UNIVERSITY OF CENTRAL FLORIDA
College of Medicine

Manage Your Research Like a Pro

A Research Project Management Training Symposium for Faculty Investigators

Faculty Collaboration and Engagement Series (FACES)

Brought to you by the Office of the Associate Dean for Research

Welcome and Symposium Highlights

- Opening Remarks from Dr. Sampath Parthasarathy, Professor, Associate Dean for Research, Florida Hospital Chair for Cardiovascular Sciences, UCF College of Medicine
- Speaker Presentations 9:10-11:00 (Coffee Break 10:10-10:20)
- Project Management Competition Announcement 11:00-11:10
- Open Forum Discussion 11:10-11:25
- Closing Remarks and Adjourn

DEFINING PLANNING AND EXECUTING A RESEARCH PROJECT

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INTRODUCTION TO PROJECT MANAGEMENT

A project is a task to accomplish a set of goals
Uses a set of interrelated tasks
Effectively uses resources
Has novelty and “newness”
Accomplishes the objectives within a time frame
Usually has sponsor(s)

May have “customers”
May have a certain degree of uncertainty
May involve one or more people/organizational units.
A project ends when its objectives have been reached, or the project has been terminated.

It is the people **(PI)** that drive the project, not tools or resources. Effective utilization of the tools and resources is critical.

Research project

A characteristic feature of the research project is the lack **of clear definition of the final outcome of the project.**

The results of the research can lead to useful results, new products, services, improvements of existing technology, solve paradoxes and propose new solutions, etc but often they don't.

Project funding falls under three categories:

1. Self or internally funded
2. Externally funded
3. Unfunded

Research comprises creative work undertaken on a systematic basis in order to increase knowledge. The term covers three activities: basic research, applied research and experimental development. Translational research, clinical research, population research etc are additional terms employed to qualify the type of research.

Basic research Experimental or theoretical work undertaken primarily to acquire new knowledge without any particular application or use in view.

Applied research Original investigation undertaken in order to acquire new knowledger, directed primarily towards a specific practical aim or objective.

Experimental development ”Systematic work, drawing on existing knowledge gained from research and/or practical experience that is directed to producing new materials, products or devices, to installing new processes, systems and services, or to improving substantially those already produced or installed”.

The Triple Constraint of Project Management

Successful project management means meeting all three goals (scope, time, and cost) – and satisfying the project's sponsor!

Quality, Resources, and Risk are also important.

(Risks could be, over commitment of time/personnel, scope, resources, and others)

Who is the PI?

In academic institutions, the term PI is often confused with the expectations/concerns of a faculty,

1. Teaching responsibilities
2. Need to get grants to support, self and others
3. Need to maintain space
4. Concern about promotion
5. Concern about long term job employment.
6. Concern about long term sustained and adequate grant support.
7. Responsibilities to graduate students and other fellows.
8. Concerns about peer recognition, publications, citations etc.
9. Concerns about peer status, relationships with other faculty including collaboration/competition, service to the institution, leadership role....
10. Fear of changes and changing funding climate

The PI is the Project Manager. He holds the full responsibility for the project. He or she will be held responsible for all aspects of the project.

Who is the PI?
(Continued)

1, Should have academic qualifications suitable for the role of the PI
2. Should have the experience, expertise, training required.
3. Should have the ability and certain leadership training to manage the project.
4. Should have adequate financial background to manage the financial resources of the project.
5. Should have adequate knowledge to comply with policies and procedures of the institution.
6. Should have the knowledge to comply with the policies and procedures of the sponsor.
7. Should have mentoring skills and foster the growth of the personnel involved in the project.
8. Should be knowledgeable in ethical conduct of research.
9. Should be cognizant of the generally acceptable scientific conduct.
10. Should have effective communication skills, applicable to the discipline.
11. Should be responsible for the successful completion of the project, regardless of the outcome.
12. Should be able to cope with changes in environment of the institution and the scientific world.
13. Should have learning and adaptive skills.
14. Should know when to quit a project and when to diversify.

Grants have several types of qualification requirements:

1. **Basic academic qualifications**-Certain type of grants require MD or other clinical degrees. There are fuzziness regarding whether you a MPH degree to engage in population research, whether a PhD could lead a clinical trial, …It might depend on circumstances and the goals.
2. **Specific qualifications:** Depending on specialty, you might need additional qualifications. However, there is nothing precludes you from submitting grants in a different branch of science. (A former Carl Sagan's assistant who studied astronomy is an internationally known cardiovascular scientist. Many physicists have become biomedical scientists)
3. Qualification versus experience/expertise: Expertise and experience is judged both by the number of years as well as by publications. Not only relevant and number of publications matter but also, in recent times, the quality of the Journal has become critically important.

4. **DO NOT PUBLISH IN FLY BY NIGHT JOURNALS.**

Suggested Skills for Principal Investigators and Laboratory Managers

- **Communication skills:** Listens, persuades, engages, motivates, mentors
- **Organizational skills:** Plans, sets goals, collaborates, consults, analyzes.
- **Team-building skills:** Shows empathy, motivates, promotes (esprit de corps) pride and belonging.
- **Leadership skills:** Sets examples, provides vision (big picture), delegates, positive, energetic, mentors, professionalism, ethical, think outside the box, problem solving..
- **Coping skills:** Flexible, creative, accommodative, patient, persistent, assertive.
- **Technology skills:** Experience, project knowledge, entrepreneuring, willing to learn,

“Leave now for dogs and apes; man has forever”-A grammarian’s funeral-Robert Browining

Consultants and Collaborators

1. Identify your weaknesses and areas that require additional expertise
2. Identify potential consultants and collaborators
3. Include them in the grant appropriately-specify which areas of your project that they would consult/collaborate. Be prepared to compensate.
4. Learn and acquire the expertise during the implementation of the project so that you can understand your collaborator/consultant's views.
5. Don’t become concerned that someone would steal your data. In NIH’s history, there are very few instances of pilfered grants (although it happened to me!).

Project Success Factors

1. Institutional support-Facilities, space, resources, title, promotion, salary support etc.
2. Experience and expertise of the PI: Continuing education, retooling, conferences, acquiring knowledge.
3. Unconditional commitment by the PI for the project.
4. Experience and expertise of the team. Continuing education, retooling, conferences, acquiring knowledge,
5. Evolving Methodology and Technology-participation in workshop, additional training etc.
6. Other criteria, such as small milestones, proper planning, time management, competent staff, and ownership of the project, analytical and data support etc.
7. Peer review, corrective actions to stay on the course.

- Develop detailed task list (work breakdown structures and delegation of laboratory responsibilities).
- Identify and evaluate risks and preparing for alternatives.
- Setting milestones.
- Reporting and data dissemination

Project Failure

1. Poorly conceived hypothesis and research plans.
2. Projects that were funded for other reasons than science
3. Project scope took a different turn and the original hypothesis is no longer attractive.
4. Committed resources are unavailable. (e.g. special animal species not available.)
5. Couldn’t hire enough or qualified people (poor budgeting)
6. Poor time management-too many needless experiments that deviated from the original plan.
7. Questionable and ambiguous results. Not enough statistical input.
8. Scooped by others
9. Not enough time to do research-overwhelming other commitments (e.g. teaching)
10. Institutional environment/direction/priorities have changed that distracted the PI.
11. Ran out of money-poor budgeting.

Project Failure (continued)

1. Poor project and PI's discipline-The PI spends more time on politics, travel, committees, unproductive activities, and negativity than project related activities.
2. Lack of academic support (academic advancement/promotion/tenure/leadership opportunities etc.)
3. No link or commitment to the project strategy
4. Wrong or unproductive team members
5. No steps to measures the outcome/success of the project
6. No risk management or critical thinking
7. Reliance on antiquated tools and techniques-no continuing updates of skills or expertise- Inability to manage change.
8. Tendency to blame diminishing sponsor funding.
9. Lack of institutional resources.

Abandoning a Project

1) Identify factors that contribute to decisions of project abandonment within the project itself, 2) Identify outside factors, 3) Identify what benefits of abandoning, 4) Identify steps that are needed.

You don’t have to have another project to kill a project

Pulling the plug on a project

There are many reasons for pulling the plug on a project:

1. The project is satisfactorily completed
2. The project is out of control and has become too complicated.
3. No more money or resources.
4. Objectives are no longer appealing, valid, timely, or could be justified.
5. Sciences has advanced so much that the project has become irrelevant.
6. No satisfactory conclusions could be made from the results. Reached a dead end. Very little deliverable (publishable) data.
7. Competition is killing me.
8. Getting tired of the same old….. Need fresh start.
9. The project is no longer competitive for funding
10. There are more exciting projects in the lab
11. The project has taken a turn in a direction that I don’t have competence
12. I don’t have time to attend to this project (or any other!)
13. I am winding up my lab and setting priorities
14. I can’t afford to pay my team members-running out of money
15. I have beaten this project so much, I am running out of ideas.
16. Marginal returns for the investment

What deters us from pulling the plug on a project?

1. Emotional attachment to the project.
2. Sunken effort and cost.
3. When the benefits of continuing no longer outweigh the future potential, if any.
4. When your time would be better spent on something else,
5. When you don't have a unique projector. Assume another identity. Reinvent yourself.
6. Negativity:

   Unaccountability. I have been doing this for years-why change?
   If I terminate the project, what else do I do?
   Who is going to pay for the new project?
   Where and how will I get new skills.
   I am tenured-I don't have to have a project. No one is complaining-why bother?
   I have delivered mountains in the past-The institution owes me a good future life.

How to find a new project? (In your own comfort zone or outside-)

1. "Join" someone else's lab in the same department/area.
2. Attend a conference in your topic and find a hot topic or an area that interests you and falls within your expertise.
3. Develop additional skills and retool to stay fresh in your area.
4. Have meetings with your trusted colleagues and find ways to improve your skills.
5. Take a long vacation to refresh your thinking.
6. Take a sabbatical to freshen your mind.
7. Engage in activities to freshen your thinking-Life style modulations, another temporary job etc.
8. Revisit forgotten projects.
9. Collaborate and get into other areas.

Reasons to step out of comfort zone:

1. Someone offered a challenging position
2. Stagnating in current position
3. Projects ending, and no new ones in sight
4. Grants are not in sight
5. Pressure to get more grants but unsuccessful grant applications
6. Field appears to be dead
7. Current research doesn't appear to be going anywhere.
8. Doom and gloom about research at the national level

After years of CV research, Sam decided to step out of his comfort zone

Found a new project-now what?

