Janelia Farm Research Campus

HHMI
HOWARD HUGHES MEDICAL INSTITUTE

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REPORT ON PROGRAM DEVELOPMENT

NOVEMBER 2003

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PREFACE

The genesis of the Janelia Farm Research Campus occurred in 1999 in a series of informal conversations with David Clayton and Gerry Rubin as we thought about ways to expand the boundaries of biomedical research at the Howard Hughes Medical Institute. The first, rough outline — literally sketched by Clayton on the back of a napkin in a Boulder, Colorado, restaurant — has evolved into a bold vision for a new research community, one that builds on our understanding of what it takes to foster the work of the nation's most creative biomedical scientists.

Our vision of a multidisciplinary, collaborative community of science is made possible by the intellectual and financial independence of the Institute. We will bring together biologists, computer scientists, engineers, physicists and chemists, free them from many of the constraints that dominate more traditional research environments and give them the opportunity to cultivate the new tools of biology. And we hope that this unique community of science will serve as a nexus for the Institute's own investigators, as well as for scientists from around the world.

The Janelia Farm Research Campus has passed many visible milestones during the intervening years. The Trustees of the Institute approved our proposal and the purchase of a stunning piece of property along the Potomac River in Loudoun County, Virginia, in 2000. Through an international architectural competition, we identified a worthy partner in architect Rafael Viñoly, whose vision for the campus buildings matched our scientific dreams. Construction is now underway and we plan to open Janelia Farm in 2006.

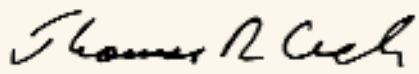
These visible milestones tell only part of the story. Under Gerry Rubin's leadership as vice president and director of Janelia Farm, we have done a great deal of listening, evaluating and synthesizing. We have consulted with HHMI investigators and other scientists from around the world in a variety of disciplines, spoken with the leaders of other research organizations, and sought the wise counsel of our Trustees.

We also looked at successful models for freestanding research communities. We identified Bell Labs in New Jersey and the Medical Research Council Laboratory of Molecular Biology in England as inspiring examples because they share the critical

characteristics of being self-funded, built on small research groups, engendering collaboration and innovation. This report distills the work of the past three years and provides a blueprint for how the new campus will be organized. It also provides the foundation for recruitment and development of the research program.

Robert McGhee, the Institute architect, has been an essential part of our planning for Janelia Farm and a true partner in developing the campus. We knew that we wanted a significant and inspirational work of architecture that embodied the freedom, independence and creativity that is a hallmark of HHMI's science. But we also needed efficient, functional and flexible workspaces that would support our interdisciplinary program. McGhee, who probably knows more about laboratory design than anyone else in the world, gave us the confidence that we could balance these demanding, and seemingly contradictory, objectives. This report also outlines McGhee's thinking about laboratory design and Viñoly's compelling architectural solution.

The scientific focus of Janelia Farm is still under development. But we can be sure that it will evolve as new opportunities emerge. The name itself provides an excellent metaphor for what we are about to undertake. After all, what is a farm? It's a place of fertile soil, where crops are nurtured. A farmer chooses what to plant, and then fertilizes and waters those crops to support a process of continual renewal. We will do something similar at Janelia Farm: We will identify the best scientists and nurture their research in a fertile environment that will help them work at the forefront of their fields. Through a process of renewal – not unlike the planting, growing and harvesting of the farmer's seasonal routine – we will establish a research culture that evolves and refreshes itself as new opportunities arise.



THOMAS R. CECH, PH.D.

JANELIA FARM PROJECT SUMMARY

A NEW CAMPUS

Historically, HHMI investigators have conducted their research in HHMI research laboratories on the campuses of universities and other research organizations throughout the United States. Janelia Farm will be the Institute's first research campus. It will house its own investigators and a permanent research staff of 300, as well as visiting researchers.

A NEW CONCEPT

The Janelia Farm research campus will be a unique center where scientists from around the world can work collaboratively to create and exploit the new tools of biomedical science. Janelia Farm will support and promote collaborative, technology-driven biomedical research.

THE LAND

- 281 wooded acres located between the Potomac River on the north and Virginia Route 7 on the south
- In Loudoun County, Virginia, six miles east of Leesburg
- Approximately eight miles from Dulles International Airport

THE BUILDINGS

- 760,000 gross square feet (approximately 375,000 net square feet)
- Laboratories (including office and support space) – 380,000 gross square feet
- Conference and educational facilities – 30,000 gross square feet
- Transient housing (for visiting scientists and their families) – 140,000 gross square feet
- Support services (food, library, recreation) – 40,000 gross square feet
- Administration – 25,000 gross square feet
- Building services – 40,000 gross square feet
- Parking (underground) – 90,000 gross square feet

- Manor house/carriage house (on National Historic Register) — 15,000 gross square feet

GREEN ARCHITECTURE

The Janelia Farm campus will be designed to integrate buildings and services into the site's natural setting and to conserve resources, a concept known as "green architecture."

GREEN ARCHITECTURE IN THE DESIGN

- Labs and administrative offices will be housed in a distinctive "landscape building" built into and following the curves of the terrain.
- A "roofscape" of grass and other green plants will cover the roofs of most buildings. The roofscape will help retain water, minimizing drainage into storm sewers.
- Parking will be underground to minimize pollution and runoff from paved surfaces.
- Laboratories and housing will be clustered to minimize dependence on vehicles.
- Natural daylight will be used in all primary work and circulation spaces to reduce the demand for electricity.
- Most office spaces will have operable windows and 100 percent fresh air supply.
- The latest energy-efficient building systems will be utilized.

GREEN ARCHITECTURE IN THE CONSTRUCTION PROCESS

- Oak trees cut from the site are being milled into hardwood flooring for the project.
- Smaller hardwood trees and limbs are being chipped and transported to Pennsylvania to fuel a plant that converts waste into energy.
- Stumps and softwoods are being ground into mulch for use in landscaping.
- Rock excavated from the site is being crushed on-site and used for roadbeds and backfill.
- Construction waste will be minimized.

THE TIMELINE

Construction at Janelia Farm began late in 2002. It is scheduled for completion in early 2006.

THE SCIENTIFIC PROGRAM

The focus will be on collaborative and innovative research that calls for the development and interdisciplinary application of cutting-edge technological tools. At Janelia Farm, computer science, chemistry, physics and engineering will join hands with biology and medicine.

HHMI will seek proposals from the scientific community at large as well as Institute investigators. Successful projects will bring together diverse individuals and expertise from a variety of environments. They will demonstrate originality, creativity and a high degree of scientific risk-taking.

THE PEOPLE

- Gerald M. Rubin, HHMI vice president and director, Janelia Farm Research Campus
- Rafael Viñoly Architects PC, New York, New York, architect
- Robert H. McGhee, Institute architect and senior facilities officer
- The Mark Winkler Company, Alexandria, Virginia, owner's representative
- Jacobs Facilities, Inc., project manager
- Turner Construction Company, general contractor

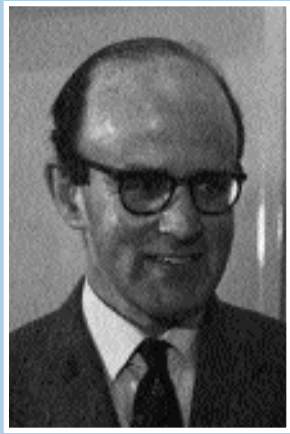
THE COST

- $500 million ($308 – $320 million of site development and construction costs)

OUTREACH

Dissemination of information and technology will be an important feature of Janelia Farm activities. Educational programs will be developed to bring the resources of the research campus to school students and teachers.

"Every now and then I receive visits from earnest men and women armed with questionnaires and tape recorders who want to find out what made the Laboratory of Molecular Biology in Cambridge (where I work) so remarkably creative. They come from the social sciences and seek their Holy Grail in interdisciplinary organization. I feel tempted to draw their attention to 15th-century Florence with a population of less than 50,000, from which emerged Leonardo, Michelangelo, Raphael, Ghiberti, Brunelleschi, Alberti, and other great artists. Had my questioners investigated whether the rulers of Florence had created an interdisciplinary organization of painters, sculptors, architects, and poets to bring to life this flowering of great art? Or had they found out how the 19th-century municipality of Paris had planned Impressionism, so as to produce Renoir, Cézanne, Degas, Monet, Manet, Toulouse-Lautrec, and Seurat? My questions are not as absurd as they seem, because creativity in science, as in the arts, cannot be organized. It arises spontaneously from individual talent. Well-run laboratories can foster it, but hierarchical organization, inflexible, bureaucratic rules, and mounds of futile paperwork can kill it. Discoveries cannot be planned; they pop up, like Puck, in unexpected corners."



— MAX PERUTZ FROM THE PREFACE TO *I Wish I'd Made You Angry Earlier* (COLD SPRING HARBOR PRESS, NY, 2000).

Perutz was the first Director of the Medical Research Council Laboratory of Molecular Biology and served in that capacity for over 20 years. He was an active scientist throughout his life. For example, he gave an excellent seminar about his recent work at one of the HHMI headquarters science meetings in 2000; he was 86 at the time. Perutz shared the 1962 Nobel Prize in Chemistry with his student John Kendrew for their studies of the structure of globular proteins, which established the modern field of structural biology.

OBJECTIVES AND ORGANIZATIONAL PRINCIPLES

Howard Hughes Medical Institute's (HHMI) Janelia Farm Research Campus is a unique, world-class biomedical research complex under construction in Ashburn, Virginia. When completed in early 2006, it will be home to a broad range of scientific programs that will represent the boldest steps yet in HHMI's quest to speed the development and application of new tools for transforming the study of biology and medicine.

The planning and development of Janelia Farm represents a milestone for HMMI as it pursues the long-term objective of offering creative scientists freedom from constraints that limit their ability to do groundbreaking research. The campus and its scientific program will closely complement HHMI's longstanding investigator program. That program currently consists of more than 300 researchers at 70 universities throughout the United States, who have the freedom and flexibility to push the bounds of knowledge in some of the most important areas of biomedical research.

Janelia Farm will be an advanced research center that will serve as an intellectual hub for several hundred scientists from diverse disciplines. They will work together in multidisciplinary teams to solve challenging biological problems that are difficult to address in existing research settings.

The scientific programs at Janelia Farm will be designed to further collaboration and creativity among scientists. Research teams will be kept small and team leaders will be expected to stay actively involved in bench research, not just manage it or guide it. The architectural design of the Janelia Farm buildings and its laboratories will respond to these same objectives, with both work and relaxation areas designed to promote interaction and collegiality – and discourage isolation.

Experience has shown that breakthroughs in computer science, chemistry, physics, and engineering can enable the development of new research tools for studying biology and medicine. But adapting these discoveries for use in biological systems requires state-of-the-art technologies, multidisciplinary expertise, and high-quality research facilities.

"It is a challenge to create a new facility, especially one that is not part of a traditional academic institution, and one that can offer a dynamic and rigorous intellectual setting that will attract quality researchers."

In establishing the Janelia Farm Research Campus, the Institute intends to be at the forefront in catalyzing this important adaptation process by developing a prototypic facility for an integrated, multidisciplinary collaborative research and training program.

Three elements are essential to the success of Janelia Farm:

- Defining its scientific activities and objectives
- Attracting creative and adventuresome scientists
- Establishing a supportive scientific "culture"

It is a challenge to create a new facility, especially one that is not part of a traditional academic institution, and one that can offer a dynamic and rigorous intellectual setting that will attract quality researchers. HHMI is strongly (and perhaps uniquely) positioned to succeed by creating a campus with a distinctive research environment, launching it with a nucleus of distinguished scientists in place, and generating opportunities to respond rapidly and effectively to emerging areas in science. We believe that Janelia Farm will be particularly attractive to scientists now working in for-profit companies who wish to return to a noncommercial or more academic-like environment.

