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## Factors That May Promote an Effective Local Research Environment

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Rapid progress in high-dimensional data generation offers unprecedented opportunities to advance biomedical research and precision health at the same time that regulatory and funding pressures appear to be increasing. In this context, local research environments can play an important role in facilitating investigative success. In this editorial, we note factors that may be helpful in promoting an effective local bench research environment. We note these factors from subjective personal experience as opposed to a systematic comparative study. The co-authors believe, however, that these factors may contribute to a research environment where investigators can effectively pursue research and where trainees can successfully grow toward independence. These factors include (i) a critical mass of investigators as well as trainees, (ii) a research space configuration that promotes interaction, (iii) a focus on technical innovation, (iv) collaboration with colleagues engaged in both fundamental science and patient-centric studies, and (v) a set of investigator research interests and community culture that promotes synergy. We believe that optimization of these factors may facilitate an effective research environment.

The local environment where research is conducted can help produce an effective research community in health-related fields, such as Dermatology. For such clinically connected biomedical fields, such a local research environment is commonly, but not exclusively, embodied organizationally at the level of the department. Additional organizational forms include institutes, multidisciplinary programs, and thematically focused research buildings. However, for the purposes of this discussion, we define the local research environment as the context around physically proximal investigators with a shared research field. Measurable features of success emerging from such an environment may include discovery of new insights and approaches that improve health, publication of high impact scholarship that advances the field, innovation of new biomedical technologies of broad utility to the global community, successful training of new independent principal investigators (PIs),

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sustainability in obtaining peer reviewed funding, and synergy in applying advances from other fields. Sustained achievement of such positive features is designed to catalyze the advances that will ultimately improve human health.

But what are important features of an effective local research environment? Surprisingly, given the importance of this question to progress in biomedicine, this issue has not, to our knowledge, been subjected to a large-scale systematic study. Although numerous publications exist on individual researcher career success, successful grant proposals, and even how to put together large disease-focused multi-institutional networks, factors important to the establishment and maintenance of effective local research communities have received less attention. Over the past decade, the co-authors have developed a shared perspective on this question. This perspective is not based on systematic data collection and analysis and is thus subjective, with the limitations that accompany such an approach. We believe, however, that a successful local bench research community benefits from a critical mass of investigators and trainees, research space that promotes interaction, a focus on technical innovation, collaboration with fundamental scientists as well as patient-centric investigators, interlocking investigator research interests, and a community culture that promotes synergy (Table 1). We acknowledge the substantial limitations of this perspective in that it is both preliminary and subjective, yet offer it in the hope stimulating future systematic studies of this question.

A critical mass of investigators and trainees can be important to research community success for multiple reasons. For example, having a large enough pool of investigators within a local research community can provide the opportunity for intellectual synergy, depth of knowledge, and diversity of perspectives that can be helpful in solving difficult research problems. It can also enlarge the scope of immediately accessible practical technical expertise to effectively address research questions experimentally. It can, moreover, facilitate successfully funded multi-investigator research proposals as well as disease-focused philanthropic support by bringing together a critical mass of different expertise to address specific questions comprehensively. A substantial trainee population may also be very helpful in the rapid flow of information between individual laboratories, leading to their rapid adoption throughout a local research community. Substantial research community size can also help assure that critical technical and theoretical knowledge is not lost to the community with the departure of any single individual or small group of individuals. Critical mass thus can support a sustainably effective local research environment in multiple ways.

Research space configured to promote interaction among PIs, staff, and trainees is another factor that can promote an effective local research environment. Many bench researchers can recall seemingly random encounters in labs, hallways, or other common spaces that led to discussions that ultimately accelerated research progress. A space arrangement such as a large shared lab space, shared hallway or shared common area may lead to frequent daily contact among members of a local research community in a manner that may help facilitate collaborative exchange of ideas. Such productive proximity can facilitate fruitful exchange of ideas and technologies. Such space is also ideal to capture cost reductions associated with adjacent shared equipment, the use of which can itself further promote synergistic interactions. Although the balance between person-to-person contact and focused

experimental execution can differ among fields and institutional cultures, a lack of daily contact within the local research environment can impair the free flow of ideas and synergistic discussions. Research space that encourages frequent contact among all members of the community may therefore help facilitate a successful local research environment.