Goals
Ideas
Innovation

Personnel,
Expertise
Skills

Equipment
Time

Money
Sponsor

JOB

You don't bring me money anymore..,

Every sponsor has expectations

Understand the sponsor's expectations, whether it is bridge funding from the department/college, a gift from a donor, grant from an agency/foundation, grant from NIH or other forms of Government.

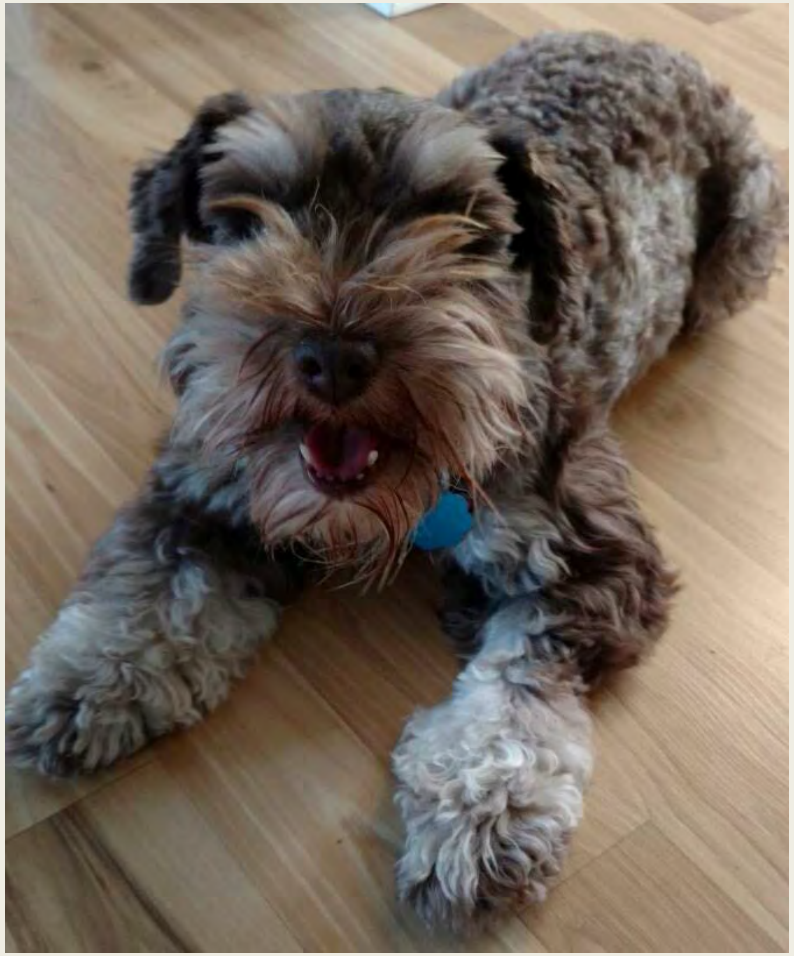
Bring money

Bring Jobs (well, if you can bring Steve Jobs back)

Bring technology and innovation

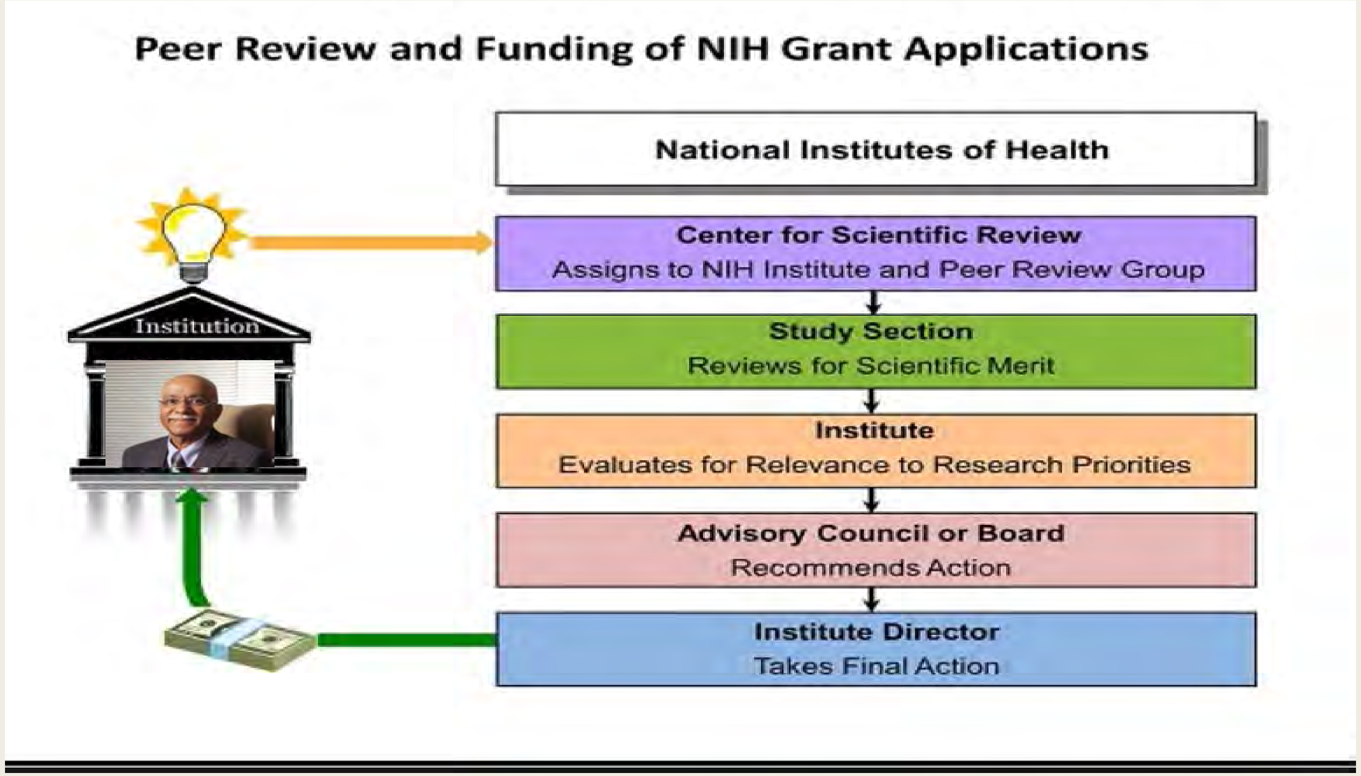
Bring fame and value to the institution

Educate and Train



OK, Now what

STAYING ALIVE



Why do I qualify to talk about grants?

- Successfully funded by NIH for over 25 years.
- Was the recipient of several NIH R-01 and P-01 grants.
- Had multiple RO-1 grants (over 3) concurrently together with a PO-1
- Had multiple projects in the same P-01 grant.
- Was a project leader in a SCORE grant.
- Was a subcontractor of a R-21 grant.
- Was funded by more than 4 Institutes/centers.
- Have been a reviewer for NIH for over 25 years.
- Chaired many NIH review committee meetings
- Have reviewed for several institutes and centers.
- Have reviewed for several types of grants.
- Was a permanent member of the NHLBI program project committee.
- Have served in several types of grant reviews (e.g. Site visits, Tele conf., Web review)
- Have been a reviewer for AHA for over three decades.
- Have reviewed grants for Australia, Canada, Qatar, Netherlands, New Zealand, England, India, Israel, Brazil, Argentina, .
- Have been a reviewer for the VA grant system.
- Have reviewed grants for many Universities and academic institutions.

Who submits academic grants?
Why are faculty hired by departments and entities?

1. There is a position available that needs to be filled.
2. There is void for expertise in certain areas.
3. There is room for expansion.
4. There is money available to hire more faculty.
5. Someone’s contract requires the hiring of additional faculty.
6. Someone’s appointment requires bringing in team and additional members.
7. Contract work-industrial funding requires additional faculty/researchers.
8. Someone who doesn't have time to do research hires additional faculty to satisfy his/her research needs.
9. A valuable member with a non-faculty appointment “threatens” to leave!
10. Hiring more faculty is seen as gaining “more control” and makes employer feel more important.
11. Sudden influx of money by windfall measures. Could be short term.
12. Academic expectation for Universities to “grow”.
13. Retirement/faculty leaving leaves gaps.
14. To teach.

Why do researchers submit grant proposals?

People submit grant proposals because:

Right reasons:

1) Feel grant submission as one of the objectives of their career.
2) Feel the study will advance science and fill gap in knowledge.
3) Universities require researchers to maintain certain percent of their salaries from grant funding. Summer time salary support for many comes from grants.
4) Being a Principal investigator of a grant offers scientific independence, opportunities to manage finance, personnel, contracts, and resources.
5) Successful grants bring peer acceptance.
6) Successful grants bring emotional satisfaction, stability in life, and a better future prospects.
7) It is the right way to exercise the mind and bring bright ideas and creative solutions together.

Wrong reasons:

1) Feel pressured to do so when not ready.
2) Think that they have an idea that could be submitted for funding, without adequate thinking and planning.
3) Someone told him/her that there is funding for "that type" of work.
4) "Just send and see if it clicks" attitude.
5) An act of desperation.
6) Expect that he/she is entitled to grant monies.
7) Superiors, friends, and others "promised" grant money.

Why do we need scientific research?

a) To promote good, high quality science and become a leader in science and technology
b) To bring grant money to the institution
c) To become competitive and attract more talent to the institution (NAS, Nobel)
d) To enrich academic life
e) To provide employment
f) To provide training to young minds
g) To attract industry and technology partnership

We need to monitor and take into consideration:

1. How many faculty are recruited each year.

2. Extra reward for, a) current grant funding, b) past grant record, c) team building quality, d) leadership quality, e) methodological and technological innovation, f) patents and technologies that would benefit OSU, g) national and international name recognition, h) publication record, i) service to current and previous organizations, j) teaching skills, k) mentoring skills, l) laboratory management expertise, m) service to NIH and other agencies, n) MBA, MPH, and other additional qualifications, etc.

3. Who will the faculty report to and who will take responsibility for failure/success. It is my belief that the chain of command is vague at most institutions. Conferences, such as this one play a major role in the success/failure of the faculty and the institution.

If we have over *** tenure track faculty, why there is only *% increase in grant funding?

1.Some faculty in the tenure track do not see the need to seek and obtain grant funding.

2.The system fails to monitor grant funding and excuses faculty if they are otherwise performing well.

3.Some departments reward grant submission regardless of outcome. For example, if one submits several grants a year and get nothing in return, it equates to funded grant in terms of points! There is less incentive for successful grant submission.

4.We recruit people with contracts and requirements for grant funding; but ignore the contract stipulations and hesitate to fire people.

5.Lack of mentorship, team leaders, and intellectual curiosity.