Two primary goals will drive the development of programs at Janelia Farm. The first is to establish a research program that places investigators at the interface between emerging technologies and their application to biomedical problems. Janelia Farm will provide an opportunity for scientists to collaborate on long-term, multidisciplinary research in a facility specifically designed to support this type of activity.

"Currently, there is no well-equipped laboratory facility where a group of scientists, each bringing a few members of their research group, can come to work together for periods ranging from a few weeks to several years."

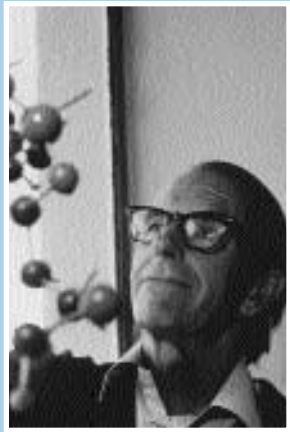
The second goal is to make available project-oriented surge space so that visitors can come together to solve interdisciplinary problems, often making use of new technologies. Currently, there is no well-equipped laboratory facility where a group of scientists, each bringing a few members of their research group, can come to work together for periods ranging from a few weeks to several years. No university or research institution is likely to dedicate the required laboratory space or research support for an activity that does not principally benefit its own faculty or teaching mission.

HHMI, which has investigators in 70 locations within the United States, and international research scholars in 100 locations in various countries abroad, has a need for a site where these researchers and others can come together to work, rather than simply to confer. The advanced technology resources and housing facilities planned for the Janelia Farm campus will make it ideally suited to foster collaborative efforts in cutting-edge, highly interdisciplinary research. This aspect of Janelia Farm is integrally linked to its technology dissemination efforts, which will also include hosting meetings, conferences, or workshops, and providing courses on how to use specific technologies.

"I have indeed actively tried to avoid both teaching and administrative work. This was partly because I thought I would be no good at them, but also out of selfishness. I do not enjoy them, whereas I find research most enjoyable and rewarding.

"Of the three main activities involved in scientific research, thinking, talking and doing, I much prefer the last and am probably best at it. I am all right at thinking, but not much good at the talking.

" 'Doing' for a scientist implies doing experiments, and I managed to work in the laboratory as my main occupation from when I started as a Ph.D. student until I retired. Unlike most of my scientific colleagues, I was not academically brilliant. … However, when it came to research where experiments were of paramount importance and fairly narrow specialization was helpful, I managed to hold my own …"



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— FRED SANGER FROM *Annual Review of Biochemistry* (1988) 57:1–28.

Sanger was the head of the Nucleic Acid and Protein Chemistry Division of the Medical Research Council Laboratory of Molecular Biology for over twenty years. He was awarded the Nobel Prize in Chemistry twice; in 1958 for his work on the structure of proteins and again in 1980 for developing methods to sequence DNA, which made the genome project possible.

SCIENTIFIC CULTURE AND INTELLECTUAL ENVIRONMENT

The planning and development of the Janelia Farm Research Campus offers an opportunity to define and create an environment that will foster basic biomedical research in a manner complementary to and synergistic with HHMI's existing programs and those of our host institutions. Although there are numerous organizational "cultures" in which scientific research is conducted, from our perspective, no single culture has emerged as "the best." Despite their variety, two factors have had the largest influence in shaping the organizational cultures of research laboratories — the conditions attached to the research funding and the career structures available to the participants.

THE CONVENTIONAL MODEL

In the traditional academic and for-profit biotechnology research models in the United States, researchers depend on external funding in ways that compel them to define in advance the goals, methods and likely outcomes of the research project in a detailed grant application or business plan.

While this "funding model" is appropriate for the vast majority of biomedical research, it has two major limitations. First, proposals for higher-risk projects — even those that may have enormous impact if successful — have traditionally fared poorly. This is especially true for non-hypothesis-driven research aimed at developing new research tools. Second, the ability to move quickly to take advantage of unforeseen targets of opportunity is severely constrained.

Freeing creative researchers from these limitations is one of the principal objectives of the current HHMI investigator program, which provides 323 investigators with funding under terms that permit rapid changes in research direction and encourage taking on challenging research problems, even if the chance of short-term success is low.

The career and reward structures in traditional academic institutions and research institutes — where the majority of basic scientific research is carried out — can present additional limitations. The period when a young scientist is both fully independent and directly engaged in the conduct of research — as opposed to directing the work of others — has been greatly shortened, and in some cases, totally eliminated.

The Medical Research Council Laboratory of Molecular Biology

The Medical Research Council Laboratory of Molecular Biology in Cambridge, England was founded in 1947 and was the world's leading molecular biology research center for a thirty-year period between 1950 and 1980. Although the laboratory never had more than a total of 250 scientists and support staff, or more than 30,000 sq. ft. of laboratory space, its scientists were awarded the Nobel Prize on eight separate occasions for discoveries made during this thirty-year period that included determining the structure of DNA, determining the three-dimensional structure of a protein using X-ray crystallography, developing methods for sequencing DNA, the development of monoclonal antibodies, and the establishment of *C. elegans* as a model system and its use to study cell death. The laboratory was also a major international center for training; four current HHMI investigators obtained their Ph.D. degrees at the laboratory and 12 did postdoctoral work there — a far higher number than any other foreign institution.

"Crick shared an office with Sydney Brenner and a blackboard so he could always have somebody to talk to. A lane in front of the blackboard between the window wall and Brenner's desk was kept clear, and there Crick, when thinking aloud, paced up and down."

— HORACE JUDSON, IN *The Eighth Day of Creation*
(COLD SPRING HARBOR PRESS, NY, 1996)

The laboratory building (opened 1962)

The rooftop cafeteria / tea room

Brief historical accounts of the Medical Research Council Laboratory of Molecular Biology can be found at: http://www.nobel.se/medicine/articles/perutz and http://www2.mrc-lmb.cam.ac.uk/origins.html. A more extensive history is contained in the book Designs for Life: Molecular Biology after World War II by Soraya de Chadarevian (Cambridge University Press, 2002).

Photos courtesy of the Medical Research Council Laboratory of Molecular Biology

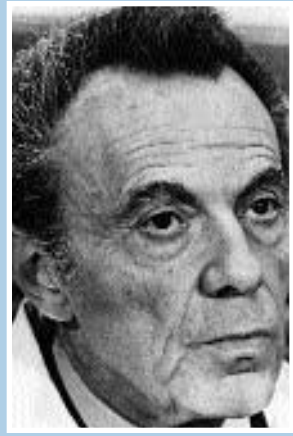
"Although there are numerous organizational 'cultures' in which scientific research is conducted, from our perspective, no single culture has emerged as 'the best.'"

In the typical academic model, an individual completing a Ph.D. thesis undertakes postdoctoral training for three to five years working as an apprentice for an established scientist. When one finally becomes an assistant professor, one must teach, participate on committees, write grant proposals, publish and engage in other activities in pursuit of tenure – all of which detract from the time one can devote to research. In fact, one can only succeed by rapidly assembling a reliable and productive research team of students and postdoctoral fellows.

Academia trains graduate students and postdoctoral fellows to function as scientists but then requires that they function as small businessmen when they become faculty members. Some of the most innovative young scientists fail to make this transition successfully. Others may find these additional required roles so distasteful or unsuitable to their talents that they end up seeking employment elsewhere, and are lost from the basic research enterprise.

Moreover, an assistant professor's freedom to select a research problem is generally limited to problems that can garner external research support. But grant-making agencies are notoriously risk averse, and the work they fund will likely be carried out by postdoctoral fellows and graduate students who are under pressure to obtain publishable results within a short time span. Thus, much emphasis is placed on quantity of output and risk aversion at the expense of originality and potential impact. To put it simply, there is a critical shortage of laboratories where very good young scientists, who generate some of the most original biomedical research, can work full time as research scientists with their own hands without the constraints of teaching, committees, and the need to pursue funding and tenure.

"Day science calls into play arguments that mesh like gears, results that have the force of certainty…. Conscious of its progress, proud of its past, sure of its future, day science advances in light and glory. By contrast, night science wanders blind. It hesitates, stumbles, recoils, sweats, wakes with a start. Doubting everything, it is forever trying to find itself, question itself, pull itself back together. Night science is a sort of workshop of the possible where what will become the building material of science is worked out."



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— François Jacob in *Of Flies, Mice and Men*
(harvard university press, cambridge, 1998)

Jacob shared the 1965 Nobel Prize in Physiology or Medicine for discoveries concerning genetic control of enzyme and viral synthesis. He spent his scientific career at the Pasteur Institute in Paris.

A related problem is that the academic culture and reward systems actively discourage collaboration among research scientists. When scientists collaborate, their unique contributions are often not apparent. This creates a situation that can adversely affect "performance reviews" and, consequently, career advancement. This problem is magnified in the case of interdisciplinary research where the research advance itself may not be seen as being at the forefront of the individual disciplines. These limitations discourage interdisciplinary research. For example, the development of the field of bio-informatics was greatly delayed because it was seen as neither high-quality, original biology nor computer science research.

Janelia Farm will address these issues, utilizing at least three of HHMI's strengths:

- The ability to move quickly and flexibly without academic bureaucracy or strict adherence to academic career structures.
- Substantial financial resources, which eliminate the restrictions imposed by the need to appeal to a grant review panel or to generate a profit.
- The intellectual resources inherent in our 323 investigators, as well as our international research scholars, who are some of the most innovative biomedical researchers in the world.

We will use these resources to support interdisciplinary, collegial research that fills specific scientific needs not easily met by the 70 institutions that currently host our investigators. We do not anticipate that the cultures at the leading research universities and research institutes that make up our host institution population will change in the near future. Nor do we expect major changes in the mechanisms by which funding is distributed by the federal government or other agencies.

It is not our intention to have Janelia Farm serve as a model to drive changes in these institutions — or in the for-profit sector — which are highly successful and appropriately structured to conduct the majority of biomedical research and training of young scientists. Rather, we intend Janelia Farm to provide a unique, complementary environment to pursue activities and support careers not well served by those institutions and funding mechanisms.

Bell Labs

AT&T's Bell Laboratories (now known as Lucent Technologies' Bell Labs), founded in the 1920s, is generally regarded as having been the most successful industrial research laboratory; many important advances in solid state physics and electronics were made there, including the development of the transistor and the laser.

"Here the idea is that distances are so constricted that you can, if you have an idea, rush over to someone who is an expert on, say, stochastic processes or invented I don't know what electronic device, and consult him. It's so nearby that it takes you less time to go over and see him than to suppress the idea. In a university you would say to yourself, 'Shall I take my raincoat?' and by the time you make up your mind it's just as easy to suppress the idea. Also here, when you come over to the guy's office, he is pleased to see you. He regards helping you as part of his job and will even wipe off the blackboard for you."

— BELA JULESZ, AS QUOTED IN *Three Degrees Above Zero* (CHARLES SCRIBNER'S SONS, NY, 1984) BY JEREMY BERNSTEIN, P. 47.

"The major developments are unexpected. If you really knew what you were trying to do, that would often be the biggest part of the battle. There does not seem to be any obvious way of knowing how some development here will impact on something over there. You just hope you have good people who are excited and that they can communicate."

— RONALD GRAHAM, AS QUOTED IN *Three Degrees Above Zero* BY JEREMY BERNSTEIN, P. 27.

Photo courtesy of Lucent Technologies' Bell Labs

View of Bell Labs at Lucent Technologies world headquarters in Murray Hill, NJ.

Constructed in 1941, Murray Hill looks much the same today and is essentially one large building housing some 4,000 people.