The capacity to address new questions in biomedicine is often enabled by new technologies, and, thus, a focus on technical innovation within a local research community can also contribute to an effective local research environment. Cross-investigator subgroups of individuals focused on technical innovation in specific areas in a local community of researchers may synergistically develop additional new technologies in these areas. Such collaborative innovation can yield particularly valuable fruits when the resulting methodologies are quickly applied to questions of interest by immediately proximal laboratory neighbors, who have themselves seen firsthand the advantages and limitations of the new technology as it has been developed. In this context, investigators trying to address a specific research question may find themselves equipped with a powerful new locally developed and validated technology that enhances their progress before that technology's more general acceptance and adoption by the global research community. A culture of technical innovation within a local research environment can thus accelerate progress by the community members involved.

Active collaboration across the spectrum of biomedical research, from fundamental scientists to patient-centered clinical investigators, can contribute to a successful local research environment, especially with respect to bringing fundamental scientific advances closer to human clinical application. In this regard, research communities organized around a specific clinical field or disease, such as Dermatology or Oncology, are positioned to recognize and apply fundamental new approaches to clinically relevant problems. For example, strong collaborations with computational biologists innovating new algorithms toward big data analysis may help unlock information of clinical relevance to precision health applications. Collaborations with patient-centric investigators can likewise be synergistic, as seen, for example, in the new clinical trials emerging from laboratory-based insights into the pathogenesis of specific skin cancers. Meaningful collaborations across the full spectrum of biomedical research are thus of potentially strong utility in creating and maintaining an effective local research environment.

Interlocking investigator research interests combined with a community culture that promotes synergy, as opposed to direct competition, are additional factors that can help facilitate local research environment success. Interlocking research interests among local investigators can enhance engagement and interest among investigators in each other's work. For example, PIs focused on different aspects of cancer may be able to both contribute to and benefit from cancer work of common interest being done by adjacent colleagues, often bringing complementary expertise to bear on challenges of interest. A happy medium somewhere between a perfect overlap of community PI interests and a complete unrelatedness of research foci is helpful in this regard, however, to forestall both direct competition and disengagement, respectively. A culture where synergy is expected and potentially destructive competition is unacceptable to all PIs may be particularly important in promoting an atmosphere of trust that enables intellectual sharing and synergy among

members of the local research community. Younger investigators, who may be particularly vulnerable to damage from direct local competition, may benefit most from a culture of generous synergy, although we suggest that such a culture can benefit all who participate in it. Clear PI adherence to norms of synergy, transparency, and local collaboration is particularly helpful in preserving a positively interacting culture in those inevitable situations where experimentalists in different groups arrive at a similar result or develop a similar new methodology that could lead to direct intracommunity competition. Shared general interests and a high-trust culture of synergy are therefore a potentially important component of a successful local research community.

We note here that a critical mass of investigators and trainees, research space configured to promote interaction, a focus on technical innovation, collaboration with fundamental scientists as well as patient-centric investigators, interlocking investigator research interests, and a community culture that promotes synergy may all help foster local research environment health. As noted, these features are identified based on the subjective impressions of the co-authors. It is our hope that this perspective will help stimulate systematic work designed to quantitatively characterize the impact of these features, as well as additional elements, that contribute to an effective local research environment.

**Table 1**

Selected potential factors that may support an effective local research environment

Critical mass of investigators	Research space configuration
Critical mass of trainees	Technical innovation focus
Collaboration with basic scientists	Collaboration with patient-centric researchers
Interlocking investigator interests	Culture of synergy

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