6.Overall decline in funding.

7.Not relevant/up to date expertise/antiquated topics, many others

Why do faculty fail as scientists/researchers and find it hard to sell their ideas for grant money?

1.Not an original thinker of ideas that could be funded.
2.Out of touch with current science and technology, despite ideas.

3.Does not pay attention to NIH rules and changes.

4.Great thinker but poor planner. Does not act.
5.Caught up with teaching, administration, and other tasks.
6.Spends too much time traveling and outside consulting.
7.Works in an area that is not mainstream, Works in an area that is “seasonal”, Works in an area that is highly competitive.
8.Does not think research is his/her priority.
9.Afraid of doing any kind of research. Has not been exposed to research.
10.Hired as faculty too soon and without experience for other reasons.
11.Hired as faculty to satisfy the needs of his/her supervisor without going through the rigors of the hiring process.
12.Poor writing/communication skills. Great ideas need great grantsmanship.
13.Many beat a dead horse!
14.Entitlement mentality! Once appointed as faculty/or become tenured, believes that grants will start flowing in! Similarly, many believe once you are tenured, you don’t have to earn your salary!
15.“I bring enough money-why should I write more grants”, “this position does not require me to write grants”,
16.Antagonized the scientific community.
17.Has poor credibility-tainted research-scientific and financial misconduct.
18.Works in an environment/department/division with no commitment/support for research. There was lack of enthusiasm from both sides. He was kept to show that research is being done at the department.

Common Mistakes

- Low productivity, few recent papers
- No collaborators recruited or no letters from collaborators
- Inadequate institutional support
- Not significant nor exciting nor new research
- Lack of compelling rationale
- Incremental and low impact research
- Too ambitious, too much work proposed
- Unfocused aims, unclear goals
- Limited aims and uncertain future directions
- Inappropriate level of experimental detail
- Feasibility of each aim not shown
- Little or no expertise with approach
- Lack of appropriate controls
- Not directly testing hypothesis
- Correlative or descriptive data
- Experiments not directed towards mechanisms
- No discussion of alternative models or hypotheses
- No discussion of potential pitfalls
- No discussion of interpretation of data
- No demonstration of expertise or publications in approaches

NIH Institutes and Centers

- National Cancer Institute (NCI) — Est. 1937
- National Eye Institute (NEI) — Est. 1968
- National Heart, Lung, and Blood Institute (NHLBI) — Est. 1948
- National Human Genome Research Institute (NHGRI) — Est. 1989
- National Institute on Aging (NIA) — Est. 1974
- National Institute on Alcohol Abuse and Alcoholism (NIAAA) — Est. 1970
- National Institute of Allergy and Infectious Diseases (NIAID) — Est. 1948
- National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS) — Est. 1986
- National Institute of Biomedical Imaging and Bioengineering (NIBIB) — Est. 2000
- Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD) — Est. 1962
- National Institute on Deafness and Other Communication Disorders (NIDCD) — Est. 1988
- National Institute of Dental and Craniofacial Research (NIDCR) — Est. 1948
- National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) — Est. 1950
- National Institute on Drug Abuse (NIDA) — Est. 1974
- National Institute of Environmental Health Sciences (NIEHS) — Est. 1969
- National Institute of General Medical Sciences (NIGMS) — Est. 1969
- National Institute of Mental Health (NIMH) — Est. 1949
- National Institute on Minority Health and Health Disparities (NIMHD) — Est. in 1993
- National Institute of Neurological Disorders and Stroke (NINDS) — Est. 1950
- National Institute of Nursing Research (NINR) — Est. 1986
- National Library of Medicine (NLM) — Est. 1956

- Center for Information Technology (CIT) — Est. in 1964
- The Center for Scientific Review (CSR)
- John E. Fogarty International Center for Advanced Study in the Health Sciences (FIC) — Est. in 1968
- National Center for Complementary and Alternative Medicine (NCCAM) — Est. in 1999
- National Center for Advancing Translational Sciences (NCATS) — Est. in 2011
- NIH Clinical Center (CC) — Est. in 1953

Overview of NIH grants

- The NIH offers a number of different types of grants (R,F, K, etc).
- No two institutes or centers of NIH offer the same mechanisms.
- Not all grant mechanisms are well known.

Buildings and Infra-structure

- Research Facilities Construction Grants
- Basic research laboratories
- Animal facilities
- Clinical facilities
- Equipment
- Conferences

Individual Fellowships are in the F-series

- F31, Predoctoral Individual Ruth L. Kirchstein National Research Service Award (NRSA).To provide predoctoral individuals with supervised research training in specified health and health-related areas leading toward the research degree (e.g., Ph.D.). (also Minority Students and Students with Disabilities)

- F32, Ruth L. Kirchstein National Research Service Award for Individual Postdoctoral Fellows. To provide postdoctoral research training to individuals to broaden their scientific background and extend their potential for research in specified health-related areas.

- F33, NIH Ruth L. Kirchstein National Research Service Awards for Senior Fellows, To provide opportunities for experienced scientists to make major changes in the direction of research careers, to broaden scientific background, to acquire new research capabilities, to enlarge command of an allied research field, or to take time from regular professional responsibilities for the purpose of increasing capabilities to engage in health-related research.

Career development awards K-series

Program	Description
K01	**Mentored Research Scientist Development Award** Career development in a new area of research. 3-5 yrs.
K02	**Independent Scientist Award** Develop the career of the funded scientist. 5 yrs; 75% effort.
K05	**Senior Scientist Award** For outstanding scientists with a sustained level of high productivity. 5 yrs; 75% effort.

K-awards

K07	**Academic Career Award** Developmental/Leadership in academic instruction, research, administration. 2-5 yrs, 25-75% effort; requires institutional sponsorship.
K08	**Mentored Clinical Scientist Development Award** Development of the independent clinical research scientist. 3-5 yrs; 75% effort.
K12	**Mentored Clinical Scientist Development Program Award** Support to an institution for the development of independent clinical scientists. 5 yrs; 75% effort; initiated by the educational institution.

Some of these are sponsored by specific institutes

K-awards

K18	**Career Enhancement Award for Stem Cell Research** Supports full-time or part-time training in the use of human or animal embryonic, adult, or cord blood stem cells. Usually 6 months to 1 year (up to 2 years allowed) full or part-time.
K22	**Career Transition Award** Support to an individual postdoctoral fellow in transition to a faculty position.
K23	**Mentored Patient-Oriented Research Career Development Award** Development of the independent research scientist in the clinical arena. 3-5 yrs, 75% commitment.

K-awards

K24	**Midcareer Investigator Award In Patient-Oriented Research** Development of clinical mentors conducting funded research. 3-5 years, 25 to 50% effort
K25	**Mentored Quantitative Research Career Development Award** To foster interdisciplinary collaboration in biomedical research by supporting career development experiences for scientists with quantitative and engineering backgrounds. 3-5 yrs; 75% effort
K30	**Clinical Research Curriculum Development** Institutional award for development of a clinical research curriculum. 5 yrs; up to $200,000 per year.

Program Project and Center Grants are in the P-series

- **P01, Research Program Projects,** To support multidisciplinary or multifaceted research programs that have a focused theme. Each component project should be directly related to and contribute to the common theme.
- **P20, Exploratory Grants**, To support planning for new programs, expansion or modification of existing resources, and feasibility studies to explore various approaches to the development of interdisciplinary programs that offer potential solutions to problems of special significance to the mission of the NIH. These exploratory studies may lead to specialized or comprehensive centers.

P-series

- **P30, Center Core Grants**, To support shared use of resources and facilities for categorical research by investigators from different disciplines who provide a multidisciplinary approach to a joint research effort, or by investigators from the same discipline who focus on a common research problem. The core grant is integrated with the center’s component projects or Program Projects, though funded independently from them. This support, by providing more accessible resources, is expected to assure greater productivity than that provided through the separate projects and Program Projects.
- **P41, Biotechnology Resource Grant Program**

P-series

- **P50, Specialized Center Grants**,To support any part of the full range of research and development from very basic to clinical; may involve ancillary supportive activities such as protracted patient care necessary to the primary research or R & D effort. The spectrum of activities comprise a multidisciplinary attack on a specific disease entity or biomedical problem area. There grants differ from program project grants in that they are usually developed in response to an announcement of the programmatic needs to an Institute or Division and subsequently receive continuous attention from staff. Centers may also serve as regional or national resources for special research purposes.

*Research Projects are in the R-series

- **R01, Modular Research Grant Application**, The modular research grant procedures will affect the NIH peer review process by enabling reviewers to evaluate proposed project budgets on the basis of a general, expert estimate of the total effort and resources required to conduct the proposed research. Reviewers will recommend changes in a proposed project's budget in $25,000 modules. NIH Institute staff will continue to make all final award decisions.
- **R01, Research Project**, Grants are awarded to institutions to allow a Principal Investigator to pursue a scientific focus or objective in his or her area of interest and competence. Institutional sponsorship assures the NIH that the institution will provide facilities necessary to conduct the research and will be accountable for the grant funds. Applications are accepted for health-related research and development in all areas within the scope of the NIH’s mission.

R-series

- **R03, Small Research Grants**, Small grants provide research support, specifically limited in time and amount, for activities such as pilot projects, testing of new techniques, or feasibility studies of innovative, high-risk research, which would provide a basis for more extended research.
- **R13, Conference**, The NIH provides funding for conferences to coordinate, exchange, and disseminate information related to its program interests. Generally, such awards are limited to participation with other organizations in supporting conferences rather than provision of sole support. Costs eligible for support include salaries, consultant services, equipment rental, travel, supplies, conference services, and publications. Prospective applicants are encouraged to inquire in advance concerning possible interest on the part of an awarding Institute/Center (IC), and to obtain more information on application procedures and costs.

R-series

- **R15, The NIH Academic Research Enhancement Awards** (AREA), To enhance the research environment of educational institutions that have not been traditional recipients of NIH research funds, this award provides limited funds to those institutions' faculty members to develop new research projects or expand ongoing research activities in health sciences and to encourage students to participate in the research activity. As funds are anticipated to continue to be available each year, the NIH is now inviting applications for AREA grants through a standing, ongoing Program Announcement.
- **R18, Research Demonstration and Dissemination Projects**, To provide support designed to develop, test, and evaluate health service activities, and to foster the application of existing knowledge for the control of categorical diseases.
- **R21, Exploratory/Developmental Grants**, To encourage the development of new research activities in categorical program areas. (Support generally is restricted in level of support and duration.)