"Academia trains graduate students and postdoctoral fellows to function as scientists but then requires that they function as small businessmen when they become faculty members."

ALTERNATIVE ROLE MODELS

In planning Janelia Farm, HHMI carefully studied the organization, management and scientific culture of other important research models at both academic and for-profit laboratories, including the Medical Research Council Laboratory of Molecular Biology (MRC LMB) in Cambridge, England, Cold Spring Harbor Laboratory, the European Molecular Biology Laboratory and Carnegie Institution of Washington's Department of Embryology and AT&T's Bell Laboratories in Murray Hill, NJ.

Although very different from the way research is carried out in any of our host institutions — or indeed, any current major biomedical research laboratory — the type of alternative research organization that we are contemplating for Janelia Farm has been successfully implemented, most notably at the MRC LMB and Bell Labs.

The MRC LMB and Bell Labs are generally considered to have been the most successful research institutions in biology and electronics, respectively, and although neither currently exists in its original form, they have served as useful models for Janelia Farm. Despite the fact that one of these institutions was a small public-sector biological research laboratory and the other a large private-sector electronics enterprise, they shared a surprisingly wide range of operating principles:

- **Individual research groups were small.** Individual groups at the MRC LMB consisted of a group leader and two to six other scientists. At Bell Labs, group size was even smaller — a group leader and one or two others. Small group size was considered essential to promote collaboration and communication between groups, as well as good mentoring. Larger projects were often conducted by assemblies of smaller groups. In contrast, the average HHMI investigator has a group size of about 15.

"The significant point is that the MRC was prepared to finance long-term work. It took Perutz twenty-three years…to solve the structure of haemoglobin, and many chemists and biologists thought he was wasting his time. It wasn't certain, when he began, that proteins even had a stable structure…It wasn't regarded as foolhardy to take on projects when you couldn't necessarily see how you were going to carry them out, as long as they were important enough. You didn't — and still don't — have to justify everything in advance; you were just given the time, and a limited amount of space and resources, to get on with it…

"It was an environment that suited me perfectly. I don't think I would have survived a conventional academic career, juggling teaching, research and administration in a university. I was incredibly lucky to end up where I did…"

Photo courtesy of The Wellcome Trust

— JOHN SULSTON IN *The Common Thread*
(BANTAM PRESS, LONDON, 2002).

Sulston shared the 2002 Nobel Prize in Physiology or Medicine with Sydney Brenner and H. Robert Horvitz for their discoveries concerning genetic regulation of organ development and programmed cell death. At the time he did his Nobel Prize winning experiments he had never had a research group larger than two individuals plus himself. He later went on to be the first director of the Sanger Centre, The Wellcome Trust's genome campus located outside Cambridge, England.

- **Group leaders were active bench scientists.** Group leaders at the MRC LMB and Bell Labs were active bench scientists who carried out experimental work with their own hands. This was true even for Nobel Prize winners and department chairs. In contrast, it is rare for a tenured faculty member in one of HHMI's host institutions to spend significant time working at the bench. At many of our host institutions, assistant professors are often advised by their senior colleagues that it is counterproductive for them to work at the bench.
- **Research was internally funded.** All research funding at the MRC LMB and Bell Labs was provided from internal sources at a dependable and generous level. Outside grant applications were not permitted, nor was there any obvious pressure for the work to be of immediate medical relevance or commercial value.
- **Excellent support facilities and infrastructure were provided**. At both the MRC LMB and Bell Labs, there was core support for routine functions, such as glassware washing, media preparation and central stores, as well as for sophisticated functions such as instrumentation design and fabrication. This enabled individuals and small groups to function effectively and to focus on creative activities.
- **Staff turnover was high and tenure limited.** At Bell Labs, there was no tenure. Department heads met once a year to determine the weakest 10 percent among the group leaders and these people were encouraged to leave. It was assumed that even the highly successful scientists would move on to university positions after about 10 years. The average age of a group leader at Bell Labs was 37 in 1968 and 36.5 in 1988.

  At the MRC LMB, tenure was initially limited. In 1972, for example, fewer than 25 percent of the group leaders were tenured. Most scientific staff moved on to university positions after five to 10 years. Thus, most scientists were at an "early career stage." (In 1974, the British government required that 80 percent of those hired as group leaders be given tenure within five years, and this requirement may have been one cause of the MRC LMB's relative decline).
- **Originality, creativity and collegiality were valued and supported.** The MRC LMB and Bell Labs emphasized tackling difficult and important

> research problems, as opposed to more typical criteria such as publication number, service on editorial boards, speaking invitations, etc. Management of both institutions felt it was their responsibility to be familiar enough with the work of their scientists to be able to evaluate their potential, as well as their accomplishments. They were patient with those who were considered to be very good, but who had not yet achieved external recognition.

It is important to state explicitly that no institutions in operation today fully fit the description above. The funding mechanism that supported Bell Labs was destroyed by the breakup of the AT&T monopoly and the MRC LMB suffered from the imposition of tenure by the British civil service as well as competition for key talent from the Wellcome Trust's research laboratories. Only a private organization with a large endowment, such as HHMI, could support such an enterprise today. This offers the Institute the opportunity to create a truly unique research facility.

We did, however, identify and examine several relevant current institutions. Below we briefly summarize some noteworthy features of the European Molecular Biology Laboratory, Carnegie Institution of Washington's Department of Embryology, and Cold Spring Harbor Laboratory.

European Molecular Biology Laboratory (EMBL) — The European Molecular Biology Laboratory (EMBL) was established in 1974 and is supported by 16 countries including nearly all of Western Europe and Israel. It has about 700 employees and is located about 20 minutes outside Heidelberg, Germany, on top of a hill in a state park surrounded by residential neighborhoods. The nearest stores and restaurants are located about a mile away. In this sense, the environment is "isolated" in a manner similar to Janelia Farm. The EMBL is generally considered one of the best research laboratories in Europe and arguably runs the most competitive graduate program in the fields of molecular and cell biology and computational biology in Europe, with a total of about 200 Ph.D. students.

At the EMBL, group leaders have an initial five-year term, which is almost always renewed for a terminal four-year term, but there is no tenure. About 15 percent of the group leaders are given "indefinite" appointments that can be terminated by the director with two years notice. These appointments are only given to individuals who take on administrative duties (program coordinators, head of graduate program, etc.). It is believed that requiring nearly all group leaders to turn over with

"There is a critical shortage of laboratories where very good young scientists can work full time as research scientists without the constraints of teaching, committees, and the need to pursue funding and tenure."

the same term, regardless of the perception of their scientific merit, reduces internal competition and increases cooperation between groups.

Group leaders generally receive funding for four or five technicians or postdoctoral associates. They are also allowed to add one new Ph.D., student per year and almost all do. They can accept externally funded postdoctoral fellows and apply for external grants, although their opportunities are limited since they are often ineligible for host country grant programs. They can have as many people in their group as they are willing to fit into their space. Average group size for mature groups is about ten. There is also a "team leader" position, a three-year appointment used mainly as a way of extending time for productive postdoctoral fellows. There is a range of opinions among those at the EMBL about the wisdom of allowing outside funding.

Carnegie Institution of Washington, Department of Embryology – Founded in 1913, this research laboratory has a longstanding association with the Johns Hopkins University and is located on its Homewood campus in Baltimore. The department consists of eight staff members, five staff associates, 30 postdoctoral fellows, 15 graduate students and approximately 40 support staff (technicians, lab aides, maintenance personnel, and administrative staff). Its scientists employ molecular and genetic approaches to study basic problems in cell and developmental biology.

Carnegie is notable as a first-class U.S. research institute (three of its eight group leaders are HHMI investigators) that does not grant tenure. Staff members have five-year appointments that are renewable at the discretion of the director. Group size – whether for a newly appointed group leader or the director – is limited to eight additional individuals. Staff members all hold adjunct faculty appointments at Hopkins. The staff associates have a similar arrangement to what we propose for

Janelia Farm fellows – a five-year appointment and a group size of three. There is excellent support for research infrastructure and all large equipment is shared. The department holds weekly research colloquia in which its scientists present their work internally. The result is a highly interactive and unusually collegial environment. Two-thirds of the funding comes from outside sources (HHMI and federal grants).

Cold Spring Harbor Laboratories (CSHL) — CSHL is a research and educational institution that was founded at the turn of the century and now has 47 research faculty members. It has research programs focusing on cancer, neurobiology, plant genetics, genomics and bioinformatics, and a broad educational mission, including a recently established doctoral program, the Watson School of Biological Sciences. CSHL is located on Long Island about an hour outside New York City. CSHL does not offer tenure, but allows the most successful scientists to be promoted to a full professor position. These professors are given rolling five-year appointments – that is, they can be given a five-year terminal appointment at any time at the discretion of the director. Group size varies from two to 20. About 80 percent of funding comes from external sources.

In addition to providing an example of a physically isolated, free-standing research institution that has been scientifically successful without granting tenure, CSHL provides a useful role model of how to overcome physical and intellectual isolation, as well as provide a service to the scientific community, by means of an extensive program of scientific conferences and training courses. About 25 advanced courses (two to three weeks in length) and 20 scientific conferences (three to six days in length) are held on campus each year, bringing 7,000 visitors to the laboratory.

SCIENTIFIC STAFF

TARGETS OF RECRUITMENT

We intend to attract early-career-stage investigators who enjoy engaging in research themselves and working closely with others. The environment at Janelia Farm will minimize the distractions of grant writing, teaching, committee work and academic politics while providing support services such as child and infant care, of particular importance for this age group.

We will also recruit a small group of senior research scientists who will both help create and profit from this collegial, interdisciplinary environment and who are skilled at, and derive great satisfaction from, mentoring junior scientists. These people may come from academia or from industry, but will be eager to regain the freedom to pursue research without the "interruptions" inherent in the pursuit of grants, administrative responsibilities, profits, etc.

Janelia Farm can also have an impact on increasing the participation rate of women in the highest-level biological research. Unlike the case of underrepresented minorities, the pipeline of talented young female biologists is full. In fact, there has been a steady increase in the percentage of Ph.D. degrees in the biological sciences that are awarded to women – from 19 percent in 1975 to 42 percent in 2001.

Yet problems still remain, as evidenced by the fact that fewer than 20 percent of full professors at research universities are women. It is widely agreed that the major factor in the declining participation of women is the conflict between the demands of an academic career in science and the demands of assuming primary childcare responsibilities. Twenty-one percent of women scientists and engineers identified balancing family and work as a career obstacle as compared to only 2.8 percent of men. Increasing demands that are not directly related to research makes it difficult to conduct a successful research career without working extremely long hours. Also, the increasingly long graduate and postgraduate training period is usually coincident with peak childbearing age.

Janelia Farm is well positioned to provide a more supportive environment for women scientists by a) eliminating nearly all professional obligations not directly related to research, thereby enhancing the ability to carry out high-level research while participating actively in family life; b) providing high-quality on-site infant

and child care; c) rewarding quality rather than quantity when judging research productivity; d) placing an emphasis on good mentoring; and e) hiring women in senior positions who will serve as role models.

Janelia Farm will also strive to recruit underrepresented minorities, but here we will face the problem that the number of qualified applicants for the group leader and fellow positions is limited. Nevertheless, we feel the supportive mentoring environment that Janelia Farm will provide will be particularly attractive to such individuals.

TYPES OF SCIENTIFIC STAFF

Researchers at Janelia Farm will fall into two main groups. The first group is resident scientists, for whom Janelia Farm is their home institution. These individuals will all be HHMI employees. The second group is visiting scientists whose primary appointment is elsewhere, but who will work at Janelia Farm for various periods. Some of these visitors will be HHMI employees based at other field sites, but others will have had no prior affiliation with HHMI.

