their research to meet the needs and requirements of the next player on the translational team, then it is unlikely to advance toward impacting human health.

The same can also be said for integrating the patient perspective and current standard of care when formulating a research question and designing an experimental protocol. Do patients want an entirely novel therapy that could take decades to bring to market, or is the current therapeutic regimen sufficient if only the side effects could be mitigated? For patients with the disease under study, is it more important to slow its progression or go all out to find a cure? What level of risk is this particular patient population willing to tolerate in a

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clinical trial? All of these questions and many more require direct patient engagement at the earliest stages of translational research and continued seeking of the patient perspective throughout.

Rigorous Researcher: *Conducts research at the highest levels of rigor and transparency within their field of expertise, possesses strong statistical analysis skills, and designs research projects to maximize reproducibility.*

Increasing rigor and reproducibility in biomedical and clinical research has been a focal point since the publication of groundbreaking studies demonstrating the irreproducibility of seminal basic and preclinical research papers.[6,7] The requirement for proper experimental design, statistical analysis, and methodological transparency is not new nor unique to translational science; however, it is especially critical to translation wherein discoveries must be sufficiently robust to function in different contexts practiced by researchers with differing expertise. Whether it be running counter-screens and orthogonal assays to validate a hit from a high throughput screen, sufficiently powering a clinical study by recruiting enough participants to generate a meaningful outcome, or employing the appropriate statistical analyses when interpreting patient reported outcomes, a lack of scientific rigor can result in wasted time and money, at best, and patient harm, at worst. Therefore, translational scientists must ensure they possess the proper knowledge and training in quantitative and qualitative experimental design and data analysis, conduct research at the highest levels of rigor and transparency, and take all means necessary to maximize the robustness and reproducibility of their work.

CONCLUSIONS

The members of Translation Together have created the infographic (Figure 1) as part of a larger effort to foster the recognition and growth of translational science as a scientific discipline with unique attributes, research goals, career paths, knowledge requirements, operational approaches and deliverables. The members of Translation Together are funding and research organizations that are keen to facilitate global data sharing, and as an organization to provide guidance and a framework to aid global collaboration among stakeholders. We encourage stakeholders throughout the translational science community to incorporate this resource into their education and training offerings and share any derivations made to adapt the illustration to local environments.

We invite stakeholders across the translational spectrum to engage in open dialogue about the career development pathways of translational scientists, incentive structures that reward the pursuit of a career in this burgeoning field, and the core competencies important for relevant training programs, among other topics. This will provide a stable foundation for the accumulation of translational scientific knowledge and a research community that will contribute to the collective advancement of translation.

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Notes

The authors declare no competing financial interest.

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(1) Translation Together is a unique collaboration of leading translational research organizations from around the world leveraging their complementary scientific and operational strengths, shared insight of the challenges facing translation, and collective voice to advance the science and understanding of biomedical translation. Members of Translation Together are NIH-NCATS (US), EATRIS (EU), CDRD (CA), LifeArc (UK), TIA (AU), and AMED (JA). www.TranslationTogether.org.

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