R-series

- **R24, Resource-Related Research Projects**, To support research projects that will enhance the capability of resources to serve biomedical research.
- **R33, Exploratory/Developmental Grants Phase II**, To provide a second phase for support of innovative exploratory and developmental research activities initiated under the R21 mechanism. Although only R21 awardees are generally eligible to apply for R33 support, specific program initiatives may establish eligibility criteria under which applications could be accepted from applicants who demonstrate program competency equivalent to that expected under R33.

R-series

- **R37, Method to Extend Research in Time (MERIT) Award**, To provide long-term grant support to investigators whose research competence and productivity are distinctly superior and who are highly likely to continue to perform in an outstanding manner. Investigators may not apply for a MERIT award. Program staff and/or members of the cognizant National Advisory Council/Board will identify candidates for the MERIT award during the course of review of competing research grant applications prepared and submitted in accordance with regular PHS requirements.

STTR and SBIR grants support partnerships with small business

- **R41, Small Business Technology Transfer (STTR) Grants - Phase I**, To support cooperative R&D projects between small business concerns and research institutions, limited in time and amount, to establish the technical merit and feasibility of ideas that have potential for commercialization.
- **R42, Small Business Technology Transfer (STTR) Grants - Phase II**, To support in-depth development of cooperative R&D projects between small business concerns and research institutions, limited in time and amount, whose feasibility has been established in Phase I and that have potential for commercial product(s) or service(s).

SBIRs

- **R43, Small Business Innovation Research Grants (SBIR) - Phase I**, To support projects, limited in time and amount, to establish the technical merit and feasibility of R&D ideas that may ultimately lead to commercial products or services.
- **R44, Small Business Innovation Research Grants (SBIR) - Phase II**, To support in-depth development of R&D ideas whose feasibility have been established in Phase I that are likely to result in commercial products or services.

Training grants are in the T-series

- **T32, NIH National Research Service Award – Institutional Research Training Grants,** To enable institutions to make National Research Service Awards to individuals selected by them for Predoctoral and postdoctoral research training in specified shortage areas.
- **T34, MARC Undergraduate NRSA Institutional Grants**, To enable minority institutions to make National Research Service Awards to individuals selected by them for predoctoral and postdoctoral research training in the biomedical and behavioral sciences.

Cooperative agreements are in the U-series

- **U01, Research Project**, To support a discrete, specified, circumscribed project to be performed by the named investigator(s) in an area representing his specific interest and competencies.
- **U10, Cooperative Clinical Research–Cooperative Agreements**, To support clinical evaluation of various methods of therapy and/or prevention in specific disease areas. These represent cooperative programs between sponsoring institutions and participating principal investigators, and are usually conducted under established protocols.
- **U19, Research Program–Cooperative Agreements**, To support a research program of multiple projects directed toward a specific major objective, basic theme or program goal, requiring a broadly based, multidisciplinary and often long-term approach.

U-series

- **U54, Specialized Center-Cooperative Agreements**, To support any part of the full range of research and development from very basic to clinical; may involve ancillary supportive activities such as protracted patient care necessary to the primary research or R&D effort. The spectrum of activities comprises a multidisciplinary attack on a specific disease entity or biomedical problem area. These differ from program project in that they are usually developed in response to an announcement of the programmatic needs of an Institute or Division and subsequently receive continuous attention from its staff. Centers may also serve as regional or national resources for special research purposes, with funding component staff helping to identify appropriate priority needs.

U-series

- **U56, Exploratory Grants--Cooperative Agreements**, To support planning for new programs, expansion or modification of existing resources, and feasibility studies to explore various approaches to the development of interdisciplinary programs that offer potential solutions to problems of special significance to the mission of the NIH. These exploratory studies may lead to specialized or comprehensive centers. Substantial Federal programmatic staff involvement is intended to assist investigators during performance of the research activities, as defined in the terms and conditions of award.

Grant Supplements for Underrepresented Minorities

Principal Investigators on NIH research grants may apply for administrative supplements to existing grants for the support and recruitment of underrepresented minority investigators and students.

Eligibility:

Principal Investigators who hold an active R01, R10, R18, R22, R24, R35, R37, P01, P20, P30, P40, P41, P50, P51, P60, U01, U10, U19, U41, or U42 grant *provided* the parent grant has support remaining for a reasonable period at the time of a supplemental award (usually two years or more).

- Minority High School Students
- Minority Undergraduate Students
- Minority Graduate Research Assistants
- Minority Individuals in Postdoctoral Training
- M inority Investigators

Interactive Research Project Grants-Collaborate

The Interactive Research Project Grant (IRPG) program provides support for formal, investigator-initiated, collaborative relationships.

An IRPG group consists of the coordinated submission of two or more applications for related research project grants (R01) that do not require extensive shared physical resources. Although these applications must describe the objectives and scientific importance of the collaboration, each project could be accomplished independently. The principal investigators may be from one or more institutions. Each application will be reviewed independently for scientific merit and those judged to have substantial merit will be considered for funding both as an independent award and as a component of the proposed IRPG group.

	Research and Research Center (R, DP, RC, P, etc)	SBIR/STTR (R41, R42, R43, R44)	Fellowship (F30, F31, F32, F33)	Career Development (K01, K02, K07, K08, K23, K24, K25, K99)	Institutional Training (T32)	Shared Instrumentation (S10)
Overall Impact	*Overall Impact*	Overall Impact	Overall Impact/Merit	Overall Impact	Overall Impact	Overall Impact/Benefit
Scored Review Criteria (Scored individually and considered in overall impact/priority score)	✓ *Significance* ✓ *Investigator(s)* ✓ *Innovation* ✓ *Approach* ✓ *Environment* PAR & RFA: May add questions to each scored or additional criterion — FOA-specific — Not given individual criterion scores	✓ *Significance* ✓ *Investigator(s)* ✓ *Innovation* ✓ *Approach* ✓ *Environment*	✓ *Fellowship Applicant* ✓ *Sponsors, Collaborators, and Consultants* ✓ *Research Training Plan* ✓ *Training Potential* ✓ *Institutional Environment & Commitment to Training*	✓ *Candidate* ✓ *Career Development Plan/Career Goals & Objectives/Plan to Provide Mentoring* ✓ *Research Plan* ✓ *Mentor(s), Co-Mentor(s), Consultant(s), Collaborator(s)* ✓ *Environment & Institutional Commitment to the Candidate*	✓ *Training Program and Environment* ✓ *Training PD/PI* ✓ *Preceptors /Mentors* ✓ *Trainees* ✓ *Training Record* Other T programs use other criteria	✓ *Justification of Need* ✓ *Technical Expertise* ✓ *Research Projects* ✓ *Administration* ✓ *Institutional Commitment* □ Overall Benefit (not scored)
Additional Review Criteria (Not scored individually, but considered in overall impact/priority score)	R01-BRP only: □ Partnership and Leadership All: ✓ *Protections for Human Subjects* ✓ *Inclusion of Women, Minorities, & Children* ✓ *Vertebrate Animals* ✓ *Biohazards* □ Resubmission □ Renewal □ Revision	□ Phase II □ Fast Track ✓ *Protections for Human Subjects* ✓ *Inclusion of Women, Minorities, & Children* ✓ *Vertebrate Animals* ✓ *Biohazards* □ Resubmission □ Renewal □ Revision	✓ *Protections for Human Subjects* ✓ *Inclusion of Women, Minorities, & Children* ✓ *Vertebrate Animals* ✓ *Biohazards* □ Resubmission □ Renewal	✓ *Protections for Human Subjects* ✓ *Inclusion of Women, Minorities, & Children* ✓ *Vertebrate Animals* ✓ *Biohazards* □ Resubmission □ Renewal □ Revision	✓ *Protections for Human Subjects* ✓ *Inclusion of Women, Minorities, & Children* ✓ *Vertebrate Animals* ✓ *Biohazards* □ Resubmission □ Renewal □ Revision	✓ *Biohazards* □ Resubmission
Additional Review Considerations (Not scored individually and not considered in overall score)	R01-BRP only: ✓ *Technology Transfer* All: □ Applications from Foreign Organizations □ Select Agents □ Resource Sharing Plans ✓ *Budget & Period of Support*	□ Select Agents □ Resource Sharing Plans ✓ *Budget & Period of Support*	✓ *Training in the Responsible Conduct of Research* □ Applications from Foreign Organizations □ Select Agents □ Resource Sharing Plans ✓ *Budget & Period of Support*	✓ *Training in the Responsible Conduct of Research* □ Select Agents □ Resource Sharing Plans ✓ *Budget & Period of Support*	✓ *Recruitment & Retention Plan to Enhance Diversity* ✓ *Training in the Responsible Conduct of Research* □ Select Agents ✓ *Budget & Period of Support*	✓ *Budget & Period of Support*
Additional Comments to Applicant	Additional Comments to Applicant	Additional Comments to Applicant	Additional Comments to Applicant	Additional Comments to Applicant	Additional Comments to Applicant	Additional Comments to Applicant

1. Major criticisms that resulted in streamlining
2. Major problems in resubmission-unfundable priority score
3. Major concerns about significance/novelty/approach etc

PO, SRO, and GMS

The Good bad and the Ugly? It depends on your perspective….

But they are on your side

The three main groups involved in the application and award processes—program officers (POs), scientific review officers (SROs) and grants management specialists (GMSs). They have non-overlapping responsibilities.

Program Officers (PO) advise investigators on applying for grants, help them understand their summary statements and provide guidance on managing their awards. They also play a leading role in making funding decisions.

Scientific Review Officer (SRO)- Once NIH's Center for Scientific Review (CSR) assign applications to the appropriate institute or center and study section, SROs identify, recruit and assign reviewers to applications; run study section meetings; and produce summary statements following the meetings

Grant Management Specialists (GMS) GMSs manage financial aspects of grant awards and ensure that administrative requirements are met before issuing a notice of award.

When to contact your PO, SRO, and DMS?

Call, e-mail but be aware that yje calls and emails are monitored and the officials will be cautious in their response. Do not expect promises. They are dedicated professionals whose job is to help investigators. Be polite and courteous and specific.

Before submitting an application, contact the PO who manages the grant in your area of application.

During the review process, communicate with the SRO of the study section to which your application is assigned.

Once the summary statement is released, usually a few weeks after the study section meeting, contact the PO (not the SRO) assigned to your application if you have questions about the review or about the possibility of funding.

The following are some examples of the types of information or guidance that your program officer can:

Assess the fit of your application with a specific RFA or PA.

Discuss new topics that their NIH institute is interested in funding.

Assess which institute would be most interested in funding your research

Assess which study section is the best fit for your research proposal..

Assess the best grant type for your application..

Clarify any specific grant requirements

Answer questions about your Summary Statement.