TYPES OF RESIDENT STAFF

We anticipate employing two types of resident investigators at Janelia Farm—group leaders and fellows. With their research groups, they will number about 180. In addition, we anticipate an additional 80 individuals whose role will be to provide core scientific support to all resident and visiting researchers. All of the scientists we select as group leaders or fellows will engage in "hands-on" research. In addition, we expect the relative freedom from other responsibilities will allow them to participate in structured and unstructured collegial interchange at a much higher level than is typical in academic environments, perhaps devoting as much as 20 percent of their time to such activities.

DIRECTOR

The Director of Janelia Farm, in addition to his administrative and institutional leadership responsibilities, will serve as the leader of a research group and will participate actively in the scientific life of the campus.

GROUP LEADERS

Group leaders will each have groups of between two and six lab members. We believe this small group size will allow group leaders to continue to do their own experi-

mental work and encourage collaboration between groups. We also believe that the extensive core support provided at Janelia Farm will allow such small groups to function effectively. We anticipate reaching a steady-state population of 24 group leaders after Janelia Farm has been operational for three or four years. Thus, group leaders and their groups will comprise a total of about 120 scientists.

Although individual group leaders will range in career stage from those who have just completed their postdoctoral training to the Director of Janelia Farm, we have chosen not to distinguish them by rank. Likewise, they will receive resources to support their research based on need rather than career stage.

The first scientific recruits will be four to six established scientists. These scientists will likely choose Janelia Farm because they are "returning to their roots"; that is, returning to the joy of engaging in actual research. They must also be willing and effective mentors. They will be expected to help define and anchor the initial areas of research to be undertaken at Janelia Farm, and to participate actively in the recruitment and then the mentoring of the remaining group leaders and fellows.

APPOINTMENT & REVIEW

The initial appointment of group leaders will be for six years. Annual performance reviews will be carried out by Janelia Farm management, focusing on a group leader's ability to function effectively in the Janelia Farm environment. A comprehensive review of scientific accomplishments and other contributions to the Janelia Farm research enterprise will be carried out after this initial six-year period. There are three potential outcomes from this review and we anticipate that they will occur in about equal proportions:

- A five-year reappointment with an invitation to remain at Janelia Farm.
- A five-year appointment with a requirement to transfer within two years to an acceptable host institution and enter the host-institution-based investigator population. This will result in a modest contribution to the investigator pool at the host institutions. However, no such additions will occur until after 2012, and then the expected level will be one per year, or about 10 percent of anticipated new investigator appointments.

- A two-year transitional appointment. Unlike investigators currently at host institutions, group leaders at Janelia Farm will be able to transfer their appointments during this transitional period if they accept a position at an acceptable academic research institution. Since the new institution may not be one of our current host institutions, we may choose to provide support for the group leader during this phase-out period through a grant or restricted gift to the new institution.

Scientific reviews will be carried out by a panel comprised of members of the HHMI's medical advisory board (MAB) and scientific review boards (SRBs), with the final renewal decision resting with the President of HHMI, as is currently the case for all HHMI investigators. Likewise, we envision the format of the review to be the same as that for HHMI investigators based at host institutions. However, the review criteria will reflect the different expectations we have for Janelia Farm scientists. Indeed, a significant factor in the decision to renew the appointments of individuals at this level will be their contributions to the collegial environment.

It is highly likely that one or more of the initial group leaders will be current HMMI investigators. It is in the Institute's interest to encourage a small number of our successful investigators with appropriate research programs and personalities to help establish the research program at Janelia Farm. Given that Janelia Farm will not have tenured appointments and these individuals are likely to be giving up a tenured faculty position, "transfer" to Janelia Farm will not require them to give up their one-time right of transfer. Moreover, we propose promising such investigators a fresh five-year term at a host institution should they wish to transfer from Janelia Farm during their first six-year term.

FELLOWS

The approximately 20 fellows will be of three types. The first group will spend the years immediately after earning their doctoral degree at Janelia Farm as an alternative to a more standard postdoctoral apprenticeship. In general, these fellows will have completed no more than two years of postdoctoral work at the time they begin working at Janelia Farm.

The second group will be fellows who have had more research experience, but who might come to Janelia Farm for a few years to change research direction—for exam-

ple, an individual leaving the biotechnology industry or one wanting to switch from pure computer sciences to computational biology.

The third group of fellows will be accomplished scientists who, after a successful career in academia or industry, wish to return to an environment highly focused on the actual conduct of research rather than assume administrative and other responsibilities that are typically expected of such individuals.

Fellows will be "independent" (that is, not formally associated with a group leader) and free to form collaborations or associations as they see fit. Each fellow will be provided with laboratory space and funding for up to two additional lab members; we anticipate that these will most likely be technicians. We also anticipate that from time to time we may get applications from two or more individuals who wish to co-apply so they might work together. Fellows will receive five-year appointments, with the general expectation that they will obtain positions elsewhere after their term at Janelia Farm. They will, however, not be excluded from competing for group leader positions. Fellows and their groups will comprise about 60 individuals.

GRADUATE STUDENTS

We believe that both postdoctoral trainees and graduate students would benefit greatly from the unique research environment at Janelia Farm. In addition, the presence of individuals at these early career stages will greatly facilitate establishing the desired research environment and scientific culture. We anticipate that at steady state we would have approximately 50 postdoctoral trainees and 20 predoctoral students on the campus at any time. These are included in the group sizes mentioned above.

Accommodating postdoctoral trainees poses no significant administrative difficulties and provides an opportunity to bring to Janelia Farm individuals with training in computer science, engineering, and chemistry who are interested in engaging in interdisciplinary research aimed at problems in biological research.

Accommodating graduate students is a more complex problem, primarily because graduate students require an affiliation with a degree-granting institution. We have examined several mechanisms for accommodating and supporting graduate students in Janelia Farm laboratories. Accreditation requirements, and the difficulty of providing the diverse curriculum that our interdisciplinary research program

requires, argue strongly against creating and maintaining an independent degree-granting program at Janelia Farm. Instead we are exploring a number of ways by which graduate students might carry out their course work at, and obtain their degree from, another institution while conducting all, or a significant part, of their dissertation research at Janelia Farm.

CORE SUPPORT

The research activities of resident and visiting scientists will be facilitated by a number of core support facilities with a total staff of about 80. These facilities — such as vivarium, DNA sequencing, instrument design and fabrication, information sciences, mass spectrometry, tissue culture, glassware washing, media preparation, central stores, and equipment maintenance — provide the infrastructure that is necessary for a small group to pursue research activities efficiently.

TYPES OF VISITORS

Visiting scientists will have their primary appointment at another institution (or company). We anticipate that typically about 100 visiting scientists will be on site. These will be of three classes: a) current HHMI investigators; b) short-term visitors collaborating with resident staff or utilizing atypical research facilities; and c) project teams. A selection committee, chaired by the Director and having members from the resident investigator population and the advisory committee, will choose the visitors from among applicants. For project team applications, the evaluation process will include scientific evaluations from outside experts, chosen from the SRB and MAB whenever possible.

VISITING INVESTIGATORS

Visiting investigators are current HHMI investigators who wish to carry out a portion of their work at Janelia Farm. They would base part of their HHMI-funded activities at Janelia Farm and spend a corresponding fraction of their own time (10-25 percent) in residence. We would expect such arrangements to be established for periods of between one and five years. Investigators wishing to avail themselves of this opportunity would submit a request and the precise arrangements would be individually negotiated with the Director of Janelia Farm and the Institute's Chief Scientific Officer. We expect these investigators to enrich the intellectual life at Janelia and provide an additional source of mentors.

"Small group size will allow group leaders to continue to do their own experimental work and encourage collaboration between groups."

SHORT-TERM VISITORS

Short-term visitors are individuals or small groups who would come to Janelia Farm for periods of one week to one year, motivated by a desire to collaborate with a resident scientist or to avail themselves of unique research resources present at Janelia Farm. In addition to visitors who apply to come to Janelia Farm, resident group leaders would be encouraged to nominate visitors whom they would like to host.

PROJECT TEAMS

Project teams are groups of two or more external scientists, who may or may not be HHMI investigators, who apply to come to Janelia Farm to carry out a collaborative project. The project may or may not involve collaboration with a resident group leader. These project teams will be expected to be present from one month to several years and have group sizes of between four and 20 individuals.

SHOULD WE PERMIT OUTSIDE GRANT SUPPORT?

Our view is that having HHMI provide all, or nearly all, funding for activities at Janelia Farm is absolutely essential for creating the interactive, interdisciplinary and collaborative research environment we envision. Only in this way can HHMI provide scientists with the freedom from distractions that will allow them to participate directly in experimental work and the freedom to tackle important problems that might be too high risk – or poorly defined – for a typical grant application. For these reasons, we strongly prefer that HHMI self-fund all ongoing research activities at Janelia Farm and neither seek nor accept outside grant funding. Because Janelia Farm researchers have small groups, their work can be supported for the same amount per investigator as we provide our host-institution based investigators; these investigators generally have much larger groups, which are co-supported by federal grant funds.

In recognition of the need to maintain flexibility, we examined this issue and asked if there might be cases in which outside grant funding could be accepted without having a negative and self-defeating effect on the scientific culture of Janelia Farm. While we feel strongly that scientists at Janelia Farm should be provided with a budget sufficient enough that they would not need to obtain outside funding, there may be cases in which it would be beneficial to apply Janelia Farm's capabilities to important, but more defined, projects for which outside funding is appropriate. For example, if the campus had existed ten years ago its capabilities might well have been ideal for the human genome project. There would be little downside to accepting grant funds for a large-scale production effort of this type, which could have been advanced by HHMI-funded research and development activities.

CONFERENCE PROGRAM

The conference program at Janelia Farm will aim to establish regular scientific conferences at the highest level of excellence. These will include the ongoing science meetings of HHMI investigators, seven of which are currently held each year at HHMI headquarters. However, we will also hold specialized meetings and workshops in research areas of interest to the researchers at Janelia Farm.

While there are already large numbers of scientific conferences held each year, there is a need for intermediate-size conferences with 100 to 120 participants. Meetings of this size are not economically viable for other organizations that seek to make a profit from their conference programs.

The conference program is a key adjunct to the research program. The program will serve three main purposes:

- Enrich the intellectual atmosphere at Janelia Farm
- Advertise the unique features of Janelia Farm to hundreds of scientists who attend these conferences each year, including many of the brightest students and postdoctoral trainees
- Provide a service to the scientific community

SYNERGY WITH HHMI'S EXISTING SCIENCE AND GRANTS PROGRAMS

We anticipate that Janelia Farm will have mutually beneficial interactions with the ongoing activities of the science and grants departments at HHMI. Janelia Farm will be particularly dependent in its initial years on the intellectual resources provided by the Institute's investigators and international research scholars as it seeks to establish itself as a vibrant research facility.

SCIENCE

The activities at Janelia Farm will directly support and interact with the work of the host-institution-based investigators in a number of ways:

- Janelia Farm will house scientific instruments (for example, electron microscopes) and other experimental resources (for example, computational resources, instrument design and fabrication shops, specialized computer software and expertise) that will be of use to our investigators and that are not available at many of our host institutions. These can be made available in a manner analogous to the HHMI-supported beam lines at national laboratories that are used by our structural biologists. The availability of short-term housing for visitors will make it convenient for investigators and their lab members to use these facilities. We anticipate that HHMI investigators and their lab members will be a major source of short-term visitors to Janelia Farm.
- HHMI investigators may wish to become visiting investigators at Janelia Farm. They would base part of their HHMI-funded activities at Janelia Farm and spend a corresponding fraction of their own time (10–25 percent) in residence.
- HHMI investigators may wish to be the organizers of, or participants in, project teams.
- HHMI investigators and their lab members will be frequent attendees at Janelia Farm conferences, workshops and training courses.