1. Don’t call just to chat-

A program officer's opinion of you could literally determine whether or not you will be successful in your research career.

2. Have a definite topic that you would like to discuss

3. Don’t rant

4. Don’t blame the reviewers (It doesn’t work)

5. Don’t threaten

6. Don’t bribe

7. Don’t beg

It's OK to have informal chats with them outside of their offices—at a professional conference. Just don’t monopolize a program officer's time and **don't pester your program officer.**

It's Ok to send a short e-mail that summarizes your issue. e-Mail allows them to respond in detail at their convenience. E-mail also gives you a reference for later.

Stick to the major points and communicate them as clearly as possible. Don't bury the program officer in methodological details, concentrate on the big picture. Don't assume he or she will automatically understand your research in every detail.

Program officers are normally evaluated on the number of quality proposals that they support, not on the overall number of proposals coming into their programs. They have a vested interest in helping you craft **a quality proposal, so let them do it.**

DEVELOPING A SUCCESSFUL NIH GRANT PROPOSAL

Debopam Chakrabarti PhD
Molecular Microbiology Division
Burnett School of Biomedical Sciences
College of Medicine

Grant Development Process

- Define an unmet need
- Core Competency
- Competitive Barriers
- Technological Advantages

Art Of Grant Writing

- Difficult to outline a scientific approach to grantsmanship
- It is highly competitive
  - *Current funding is at 10th percentile*
- Goal is to write quality proposals
- We all think that our proposals are cutting edge science- so are the majority of submitted proposals
- How to make your proposal stand out from other excellent proposals.

How To Succeed In This All Time Low Funding Climate

- In addition to the scientific content of the proposal, the PI needs to also understand the art of persuasion, and marketing.
- Even if the science is excellent in the proposal, the reviewers may not realize the value.
- Because grant proposals are prospective, PI needs to define the value of proposed research.

Developing The Art Of Persuasion

- According to the PI, the value of the proposal is enormous.
- But the value may not be apparent to the reviewers.
- PI needs to define the value and the promise of the proposal clearly.
- Need to identify a problem and demonstrate how the work done in the proposal will solve the problem.

Generating Enthusiasm for Your Proposal

- You need to have the reviewer excited about the work proposed- generate an emotional reaction.
- Proposal needs to be important and exciting.
- It would appear to be innovative.

Need To Make The Proposal Reviewer Friendly

- ❖ Do not make the proposal dense- full of dry facts and logic.
- ❖ Overload of facts annoys reviewers.
- ❖ Annoyance leads to an indifferent review.
- ❖ Indifferent reviewer can be critical, which leads to finding holes in your proposal.
- ❖ Need to generate reviewers’ passion for your proposal in a subtle way.

Focus On Presenting Your Idea Lucidly On An Important Topic

- ❖ Need to develop a proposal focused on a problem of great significance.
- ❖ Develop the proposal with an aim to solve that problem.
- ❖ A proposal need to be written for non-specialists in the field.

What The Reviewers' Are Looking For?
Overall Impact and Significance

- ❖ Overall Impact: The likelihood for the project to exert a sustained, powerful influence on the research field involved.
- ❖ Significance: Does the project address an important problem or a critical barrier in the field? If the aims of the project are achieved how will the scientific knowledge, technical capabilities, or clinical outcome will drive the field
  - ❖ *Premise (pertaining to the strength of the scientific foundation) for objectives of the study*
  - ❖ *Is the project based on sound scientific knowledge or concept*

What The Reviewers' Are Looking For?
Investigators

- ❖ Are PI(s), collaborators, and other researchers well suited for the project?
- ❖ Are New Investigators/Early stage investigators have appropriate experience and training?
- ❖ Do established investigators demonstrated an ongoing record of accomplishments that have advanced their fields?
- ❖ If the project is collaborative, do the investigators have complementary or integrated expertise

What The Reviewers' Are Looking For? Innovation

- ❖ Does the application challenge and seek current research paradigms by utilizing novel concepts, approaches or methodologies, or interventions?
- ❖ Are the concepts, approaches or interventions novel in a broad sense?
- ❖ Does the research proposed leverage multi-disciplinary involvement to accelerate therapeutics or diagnostics product, may aspects are inherently innovative?
- ❖ Does the approach represent the best use of current and emerging technologies and approaches to achieve the research objective?

What Are The Reviewers’ Looking For?
Approach

- ❖ Are the overall strategy, methodology, and analyses well-reasoned and appropriate to accomplish the specific aims of the project?
- ❖ Are there strategies to ensure a robust and unbiased approach (e.g. proper control, reliability, statistical analyses)?
- ❖ Are potential problems, alternative strategies, and benchmarks for success presented?
- ❖ Are there consideration given to sex as a biological variables in experiments involving vertebrate animals?

What Are The Reviewers’ Looking For?
Environment

- ❖ Will the scientific environment in which the work will be done contribute to the probability of success?
- ❖ Are the institutional support and other physical resources available to the investigators adequate for the project proposed?
- ❖ Will the project benefit from unique features of the scientific environment, or collaborative arrangements?

Focus On Developing The Specific Aims

- ❖ The Specific Aims page is the most crucial component of the grant application
- ❖ This is an opportunity to gain reviewers’ confidence and enthusiasm.
- ❖ The specific aims section should be written for non experts in your field.

Managing a Research Project Budget and Resources

ELISE DANTUMA, MBA
ASSISTANT DIRECTOR, RESEARCH PROGRAMS
COLLEGE OF MEDICINE

Managing a Research Project Budget and Resources

Project Budget Considerations

At the time of Intent or Notice of Award

- Review the proposed budget – has anything significantly change?
- Setup a project kick-off meeting
  - Who will need ePAFs on the project? At what percentage?
  - Major equipment purchases needed?

Throughout the project timeline

- Review expenditures monthly – are the appropriate charges hitting the account?
  - Have the personnel working on the project changed? Do we need updated ePAFs?
  - What is the burn rate? Will the project be over/under spent by the end of the project?

End of project

- Have all of the project costs been accounted for? Have all personnel been moved off of the project?

Managing a Research Project Budget and Resources

Resources Management

Contracts/Agreements necessary for project operation (MTA, CDA, license, etc.)– are agreements needed under the project?

- Agreements need to be reviewed/approved/signed by the appropriate university department
- Earlier initiation of the process – the better! Do not want delays on project

Deliverables – when are deliverables due to the agency?

- At kick-off of the project, work with research office point of contact to review the requirements and timelines for deliverables

Promoting Effective Collaboration Within an Interdisciplinary Research Environment

Stephen M. Fiore, Ph.D.
University of Central Florida
Cognitive Sciences, Department of Philosophy and Institute for Simulation & Training

Fiore, S. M. (2017). Promoting Effective Collaboration Within an Interdisciplinary Research Environment. *Invited Talk at College of Medicine Research Project Management Training Symposium*, May 12th, Orlando, FL

Overview of UCF CoM and Team Science

OVERVIEW - Why Team Science?
- Setting the Stage

Part I. UCF CoM Challenge 1
- Defining Research Approaches

Part II. UCF CoM Challenge 2
- Understanding Team Science

Part III. UCF CoM Challenge 3
- Understanding Teamwork

Part IV. UCF CoM Challenge 4
- Preparing for Team Science

UNIVERSITY OF CENTRAL FLORIDA
College *of* Medicine

Why Team Science?
Setting the Stage

ISSUE - ***Dealing with Scholarly Structure***

- Disciplines are distinguished partly for historical reasons and reasons of administrative convenience (such as the organization of teaching and of appointments)… But all this classification and distinction is a comparatively unimportant and superficial affair. **We are not students of some subject matter but students of problems. And problems may cut across the borders of any subject matter or discipline** (Popper, 1963).

ISSUE - ***Dealing with University Structure***

- What is critical to realize is that "the way in which our universities have divided up the sciences does not reflect the way in which nature has divided up its problems" (Salzinger, 2003, p. 3)

ISSUE - Collaborations influencing the **practice of science** and **production of knowledge**. *To achieve success in scientific collaboration we must surmount these challenges.*

Popper, K. (1963). *Conjectures and Refutations: The Growth of Scientific Knowledge.* London: Routledge.

Salzinger, K. (2003). Moving Graveyards. *Psychological Science Agenda, Summer, 3.* Washington, DC: American Psychological Association.

Why Team Science?
Setting the Stage

UCF Cognitive Sciences

- Consider what was published on this topic in the journal *Science*:
  - "The interdisciplinary approach is becoming one of the prominent characteristics of [science] and represents a synthesizing trend which focuses the specialized research techniques on problems common to a number of separate disciplines. Such cooperative research has to overcome serious obstacles when operating within the existing departmentalized framework of the universities. It appears that real progress in this direction will be made in institutions which are organized on a permanent and frankly cooperative basis. Psychologically, interdisciplinary research requires not only abstract, theoretical intelligence…, but also 'social intelligence.' Cooperative work is a social art and has to be practiced with patience."

Part 1. Laying the Foundation for a Science of Team Science

UCF Cognitive Sciences

What is informative here?

- Increasing influence/importance of interdisciplinarity as method of inquiry
- Challenge of interdisciplinarity distinguished in 2 ways:

1) The problem of **INFRASTRUCTURE** - tangible and tacit

- Inherent challenge associated with structure of the modern university - **the discipline bound department**
- **Tacit norms** which prevent or stifle interaction amongst them

2) The problem of **INTERACTION**

- Difficulty in **communicating** across disciplines
- Need for patience and **particular form of social intelligence** to effectively collaborate

Part 1. Laying the Foundation for a Science of Team Science

- Anyone familiar with some manner of cross-disciplinary collaborative effort will likely have experienced some or all of these factors
  - ***So one might wonder why this quote is particularly informative***
- What is informative is not **<u>what</u>** was said,
  it is **<u>when</u>** it was said
  - ***Written well over a half century ago in one of first articles specifically addressing interdisciplinary research (Brozek & Keys, 1944).***
- **Science still struggles so why should we think anything will change?**
  - ***Should we be so bold as to think that we have a better chance at overcoming these challenges than those from generations before us?***

Part 1. Laying the Foundation for a Science of Team Science

YES - for THREE main reasons:

1. Increased **emphasis on collaborative research** projects that create a team of scholars cutting across disciplines to address complex phenomena
2. **Policy, Academia, and Industry** communities all making more of a concerted effort to understand and improve collaborations
3. Tremendous **growth** in study and understanding of teams

- ***It is the scientific study of teamwork that could be the true catalyst for change***
  - Matured into its own area of inquiry producing a rich base of knowledge
  - Helped us to better understand the complex coordinative processes engaged by teams

Overview of UCF CoM and Team Science

UCF Cognitive Sciences

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UNIVERSITY OF CENTRAL FLORIDA
College *of* Medicine

Part I. UCF CoM Challenge 1
Defining Research Approaches

UCF CoM CHALLENGE 1 - *Understand what it means to do research across disciplines*

CROSS-disciplinary Research

- Offer this as a general term to describe:
  - Research meant to utilize, in some way, varied concepts, methods, and theories from differing fields
  - Where science team members contribute their disciplinary expertise and collectively contribute to the production of new knowledge
  - ***Multi-, Inter-, and Trans-disciplinary Research***

Hall, K.L., Vogel, A. L., Stipelman, B.A., Stokols, D., Morgan, G., & Gehlert, S. (2012). A four-phase model of transdisciplinary team-based research: Goals, team processes, and strategies. *Translational Behavioral Medicine, 2(4)*, 415-430.