- HHMI investigators with relevant research programs will be encouraged to take sabbaticals at Janelia Farm.
- HHMI investigators might prefer the unique research environment afforded by Janelia Farm and request to transfer their laboratories there.

GRANTS

The Grants activities of the Institute will also benefit from several areas of interaction with Janelia Farm:

- International research scholars might particularly benefit from becoming visitors to Janelia Farm, given the limited availability of specialized research facilities in their home countries.
- International research scholars will be able to identify, nominate and help mentor promising students from their home countries who wish to carry out their graduate research in a Janelia Farm laboratory.
- The conference facilities and ability to house sabbatical visitors provide an opportunity to organize novel approaches to curriculum development and teacher training, perhaps involving the HHMI professors.
- The laboratory facilities at Janelia Farm will provide an opportunity for development and testing of new educational materials involving wet bench work.
- Janelia Farm offers a base from which the Institute can interact with a local school system to evaluate, further develop and apply innovations developed through its current funding mechanisms.
- Janelia Farm will offer a research site for participants in the Institute's new Exceptional Research Opportunities Program (EXROP), which aims to provide a strong summer research experience for talented students from underrepresented groups.

THE PROCESS FOR SELECTING RESEARCH AREAS

We have yet to define the precise research areas or scientific problems to be addressed at Janelia Farm. We expect that these will change over time but that they will always focus on areas at the forefront of technological innovation that will benefit from the unique collaborative and interdisciplinary culture we establish at Janelia Farm. Indeed, Janelia Farm's "uniqueness" will derive more from the manner in which we tackle problems than from identifying research problems that have not yet been recognized as being important or interesting by others.

Establishing the initial research areas for Janelia Farm will, of necessity, need to occur concurrently with the recruitment of the senior scientific staff. We expect Janelia Farm to have a strong focus on developing new tools – experimental methods, computer software, and scientific instruments – needed to advance research capabilities.

We aim to identify important biomedical problems for which future progress requires technological innovation and then foster the establishment of integrated teams of biologists and tool-builders who seek to break through existing barriers. The scientific problems we choose to pursue will drive the choices of tools we seek to develop; the software and instrument development activities will work in concert with, and support, the ongoing experimental work of the resident staff and visitors.

How will we narrow our focus to the three to five areas we will initially pursue? We have begun to organize a series of workshops with leaders in several fields of interest, particularly in areas where our expertise at HHMI headquarters is limited. The existing HHMI investigators are a rich intellectual resource, and they will be involved heavily in planning and participating in these workshops.

We have scheduled five workshops that will take place in the first half of 2004, each with 25-35 participants. Two of the workshops are being jointly organized with the Max Planck Society:

- "Perception and behavior" will be held on January 20–23, 2004, organized by HHMI investigators Cori Bargmann and Richard Axel. This workshop will consider aspects of neuroscience research that might particularly benefit from Janelia Farm's emphasis on imaging and computation.
- "Biochemistry of single cells" will be held on March 28–31, 2004, organized by HHMI investigators Robert Tjian and Gerald Crabtree. This workshop will consider approaches to developing the sensitive methods required to study biochemical reactions and processes in single cells.
- "Membranes, membrane proteins, and membrane associated molecular machines," May 4–7, 2004, will be organized by HHMI investigators Rod MacKinnon, Eric Gouaux and Tom Rapoport. This workshop will consider approaches to overcoming the unique challenges limiting experimental study of cellular processes that occur at or within membranes.
- "Functional imaging in living systems" will be held at HHMI headquarters on June 13-16, organized by HHMI investigators Roger Tsien and Eric Kandel and Max Planck institute directors Winfried Denk and Nikos Logothetis. This workshop will consider emerging methods for monitoring gene activity, protein modification and subcellular localization, ion fluxes and other metabolic activity in living cells (in culture and in intact organisms).
- "Imaging cellular structures" will be held in Germany on July 12–14, 2004, organized by HHMI investigators David Agard and Eva Nogales and Max Planck Institute directors Wolfgang Baumeister and Stephan Hell. This workshop will consider emerging methods in light and electron microscopy for determining the structure of cellular components ranging in size from protein complexes to cellular organelles. (Note: Rescheduled from March 4-7, 2004)

“Creativity in science, as in the arts, cannot be organized. It arises spontaneously from individual talent. Well-run laboratories can foster it, but hierarchical organization, inflexible, bureaucratic rules, and mounds of futile paperwork can kill it. Discoveries cannot be planned; they pop up, like Puck, in unexpected corners.”

— MAX PERUTZ

CAMPUS DESIGN

The Janelia Farm complex – which includes a "landscape" laboratory building, conference facilities and transient housing for visiting scientists – will blend into the natural surroundings of the site and feature highly flexible laboratory space that can be adapted easily to meet changing research needs. All aspects of the research center – the programs, the people, the design of the buildings and infrastructure – are planned to stimulate the multidisciplinary, team-driven research needed to advance biomedical science.

The design of the Janelia Farm Research Campus proposed by internationally renowned architect Rafael Viñoly makes the most of an environmentally sensitive and historically significant site. Viñoly's team worked closely with Gerald Rubin, Robert McGhee and other members of the HHMI planning team to refine and implement the campus design. It is worth noting that this project is somewhat unique in that the planning for both the scientific program and the campus facilities has been intertwined, with each part overlapping and influencing the other.

Viñoly's firm was selected from a slate of distinguished architects participating in an architectural charette at HHMI headquarters in late 2001. The charette involved a series of collaborative meetings between the architects and HHMI planning groups where participants shared and discussed ideas about the project. The charette followed an initial planning phase that was led by the Institute's Janelia Farm Strategic Planning Committee, which in turn relied on the advice of Institute Medical Advisory Board members, HHMI investigators, and other renowned scientists and science administrators.

As a result of this process, the architectural designs of the buildings and the laboratories are aimed at achieving Janelia Farm's central objectives – collaboration and flexibility. The design is guided by four principles that McGhee has gleaned from his considerable experience in creating successful work environments for scientists:

- Understand the researchers' needs versus their preferences
- Focus the planning effort on what will or could happen versus what is happening today
- Keep work spaces standardized and rational
- Make the work spaces adaptable over time to accommodate changes in research

Viñoly's vision for the site includes a landscape building that emerges gracefully from the sloping hillside. The main building will be a low-rise, terraced structure that conforms to the topography of the surrounding landscape and preserves views of the nearby countryside. The building's design maximizes interaction between scientists, a key aspect of HHMI's design philosophy, which has been honed by years of developing laboratories at many major research institutions.

Regional map showing the location of Janelia Farm in relation to HHMI headquarters in Chevy Chase, MD., Dulles International Airport and Washington, D.C.

SITE SELECTION AND CAMPUS BUILDING REQUIREMENTS

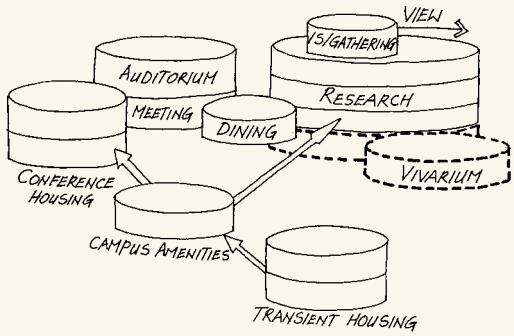
SITE SELECTION

In early 2000, HHMI began the search for a research campus site, guided by a preliminary definition of the program objectives. The search criteria included a minimum site size of 90 acres; proximity to a major airport; a 45-minute maximum drive to the Institute's headquarters in Chevy Chase, Maryland; the availability of reliable utility services; and zoning which would allow a research campus.

The criteria also took into consideration the availability of affordable housing, quality schools and a wide range of residentially related services. Additionally, the site needed to have aesthetics that would be consistent with a high quality development. After exploring all available sites that met these criteria, HHMI selected the Janelia Farm site in Ashburn, Virginia in the fall of 2000.

The property is situated on Virginia Route 7, the major east-west highway from the Tyson's Corner area to Leesburg, and is bounded on the north by the Potomac River. It is eight miles from Dulles International Airport and 25 miles from HHMI headquarters in Chevy Chase, Maryland.

The scenic campus, which is mostly given over to woods, pasture and three ponds, is 30 miles — 45 minutes by car — from Washington, D.C. The property borders the Lansdowne Resort and Conference Center, a development that includes corporate offices, a conference facility, more than 300 hotel rooms, and other amenities, such as golf and tennis. The nearby area includes an ample selection of quality housing options in a variety of price ranges with excellent schools and shopping. Janelia Farm is an aesthetically pleasing property with ponds, meadows, mature trees, and offers beautiful views across the Potomac River to the rural Maryland countryside.



BUILDING PROGRAM

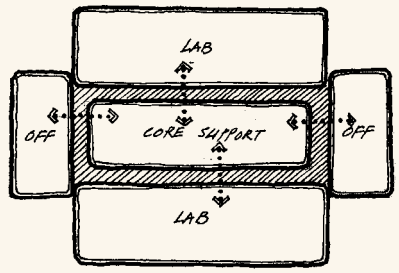
After the site was selected, the Institute proceeded to develop architectural planning criteria and an overall building design program. A building program is an essential step in the planning process, informing architects in detail what is expected from the design. The program was developed with input from the Janelia Farm Strategic Planning Committee, which included HHMI investigators Patrick Brown (Stanford University) and Stuart Schreiber (Harvard University), HHMI medical advisory board members Carla Shatz (Harvard Medical School) and Olke Uhlenbeck (University of Colorado, Boulder), and advisors David Lipman (Director of the National Center for Biotechnology Information), Gregory Petsko (Director of the Rosenstiel Center at Brandeis University) and Bruce Stillman (Director of Cold Spring Harbor Laboratory). The program was written by Robert McGhee, who authored the building programs for all the new Institute facilities (as well as those for many other institutions). It also benefited from the comments of Institute staff and other outside reviewers.

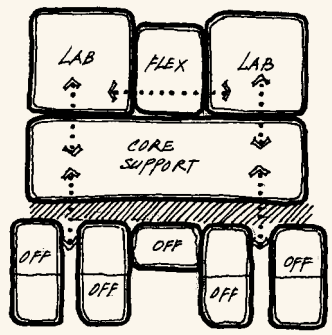
The program outlined approximately 370,000 NSF (630,000 GSF) plus underground parking. The research components will constitute more than half (approximately 195,000 NSF) of the construction. The program also included 96 rooms for conference housing, 24 studio and 36 two-bedroom apartments, meeting, support, recreational activities, and administrative facilities.

The program is based on the ideas that the research groups will be relatively small and that collaboration between the groups and with visiting scientists is of paramount importance. It is important to note that the research facilities are being developed for programs that do not yet exist and for investigators who have yet to be selected. Thus, the program reflects the need for flexibility and adaptation of facilities to meet a variety of unknown future needs.

Highlights of the building program section covering the research requirements are presented below. Similar discussions were included in the program for the remain-

der of the campus spaces. The main goal was to provide enough services and amenities to create a campus-like culture, as opposed to merely developing a suburban freestanding research facility. The conference and transient housing were seen as key elements for a campus culture. Conference housing and associated meeting spaces serve to bring science and scientists to the campus. Transient housing is included to accommodate the visiting investigator program and to give the campus an around-the-clock life.



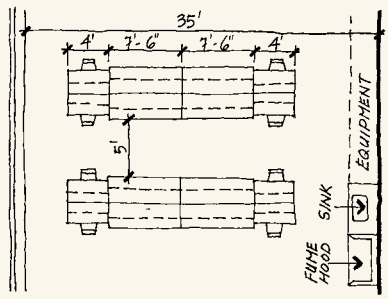


Research Floor Plan Organization – Initial discussions about the facility defined it as a single-corridor building with no more than three typical research floors above grade and with separate spaces for service and heavy instrumentation facilities. The building corridor concept has a large impact on the building character and the amount of interaction on the floor. Loop or racetrack schemes result in deep buildings with exterior labs, separated offices, and central support space.

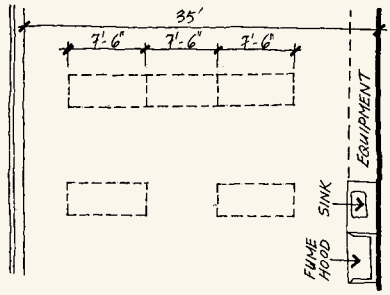
The Institute and its advisors preferred a single-corridor system in spite of the resultant length of the building. They preferred an organization scheme for the Janelia campus that would have labs and flex zones located on one side of the building with adjacent support space, a public corridor located next to that support space, and office spaces located on the other side of that corridor.

Laboratory Module – The laboratory module is the planning core of biomedical research buildings. The typical bench layouts determine the module depth. Laboratory modules are based on a width of 10' to 11', allowing for 30" deep benches, and a 5' to 6' circulation space between the benches. The typical laboratory module depths in biomedical research buildings have varied from 20' to 35'. The Institute has learned that a deep lab provides a more efficient and flexible space than a shallow lab. The deeper plan can house four people per module versus the more traditional two persons per module. The proposed laboratory module for the Janelia

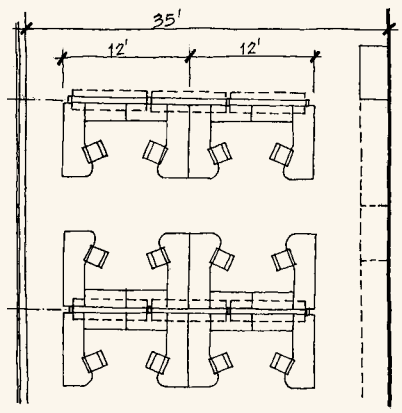
Farm campus is 10'6" wide and 35' long. The labs will be primarily configured as larger open lab spaces, allowing occupancy by more than one research group. *The labs can be outfitted in a variety of configurations as follows.*



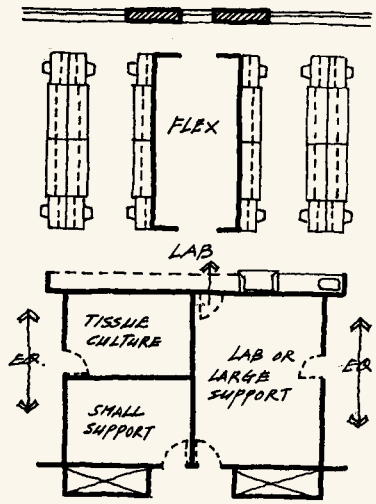
Biochemistry plan – The module when configured for biochemistry research will have two aisles, shared 15' benches, 4' desks, and a 3' deep equipment zone. The 15' bench length can normally accommodate two staff members on each side, or four persons per module. The desk units will be designed such that they can be reconfigured from desks to additional bench space if required.



Robotics plan – The laboratory module could be partially or totally stripped of the center benchwork and used for other purposes including robotics or instrumentation suites. The modules can be arranged in a variety of ways using the benchwork service system. Portable tables, benches, or equipment racks could be used to house specialized equipment. This plan will require a service system from above or below.



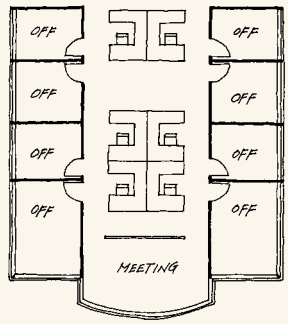
Computational Biology plan – The laboratory module can also be configured for computational workstations. Each person could have a 6' by 8' desk/computer workspace. The equipment zone containing the sinks and fume hoods could be used for common printers, equipment and storage.



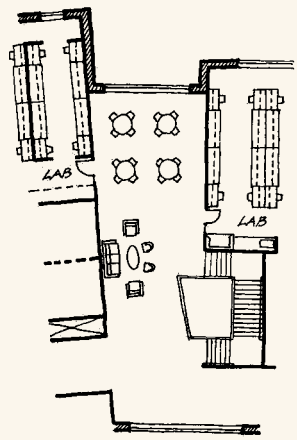
Support Spaces – While most laboratory buildings have an amount of support space less than or equal to the lab space, the Janelia program described approximately 50 percent more support space to handle unknown equipment needs and other future requirements. The majority of these support spaces should be located in zones adjacent to the laboratory units. The support zone is envisioned as a 22' deep zone, penetrated periodically by entrances to the labs. Some flex space is also included in the support zone and it could be used for lab office or support functions.

The lab-adjacent support zone will be configured in a variety of configurations. Large spaces can be used as shared tissue culture facilities, special instrumentation suites, or additional laboratory spaces. Medium spaces are sized to house tissue culture hoods, special procedure functions, or equipment (such as cell sorters or confocal microscope units). The smallest of the spaces are used for microscopes, dark rooms, robotics, chemical rooms, and equipment. These support spaces should be designed and serviced to accommodate a variety of other configurations without major disruption or service changes.

In addition to the normal lab support facilities, the program included a large amount of other support space for special instrumentation, imaging, instrument design and fabrication, and other unknown future requirements. Some of the space was defined as having very high ceilings and low vibration characteristics. Other spaces were defined as large open spaces that could be shared or divided as needed for future requirements.



Office Spaces – The amount of office space anticipated for this building is larger than that found in many contemporary biomedical research facilities. The increase is due to inclusion of space for computational biology and other 'dry' research. The planning group explored several options to accommodate the increased amount of office space, and concluded that it would be advantageous to develop office clusters. The clusters offer opportunities for a variety of faculty and staff interactions and collaborations consistent with the scientific goals of the campus. The office groupings are seen as blocks with offices on both sides of a wide aisle. The center space is used for flexible offices with meeting space at the end. The clusters could house a variable number of occupants, depending on the furnishings of the closed and open office spaces.



Interaction Spaces – A number of interaction spaces have been considered. The Institute has learned that interaction spaces work best when they are between or adjacent to laboratory units, but don't work as well if they are remote from the lab units. These interaction spaces serve as casual meeting places for laboratory staff. The spaces should have coffee service, white boards, and seating at tables and living room arrangements. They should be arranged to facilitate chance encounters between members of different laboratory groups and, as such, they should not become the domain of any one group.

Interaction spaces are also included that serve the building as a whole. Stairs are important in their role to facilitate communications. General communication stairs should be considered in addition to the routine fire stairs. It is possible to combine floor-to-floor stairs with interaction spaces in order to encourage laboratory units to have interactions with units on other floors. Stairs with open space and natural light also offer an opportunity for visual connections between floors. Additionally, the program suggests indoor and outdoor places for social gatherings that could not be included on the research floors and that encourage interaction among the larger community.

SELECTION OF AN ARCHITECT AND CAMPUS DESIGN PROPOSAL

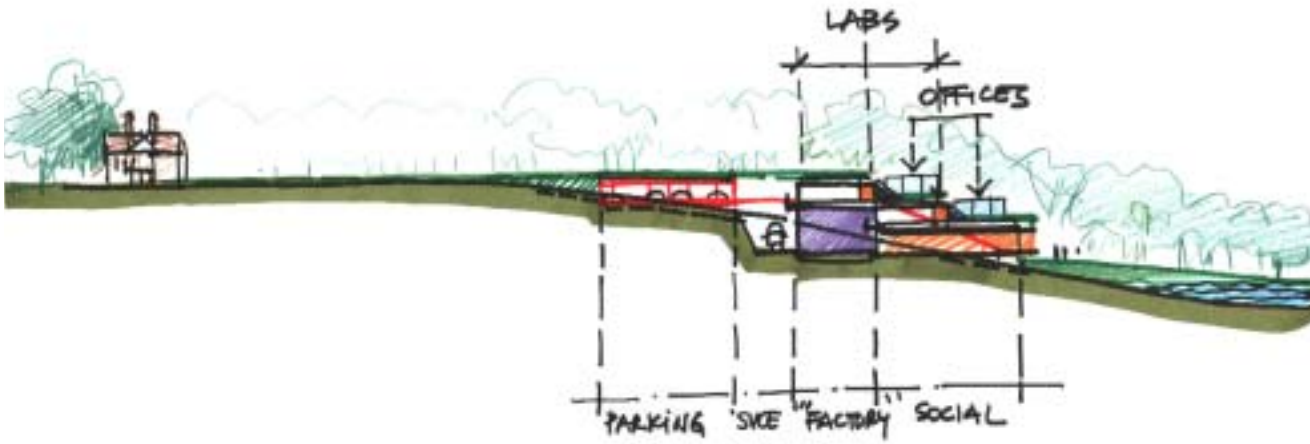
COMPETITION PROPOSAL

In the fall of 2000, the Institute held a campus design competition, which was limited to four groups of architects following proposals and interviews with twelve well-known architectural firms. The selected groups were asked to design a campus plan based on the building program and interactions with HHMI over a seven-week timeframe. Each presented their work to an Institute selection committee, including advisors, and then to the Trustees. The Institute Trustees, with the support of a selection committee, approved the proposal from Rafael Viñoly.

Viñoly's proposal was the most responsive to the building program, effectively addressing all the important planning criteria. His competition proposal served as the basis for the campus plan and design of the research building. Viñoly's plan put most of the program in a single structure, which he called the landscape building, by constructing a stair-stepped building into the hillside and covering the roofs with plantings.

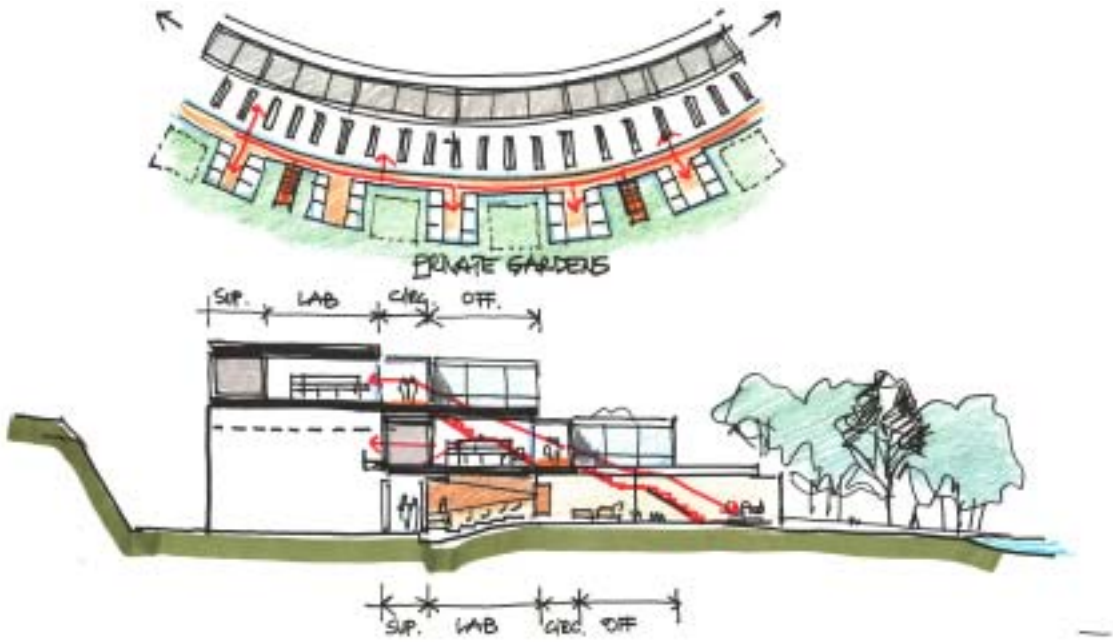
Viñoly proposed a three-story structure with two upper lab floors and a meeting and service floor below. The lab floors were offset allowing terraces outside lab space on both floors. Office blocks were located on the terraced roofs. Stairs traversed the building, connecting the floors in a straight run and thus providing excellent

functional and visual floor connections. The public space was located on the ground floor with loft high-bay research space behind. Parking was located behind the building but below the revised grade.