Klein, J. T. (2010). A taxonomy of interdisciplinarity. In R. Frodeman, J. T. Klein, & C. Mitcham (Eds.), *The Oxford Handbook of Interdisciplinarity* (pp. 15-30). Oxford: Oxford University Press.

National Academies, Committee on Facilitating Interdisciplinary Research (2004). *Facilitating interdisciplinary research.* Washington, DC: National Academies Press.

Stokols, D., Hall, K.L, Taylor, B., Moser, R.P., (2008). The science of team science: Overview of the field and introduction to the supplement. *American Journal of Preventative Medicine, 35(2S)*, S77-S89.

Part I. UCF CoM Challenge 1
Defining Research Approaches

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Cognitive Sciences

MULTI-disciplinary Research

- **Collaborative effort** of several disciplines to achieve a common goal
  - *Purpose is to achieve **broader analyses** of common research problems*
- Work independently or sequentially
  - *Periodically come together to **share perspectives***
- Contributions drawn from different disciplines are **complementary**
  - *In service of objective, adopts but not necessarily integrate methods, concepts, theories*

- ***Scientists in multidisciplinary teams remain firmly anchored in the concepts and methods of their respective disciplines.***

Part I. UCF CoM Challenge 1
Defining Research Approaches

INTER-disciplinary Research

- Demands **more than just complementarity**
  - Team members **combine or juxtapose** concepts and methods from different disciplines
  - Overarching goal is systematic **integration**
    - **Integrates** information, data, techniques, tools, perspectives, concepts, and/or theories from **two or more disciplines** or bodies of specialized knowledge
- ***Goal is to advance fundamental understanding or to solve problems whose solutions are beyond the scope of a single discipline or field of research practice.***

Part I. UCF CoM Challenge 1
Defining Research Approaches

UCF Cognitive Sciences

TRANS-disciplinary Research

- Integrates and **builds from** discipline-specific theories, concepts, and methods
  - Pursues collaboration **across levels of analysis** (e.g., from cells to society)
  - Develops **comprehensive understanding** of problem **(as a system)**
  - **May** also include:
    - A focus on **societal problems** and development of **practical knowledge**
    - **Translational partners** from differing sectors (NGO, Community, Industry)
- ***Transcends disciplinary perspectives and professions and enables development and application of new methodologic or conceptual frameworks***

Part I. UCF CoM Challenge 1
Defining Research Approaches

UCF Cognitive Sciences

Addressing UCF CoM Challenge 1

- Helps research teams realize mission
  - To **advance** (inter/trans)disciplinary education, research, practice
- Support research teams in their scientific goals
  - To utilize complementary approaches and/or to **integrate** knowledge
- Cultivate involvement of stakeholders
  - To develop knowledge… to translate scientific findings – from bench to bedside

- UCF CoM Goals
  - Assist members in **building collaborations** that strengthen research that does (or will) transcend disciplinary boundaries and solves (or will solve) complex problems

UCF CoM MESSAGE: ***UCF CoM should help teams pursue the appropriate form of cross-disciplinary research.***

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UNIVERSITY OF CENTRAL FLORIDA
College of Medicine

Part II. UCF CoM Challenge 2
Understanding Science of Team Science

UCF Cognitive Sciences

UCF CoM CHALLENGE 2 – *Understand what is the Science of Team Science*

- What do we mean by teams
  - Multiple information sources and intensive communication
  - Task-relevant knowledge with meaningful task interdependencies
  - Affective and attitudinal factors influence group dynamics
  - Coordination among members with specialized roles
- Reframing interdisciplinarity as a process of teamwork to be mastered (Fiore, 2008)
  - Allows us to leverage science of teams
  - Changes question to understanding team activities necessary for science
  - Makes the achievement and measurement of interdisciplinarity more tractable

Fiore, S. M. (2008). Interdisciplinarity as teamwork: How the science of teams can inform team science. *Small Group Research, 39(3),* 251-277.

Part II. UCF CoM Challenge 2
Understanding Science of Team Science

UCF Cognitive Sciences

A New Field - *Science of Team Science*

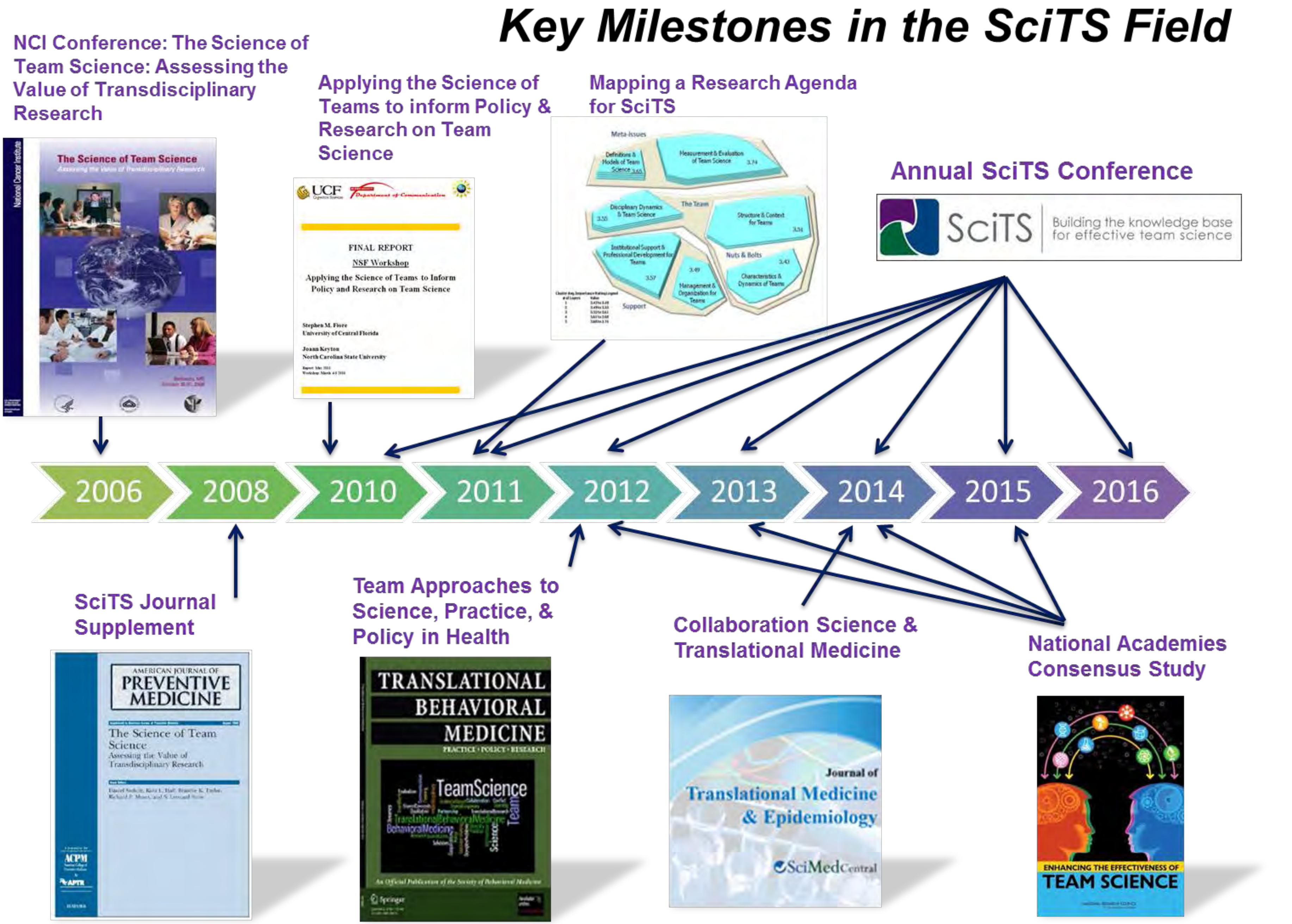
- Commitment to **develop scholarly examination of teamwork in science**
  - Goal to understand and improve how scholars interact and integrate across disciplinary, professional, and institutional boundaries

"*the inherent complexity of contemporary public health, environmental, political, and policy challenges… [leads to] realization that an integration of multiple disciplinary perspectives is required to better understand and ameliorate these problems*" (Stokols et al., 2008).

- Must understand how to make full use of the **scientific capacity** of science teams (Salazar et al., 2012)

Salazar, M. R., Lant, T. K., Fiore, S. M., & Salas, E. (2012). Facilitating innovation in diverse science teams through integrative capacity. *Small Group Research, 43(5),* 527-558.

Stokols, D., Misra, S., Moser, R. P., Hall, K. L., & Taylor, B. K. (2008b). The ecology of team science - Understanding contextual influences on transdisciplinary collaboration. *American Journal of Preventive Medicine, 35(2),* S96-S115.



Hall, K. L., Stipelman, B. A., Vogel, A. L., & Stokols, D. (in press). Understanding cross-disciplinary team-based research: Concepts and conceptual models from the Science of Team Science. In Frodeman, R., Klein, J. T., & Mitcham, C. (Eds). *Oxford Handbook on Interdisciplinarity, 2nd Edition*. Oxford, UK: Oxford University Press.

Part II. UCF CoM Challenge 2
Understanding Science of Team Science

UCF Cognitive Sciences

National Academies of Science Consensus Study

- **Rationale:** Clear need to **provide research-based guidance** to improve the processes and outcomes of team science
- **Sponsor:** National Science Foundation, Directorate of **Computer and Information Sciences and Engineering**

- **Goal:** **Enhance effectiveness** of collaborative research in science teams, research center, and institutes.
- **Audiences:** NSF and other **public and private research funders** and **scientific community**.