Viñoly's plan addressed the limitation of a building with views from only one side by locating a glass-roofed corridor adjacent to the labs. The corridor connected office clusters with the labs and allowed views from the labs between the clusters. The building length was proposed at 900 feet, though the curving corridor mitigated long corridor views. In later plans, the support and interaction spaces were located across from the office clusters, giving all the lab space exterior views, versus having some blocked by the office clusters.

The scheme strongly tied the labs to the offices and located the support zone inboard, behind the labs. A secondary equipment and service corridor was added behind the support zone, separating service from public traffic. Each lab space and office space had access to the outside terraces located between the office clusters. The scheme recreated the landscape and focused the views on the best part of the site. The resulting site plan locates a gently curving laboratory building overlooking a new lake and the conference housing structure. The building is located behind the Manor House, but the structure is not visible from the Manor House side of the site. Transient and conference housing were located in other structures.



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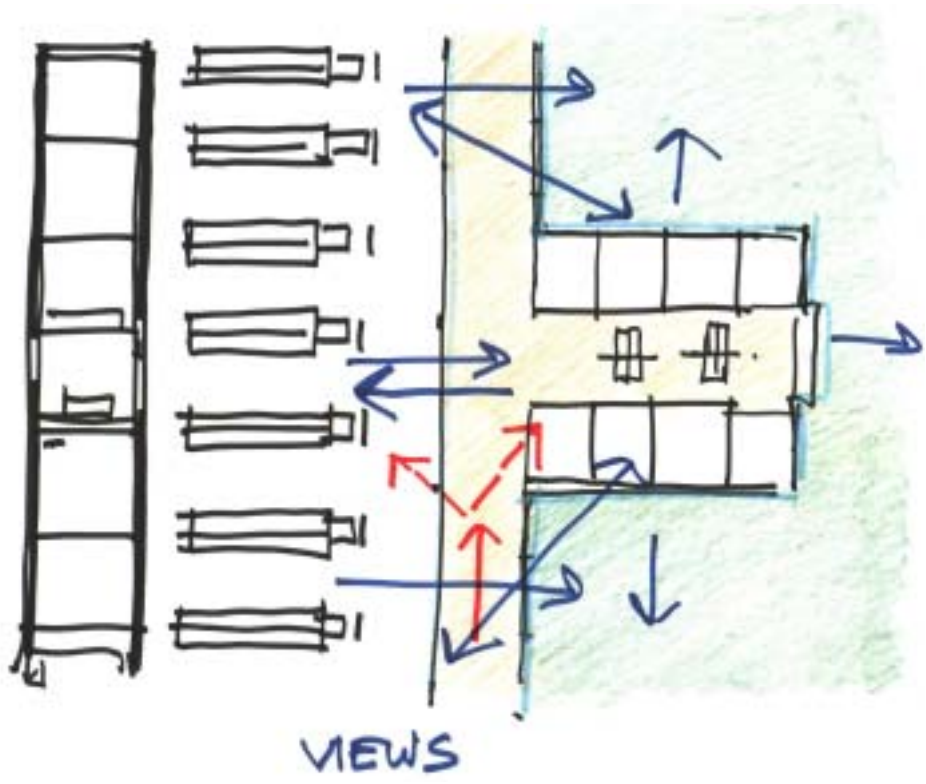
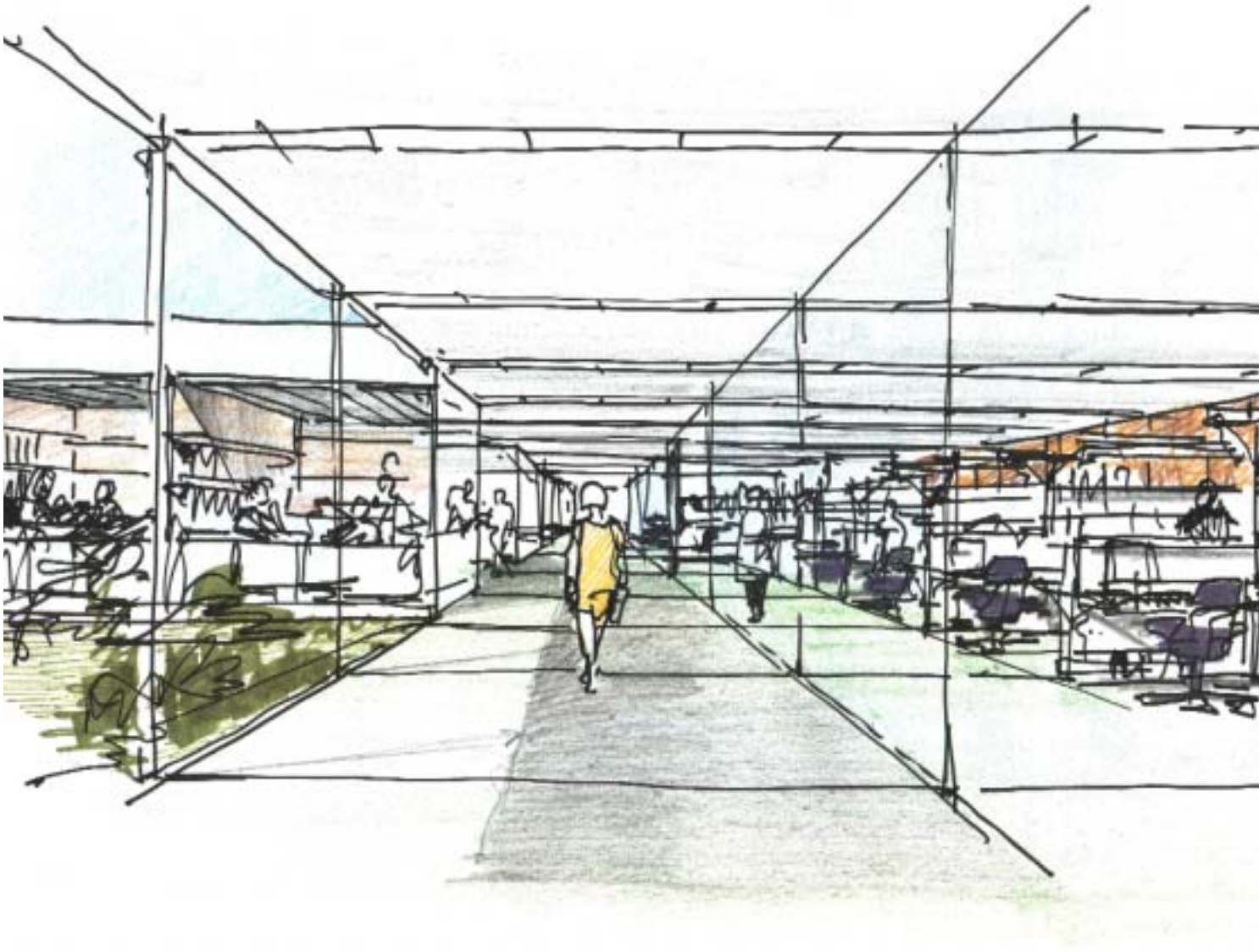




A CURRENT VIEW OF THE CAMPUS DESIGN

The competition plan submitted by Viñoly has been refined over the last two years, through a series of weekly design meetings, to reflect additional programmatic and architectural input from the Institute. While the development of the building plans has been consistent with the original direction established by the Institute in 2001, it has been greatly influenced by the ongoing development of the scientific program.

The contemporaneous development of the scientific program and building plans by overlapping teams has assured a continual dialogue about function, culture, and place. The project has been fast-tracked allowing excavation to begin before construction documents were completed. At this time, construction work is under way on the landscape building as the rest of the plans are being completed.

The plans reflect the unique program goals of the campus, and they are different from more traditional freestanding research structures in a number of ways:

- A significant amount of conference space, including meeting spaces, social spaces, and conference housing, has been included to support a conference and training program and to assure the scientific vitality of a freestanding institution.
- Onsite housing and related amenities are included to support the visiting scientist program.
- The relationship of site and buildings reflects a concept of buildings that are part of the site versus structures placed on the site.
- There are easy connections between the interior spaces and the site on all the floors of the landscape building.
- The research space has been planned to encourage collaboration among small groups through the clustering of offices and the inclusion of larger shared laboratory spaces.

- The amount of office space and the arrangement of the office clusters have been planned to reflect the increasing need for dry work space as well as the need for a different type of interaction among scientists.
- The location of the office clusters reflects the programmatic need for a very close tie between the laboratory spaces and the office spaces.
- The general wet biochemistry laboratories are designed to be adaptable to a variety of functions without requiring costly or time-consuming renovations.
- Small gathering and services spaces are located at critical connections between the public corridor, labs, and office clusters to foster the notion of collaboration and interaction.
- There is a large amount of routine support space adjacent to the labs which is highly flexible, serving a wide range of potential functions.
- There is a large amount of additional support space for large or sensitive instrumentation and for future activities that currently cannot be predicted.
- The overall amount of lab, office, and support spaces is large enough to house a significant visiting scientist program.

All these concepts have shaped the buildings and have given a series of structures that are unique in their construction and in their relationship to and their shaping of an attractive site.

These interior views of the ground floor of the landscape building highlight the lobby and reception areas.

A computer rendering shows the Janelia Farm Research Campus as it would appear in an aerial view.

This computer rendering shows an aerial view of the landscape building and conference housing as it might appear at night.

SITE PLAN

The landscape building faces north across the new lake. The entry to the building for visitors occurs at the ground level. The conference housing is across from the entry but connected by a tunnel below. The entry for employees is from the top level parking garage, behind the building. The parking is below grade with a landscaped roof. The transient housing is located in a wooded area adjacent to the conference housing.

The plan separates service traffic from the visitor and employee entrance. Service vehicles access the site from the left or west. There are no roads behind the lake or in locations visible from the landscape building. The existing buildings are screened from the landscape building but are close enough to be used for ancillary functions if needed.

LANDSCAPE BUILDING

The landscape building is a very large structure, some 900' long and 270' deep at the ground floor. In spite of its size, the building has minimum visibility from any part of the site, due to construction into the hillside and the landscaped roofs. The building is stepped up the hill, giving each floor continuous access to landscaped outdoor spaces. The ground floor has meeting, food service, administrative, service and vibration- and height- sensitive support spaces. There are two upper laboratory floors. Major stairs are located at third points along the building length with other stairs at the ends of the structure. Horizontal public circulation generally occurs at the building exterior, and service circulation is located inboard.