Enhancing the Effectiveness of Team Science (2015) -- http://www.nap.edu/catalog/19007/enhancing-the-effectiveness-of-team-science

Part II. UCF CoM Challenge 2
Understanding Science of Team Science

UCF Cognitive Sciences

NRC Report on *Enhancing the Effectiveness of Team Science*

Key Features	Ranges Possible in Team Science		
Size	Small (2)	⟷	Mega (1000s)
Task Interdependence	Low	⟷	High
Boundaries	Stable	⟷	Fluid
Goal Alignment	Aligned	⟷	Divergent or Misaligned
Integration	Unidisciplinary	⟷	Transdisciplinary
Diversity	Homogeneous	⟷	Heterogeneous
Proximity	Co-located	⟷	Globally Distributed

Part II. UCF CoM Challenge 2
Understanding Science of Team Science

UCF Cognitive Sciences

The GOOD NEWS

- The science points to interventions for:
  - Assembling teams
  - Providing professional development and education opportunities
  - Supporting leadership development opportunities
  - Virtual collaboration
  - P&T credit for team-based work
  - Study and measurement of science teams

UCF CoM MESSAGE: *UCF CoM help researchers understand that there is a rich and robust scholarly literature on team performance that can improve team science effectiveness*

Overview of UCF CoM and Team Science

UCF Cognitive Sciences

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UNIVERSITY OF CENTRAL FLORIDA
College of Medicine

Part III. UCF CoM Challenge 3
Understanding Teamwork Basics

UCF Cognitive Sciences

Guidance for UCF CoM

- GOAL 1: Provide summary of subset of concepts necessary for team effectiveness
- GOAL 2: Make explicit key areas of teamwork necessary for success on collaborative research
  - Good scientists already reflect on their scientific process; that is, they reflect on the research processes
    - In which s/he is engaged
    - In which his/her colleagues and peers are engaged
    - In which his/her students are engaged
- OUTCOME: Recognize that, to be a good 'team scientist' researchers also need to reflect on *team processes*

Part III. UCF CoM Challenge 3
Understanding Teamwork Basics

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Cognitive Sciences

THINK	FEEL	DO
Cognition	Affect	Behaviors
Knowledge Component	Attitudinal Components	Skill Components

Knowledge Component

- Mental Models
- Metacognition
- Decision Making
- Problem Solving

Attitudinal Components

- Cohesion
- Collective Efficacy
- Collective Orientation
- Trust

Skill Components

- Leadership Sharing
- Communication
- Performance Monitoring
- Backup Behavior

Part III. UCF CoM Challenge 3
Understanding Teamwork Basics

UCF Cognitive Sciences

Effective teams engage in both taskwork and teamwork (Fiore et al., 2015; Fiore, 2008)

- **TASKwork refers to what needs to be accomplished to meet goals and complete objectives**
- **This is the scientific "work" of science teams**
  - **Understanding the relevant theory and constructs**
  - **Developing studies and executing appropriate methods**
  - **Conducting analyses and interpreting results and writing up findings**
- **TEAMwork refers to the attitudinal, behavioral, and cognitive factors required to function effectively as part of an interdependent team**
  - **Attitudinal – Affect arising from working with teammates (trust)**
  - **Behavioral – Skills supporting interacting with teammates (communication)**
  - **Cognitive - Knowledge associated with teammates (roles, responsibilities)**

Fiore, S. M. (2008). Interdisciplinarity as Teamwork: How the Science of Teams can inform Team Science. *Small Group Research*, *39(3)*, 251-277.

Fiore, S.M., Carter, D.R., & Asencio, R. (2015). Conflict, Trust, and Cohesion: Examining Affective and Attitudinal Factors in Science Teams. In E. Salas, W.B. Vessey, & A.X. Estrada (Eds.), *Team Cohesion: Advances in Psychological Theory, Methods and Practice* (pp. 271-301). Emerald Group Publishing Limited.

Part III. UCF CoM Challenge 3
Understanding Teamwork Basics

UCF Cognitive Sciences

Need to MEASURE Taskwork and Teamwork

- **Questionnaires using Self and Peer Ratings**
  - Ohland et al. (2012) - Comprehensive Assessment of Team Member Effectiveness (CATME)
  - Assesses teamwork and taskwork using **behavioral referents**:
    - (1) **contributing** to the team's work
    - (2) **interacting** with teammates
    - (3) keeping the **team on track**
    - (4) expecting **quality**
    - (5) having **relevant KSAs**

Ohland, M.W., Loughry, M.L., Woehr, D.J., Finelli, C.J., Bullard, L.G., Felder, R.M., Layton, R.A., Pomeranz, H.R., & Schmucker, D.G. (2012). The Comprehensive Assessment of Team Member Effectiveness: Development of a Behaviorally Anchored Rating Scale for Self and Peer Evaluation. *Academy of Management Learning & Education, 11 (4)*, 609-630.

						This self and peer evaluation asks about how you and each of your teammates contributed to the team during the time period you are evaluating. For each way of contributing, please read the behaviors that describe a "1", "3," and "5" rating. Then confidentially rate yourself and your teammates.
Contributing to the Team's Work	**5**	**5**	**5**	**5**	**5**	• Does more or higher-quality work than expected. • Makes important contributions that improve the team's work. • Helps to complete the work of teammates who are having difficulty.
	4	**4**	**4**	**4**	**4**	Demonstrates behaviors described in both 3 and 5.
	3	**3**	**3**	**3**	**3**	• Completes a fair share of the team's work with acceptable quality. • Keeps commitments and completes assignments on time. • Fills in for teammates when it is easy or important.
	2	**2**	**2**	**2**	**2**	Demonstrates behaviors described in both 1 and 3.
	1	1	1	1	1	• Does not do a fair share of the team's work. Delivers sloppy or incomplete work. • Misses deadlines. Is late, unprepared, or absent for team meetings. • Does not assist teammates. Quits if the work becomes difficult.
Interacting with Teammates	**5**	**5**	**5**	**5**	**5**	• Asks for and shows an interest in teammates' ideas and contributions. • Improves communication among teammates. Provides encouragement or enthusiasm to the team. • Asks teammates for feedback and uses their suggestions to improve.
	4	**4**	**4**	**4**	**4**	Demonstrates behaviors described in both 3 and 5.
	3	**3**	**3**	**3**	**3**	• Listens to teammates and respects their contributions. • Communicates clearly. Shares information with teammates. Participates fully in team activities. • Respects and responds to feedback from teammates.
	2	**2**	**2**	**2**	**2**	Demonstrates behaviors described in both 1 and 3.
	1	1	1	1	1	• Interrupts, ignores, bosses, or makes fun of teammates. • Takes actions that affect teammates without their input. Does not share information. • Complains, makes excuses, or does not interact with teammates. Accepts no help or advice.
Keeping the Team on Track	**5**	**5**	**5**	**5**	**5**	• Watches conditions affecting the team and monitors the team's progress. • Makes sure that teammates are making appropriate progress. • Gives teammates specific, timely, and constructive feedback.
	4	**4**	**4**	**4**	**4**	Demonstrates behaviors described in both 3 and 5.
	3	**3**	**3**	**3**	**3**	• Notices changes that influence the team's success. • Knows what everyone on the team should be doing and notices problems. • Alerts teammates or suggests solutions when the team's success is threatened.
	2	**2**	**2**	**2**	**2**	Demonstrates behaviors described in both 1 and 3.
	1	1	1	1	1	• Is unaware of whether the team is meeting its goals. • Does not pay attention to teammates' progress. • Avoids discussing team problems, even when they are obvious.

What about conflict…?

Item	Type	Rank	Conflict Experienced
1	L		TEAM members disagree about the optimal amount of time to spend in meetings
2	T		TEAM argues the pros and cons of different options
3	R		Personality conflicts are evident in your TEAM
4	C		Tension in your TEAM is caused by member(s) not completing their assignment(s) on time
5	T		Members of your TEAM engage in debate about different opinions or ideas
6	R		There is tension among members of your TEAM
7	T		TEAM members discuss evidence for alternative viewpoints
8	L		TEAM members disagree about the optimal amount of time to spend on different parts of teamwork
9	L		Members of your TEAM disagree about who should do what
10	R		Friction exists among members of your TEAM
11	C		Tension in your TEAM is caused by member(s) not performing as well as expected
12	R		There is emotional tension among members of your TEAM
13	C		Tension in your TEAM is caused by member(s) arriving late to meetings

Behfar, K. J., Mannix, E. A., Peterson, R. S., & Trochim, W. M. (2011). Conflict in Small Groups: The Meaning and Consequences of Process Conflict. *Small Group Research*, *42(2)*, 127-176.

Part III. UCF CoM Challenge 3
Understanding Teamwork Basics

UCF Cognitive Sciences

Need to Distinguish Between FORMS of CONFLICT

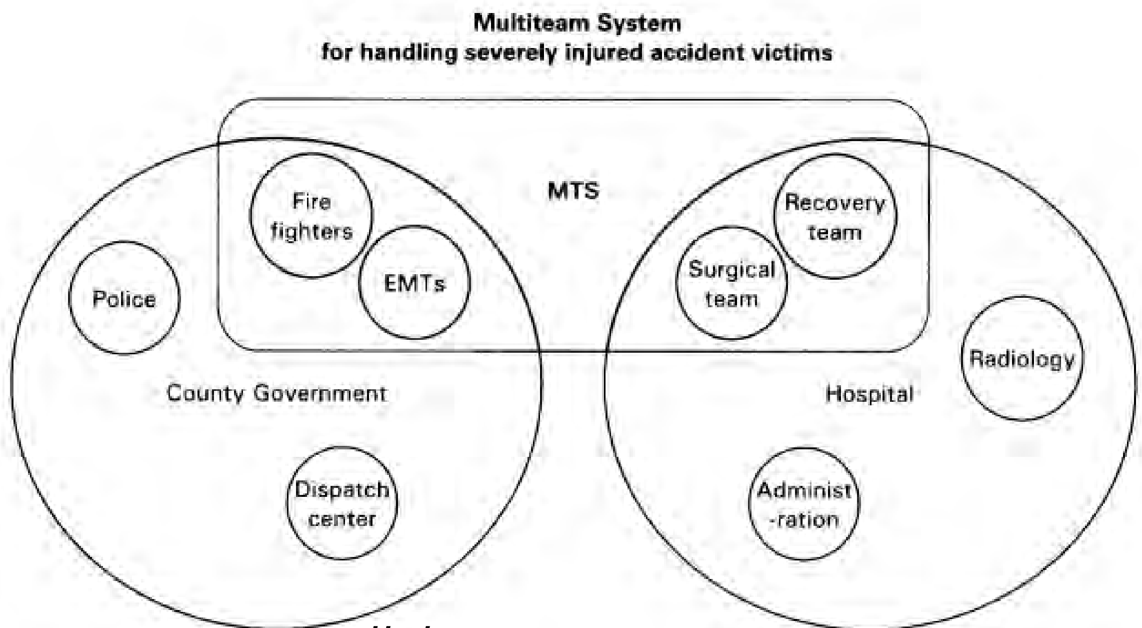
- TASK Conflict
  - Awareness of differences in viewpoints regarding group's task
  - Discussing pros and cons, considering alternative courses of action, or evaluating how conflicting evidence fits with the group's decisions.
- RELATIONSHIP Conflict
  - Awareness of interpersonal incompatibilities, including feelings of tension/friction
  - Associated with negative emotion and strongly reflects operating norms
- CONTRIBUTION Conflict
  - Conflict about member contributions (or lack thereof) that disrupts group process.
  - Influences member satisfaction and commitment to the group
  - Disrupts planned process for getting work done (members must compensate)
- LOGISTICAL Conflict
  - Disagreements about how to most effectively organize/utilize resources to accomplish task
  - Assigning member responsibilities and deciding how to best use group's time and resources.