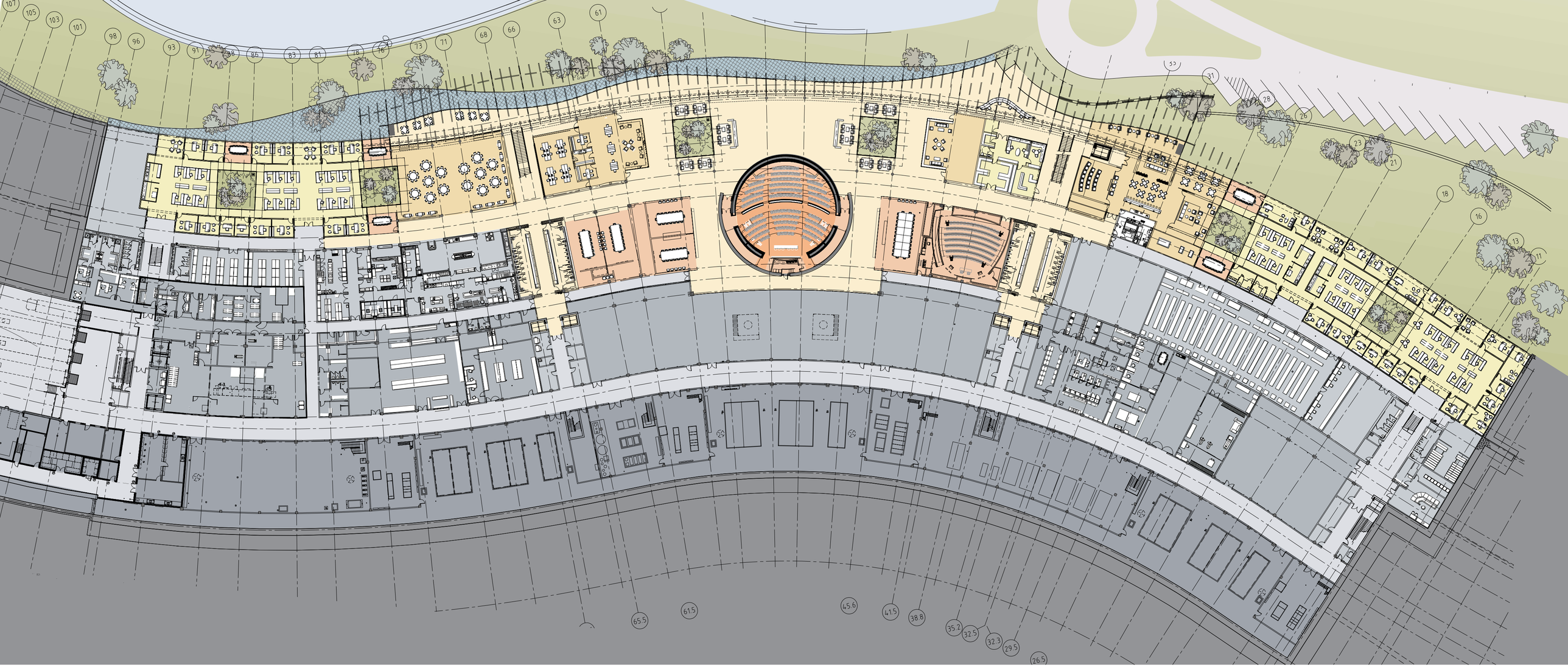
The primary function of the landscape building is to support the research enterprise. The two upper floors consist of research space. The laboratory floors have similar plans with a clear organization of office, lab, support, and interaction spaces. The building corridor is at the exterior of the building, with the office clusters on the outside of the corridor and lab and support space on the inside of the corridor.

Office Cluster and Interaction Spaces – The office cluster is a direct translation of the office program requirement. The cluster has six offices organized around a center workspace with an end meeting space. The office clusters are designed to house several research groups and the occupancy of the office clusters can be increased or decreased by changing the furnishings. The separation of the offices from the labs allows them to have a simpler construction and operable windows.

Typical lab floor section showing alternate configurations of office pods and laboratory space.

Janelia Farm
Research Campus

FLOOR PLANS FOR
THE LANDSCAPE BUILDING



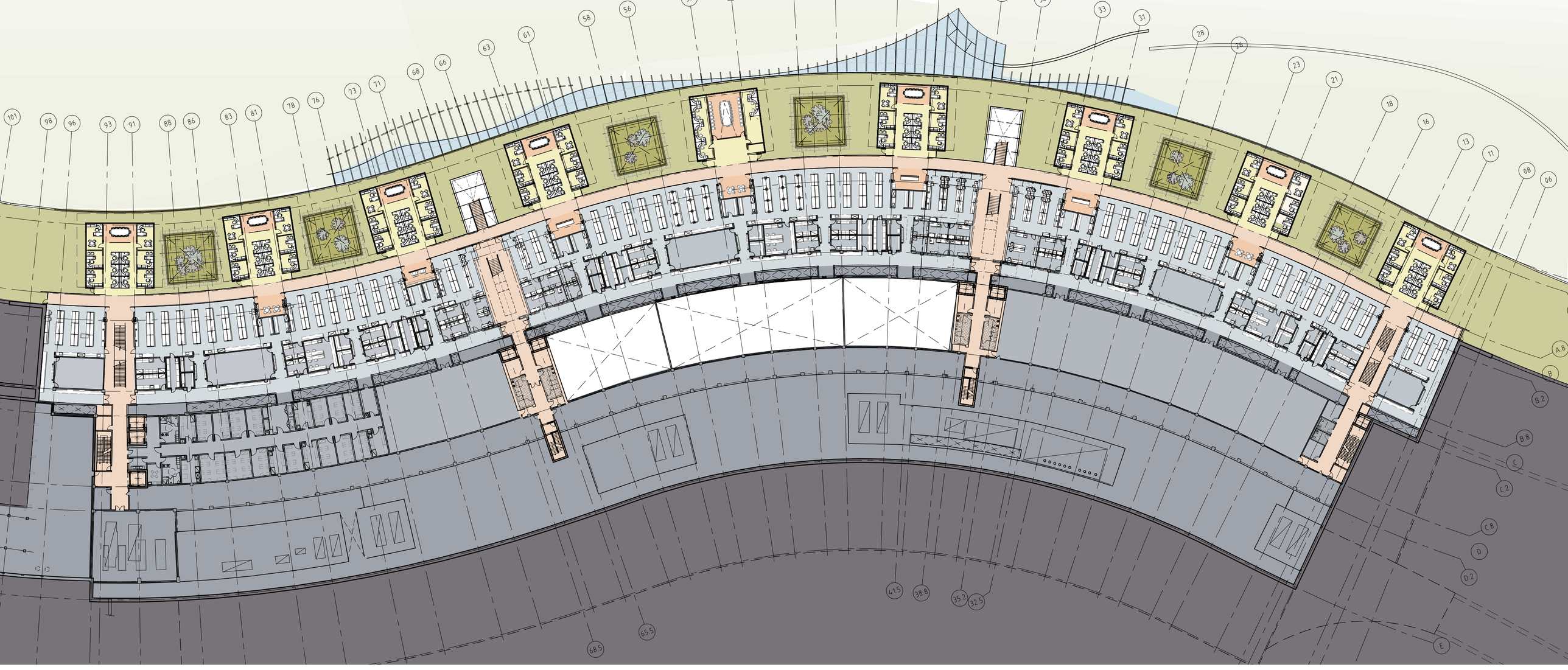
JANELIA FARM RESEARCH CAMPUS BUILDING PLANS *ground floor*

Dining / Library / Social
Meeting / Conference
Offices
Lobby / Public Circulation
Major Equipment
Mechanical

"It is a building about nature. Nature is the centerpiece of research at Janelia Farm, and the building follows that idea."

— Rafael Viñoly

on the occasion of
the Janelia Farm Research Campus
groundbreaking ceremony
on May 5, 2003, in Ashburn, Virginia.

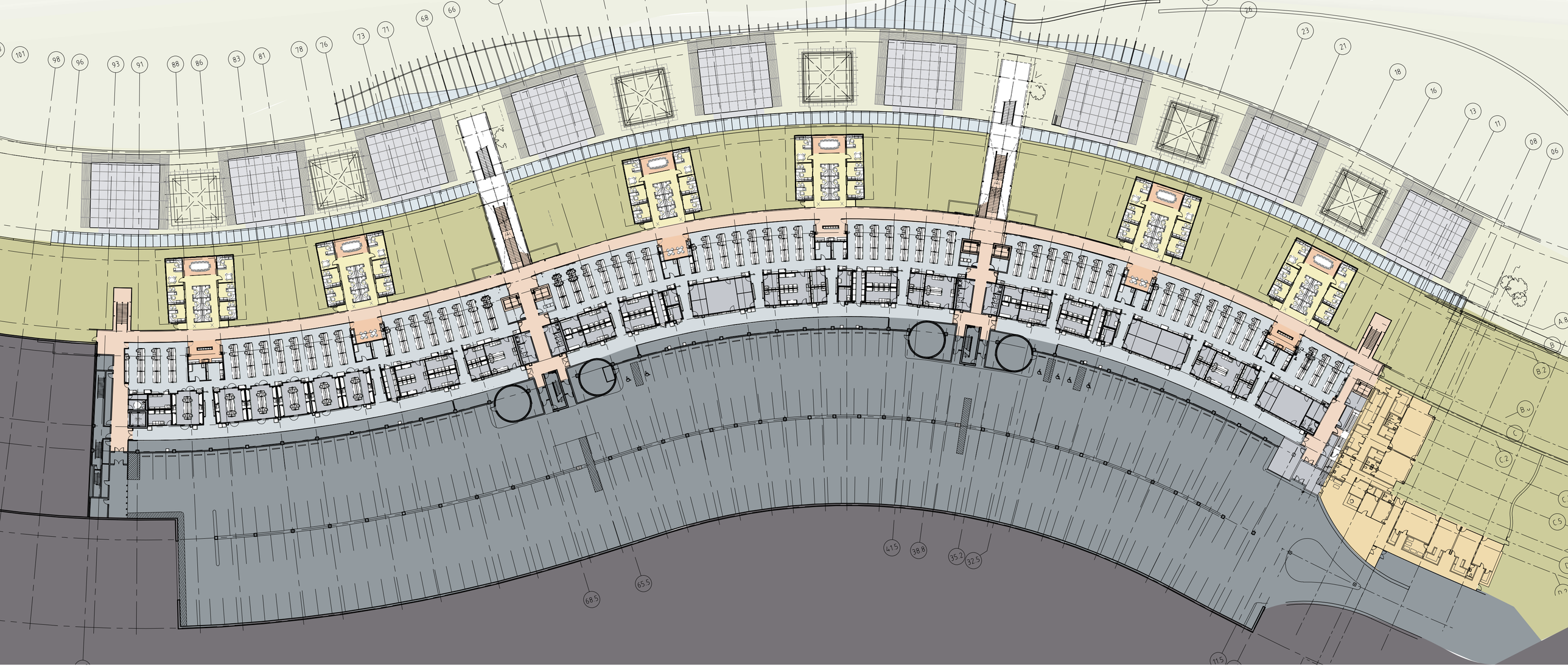


JANELIA FARM RESEARCH CAMPUS BUILDING PLANS *second floor*

Open Laboratory | Laboratory Support | Meeting / Conference / Copy | Offices | Major Equipment | Mechanical | Circulation

“This is an enterprise of collaboration. The need for interaction, for collaboration, is what has inspired this project and this way of working.”

— Rafael Viñoly
May 5, 2003



JANELIA FARM RESEARCH CAMPUS BUILDING PLANS *third floor*

Open Laboratory
Laboratory Support
Offices
Circulation
Daycare Center
Parking

"Science is advancing at an extraordinary pace due to the loosening of the dimensions of the boundaries between people. In a time of war and complexity in social terms, scientists have been able to cross those barriers."

— Rafael Viñoly
May 5, 2003

“Day science calls into play arguments that mesh like gears, results that have the force of certainty…. Conscious of its progress, proud of its past, sure of its future, day science advances in light and glory. By contrast, night science wanders blind. It hesitates, stumbles, recoils, sweats, wakes with a start. Doubting everything, it is forever trying to find itself, question itself, pull itself back together. Night science is a sort of workshop of the possible where what will become the building material of science is worked out.”

— FRANÇOIS JACOB

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