Behfar, K. J., Mannix, E. A., Peterson, R. S., & Trochim, W. M. (2011). Conflict in Small Groups: The Meaning and Consequences of Process Conflict. *Small Group Research*, *42(2)*, 127-176.

Part III. UCF CoM Challenge 3
Understanding Teamwork Basics

UCF Cognitive Sciences

- **Multiteam System (MTS)**
  - "two or more teams that interface directly and interdependently in response to environmental contingencies toward the accomplishment of collective goals" (Mathieu, Marks, & Zaccaro, 2001, p. 290).



- **Challenges**
  - *Maintain internal team dynamics, manage collaborations across team boundaries*
  - *Deal with conflicting sub-goals while achieving overall goal*
  - *Understanding how problem solving unfolds within and across teams*

Mathieu, J. E., Marks, M. A., & Zaccaro, S. J. (2001). Multi-team systems. In N. Anderson, D. Ones, H. K. Sinangil, & C. Viswesvaran (Eds.), International handbook of work and organizational psychology (pp. 289 –313). London: Sage.

Part III. UCF CoM Challenge 3
Understanding Teamwork Basics

MTS particularly applicable to scientific ecosystem - Complexity of transdisciplinary scientific problems and translation of knowledge

Part III. UCF CoM Challenge 3
Understanding Teamwork Basics

UCF Cognitive Sciences

Collaboration CHALLENGE 3 – *Understand Teamwork Basics*

- We must understand the complex inter-relations between these factors and how they relate to scientific productivity (Fiore, 2008).
  - Management of TEAMwork and TASKwork related to effectiveness of science teams (e.g., addressing variations in knowledge and conflict arising)
  - Nature of the teamwork competencies will vary tremendously and influence outcomes of scientific collaboration
  - Recognize that varied forms of conflict will occur as project complexity increases.
  - Recognize complexity inherent in multi-team systems approach to scientific ecosystem

UCF CoM MESSAGE: *Develop understanding of foundational concepts in teamwork to make scientific discoveries and develop new treatments in service of society.*

Overview of UCF CoM and Team Science

OVERVIEW - Why Team Science?
- Setting the Stage

Part I. UCF CoM Challenge 1
- Defining Research Approaches

Part II. UCF CoM Challenge 2
- Understanding Team Science

Part III. UCF CoM Challenge 3
- Understanding Teamwork

Part IV. UCF CoM Challenge 4
- Preparing for Team Science

UNIVERSITY OF CENTRAL FLORIDA
College of Medicine

Part IV. UCF CoM Challenge 4
Preparing for the Team in Team Science

UCF CoM CHALLENGE 4 – Challenge in preparing researchers for the team part of team science initiatives

- **Research Orientation Scale** (Hall, Stokols, et al., 2008)
- Assesses **collaboration values and attitudes** in science team members
- Measures each of four major research orientations:
  - Unidisciplinary
  - Multidisciplinary
  - Inter/Transdisciplinary

Hall, K. L., Stokols, D., Moser, R. P., Taylor, B. K., Thornquist, M. D., Nebeling, L. C., et al. (2008). The collaboration readiness of transdisciplinary research teams and centers findings from the National Cancer Institute's TREC Year-One evaluation study. *American Journal of Preventive Medicine, 35(2S)*, S161-S172.

Part IV. UCF CoM Challenge 4
Preparing for the Team in Team Science

UCF Cognitive Sciences

- **Scholarly Activities Scale** (Hall, Stokols, et al., 2008)
- Assesses **intentions for exploration** in science team members
- Assesses **behaviors demonstrating integration** in science team members

Referring to ALL of your professional activities:	*Never*	*Rarely*	*Once a Year*	*Twice a Year*	*Quarterly*	*Monthly*	*Weekly*
(1) Read journals or publications outside of your primary field	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
(2) Attend meetings or conferences outside of your primary field	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
(3) Participate in working groups or committees with the intent to integrate ideas with other participants	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
SUM SCORE from Items 1 thru 3: ________							
(4) Obtain new insights into your own work through discussion with colleagues who come from different fields or disciplinary orientations	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
(5) Modify your own work or research agenda as a result of discussions with colleagues who come from different fields or disciplinary orientations	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
(6) Establish links with colleagues from different fields or disciplinary orientations that have led to or may lead to future collaborative work	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
SUM SCORE from Items 4 thru 6: ________							

Hall, K. L., Stokols, D., Moser, R. P., Taylor, B. K., Thornquist, M. D., Nebeling, L. C., et al. (2008). The collaboration readiness of transdisciplinary research teams and centers findings from the National Cancer Institute's TREC Year-One evaluation study. *American Journal of Preventive Medicine, 35(2S)*, S161-S172.

Part IV. UCF CoM Challenge 4
Preparing for the Team in Team Science

UCF Cognitive Sciences

NIH Field Guide's Scientific "Prenuptial Agreement"

- Collaborative agreement first and most important step toward a successful research partnership
  - Best way to **begin to develop trust** among those with whom you wish to have strong, highly collaborative scientific interactions
- Can lay the **foundation** for the continued relationship by **putting a system in place** that establishes and supports trust.
  - **Explicitly and precisely state goals** of the project
  - Describe how each of the **collaborators will contribute** to the project
  - Delineate how to handle **communications, data sharing, differences of opinion, and other project management** process issues
  - Address **administrative aspects of the collaboration**—finances, accountability, staffing, etc.
  - Provide an opportunity to **reflect on potential conflicts** of interest

ADAPTED FROM: Bennett, L. M., Gadlin, H., & Levine-Finley, S. (2010). *Collaboration & Team Science: A Field Guide.* Bethesda, MD: National Institutes of Health.

Part IV. UCF CoM Challenge 4

Preparing for the Team in Team Science

UCF Cognitive Sciences

Overall Goals [VISION]
- [K] What are the scientific issues to be addressed?
- [H] What are the scientific goals we are pursuing?
- [R] What are the anticipated products of the collaboration?

Who Will Do What? [TASK ORIENTED]
- [S] What are the expected contributions of each participant?
- [N] Who will write any progress reports and final reports?
- [B] How and by whom will data be managed? How will access to data be managed? How will you handle long-term storage and access to data after the project is complete?

Who Will Do What? [PROCESS ORIENTED]
- [M] What will be your mechanism for routine communications among members of the research team (to ensure that all appropriate members of the team are kept fully informed of relevant issues)?
- [E] How and by whom will personnel decisions be made?
- [T] How and by whom will personnel be supervised?

Authorship, Credit [MANAGEMENT]
- [F] What will be the criteria and the process for assigning authorship and credit?
- [J] How will credit be attributed to each collaborator's institution for public presentations, abstracts, and written articles?
- [I] How and by whom will public presentations be made?
- [C] How and by whom will media inquiries be handled?
- [U] When and how will you handle intellectual property and patent applications?

Contingencies [OUTCOMES ORIENTED]
- [G] When is the project over?
- [L] How will you decide about redirecting the research agenda as discoveries are made?
- [P] How will you negotiate the development of new collaborations and spin-off projects, if any?
- [D] Should one of the principals of the research team move to another institution or leave the project, how will you handle data, specimens, lab books, and authorship and credit?

Conflict of Interest [ETHICS ORIENTED]
- [O] How will you identify potential conflicts of interest among collaborators?
- [A] Could a collaborator or any close family members or associates benefit financially from the research?
- [Q] Is a collaborator receiving money from someone who could benefit financially from the research?

Part IV. UCF CoM Challenge 4

Preparing for the Team in Team Science

UCF Cognitive Sciences

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Part IV. UCF CoM Challenge 4
Preparing for the Team in Team Science

UCF Cognitive Sciences

Developing a Collaboration Agreement

- Building and maintaining trust takes work
  - There is a risk in hoping (assuming) there will be interpersonal agreement
- Being explicit about trust is challenging but effective collaboration tool
  - Difficult to achieve trust if not explicit about what expect from each other
  - Helps focus on quality of scientific and relational interactions in teams
- Remember
  - Written collaborative agreement can provide guidelines and processes for addressing every major issue that might arise in a collaboration

UCF CoM MESSAGE: ***The time to decide how to address issues is at the beginning of the collaboration before there are any problems to resolve.***

ADAPTED FROM: Bennett, L. M., Gadlin, H., & Levine-Finley, S. (2010). *Collaboration & Team Science: A Field Guide.* Bethesda, MD: National Institutes of Health.

Part IV. UCF CoM Challenge 4
Preparing for the Team in Team Science

Research teams need to understand how to plan for variety of research outcomes when working on team science

Outcomes from Team Science (Pennington, 2011)

- Quality and form of the material artifacts produced
- Quality and nature of shared vocabulary developed
- Density and diffusion of social ties created/strengthened
- Number of collaboration skills developed

Project Outcomes (Cummings & Kiesler, 2005)

- Ideas
  - Started new field or area of research
  - Created new grants or spin-off projects
  - Developed new methodologies
  - Recognized for contribution to field
- Tools
  - Created new software
  - Created new hardware
  - Generated new datasets
  - Submitted patent application
- Education/Learning
  - Undergrad/graduate student finished thesis
  - Undergrad/graduate/postdoc got academic job
  - Undergrad/graduate/postdoc got industry job
- Outreach
  - Formed partnership with industry
  - Formed community relationships through research
  - Formed collaborations with different researchers

Cummings, J.N., S. Kiesler. (2005). Collaborative Research Across Disciplinary and Organizational Boundaries. Social Studies of Science, 35(5), 703-722.

Pennington, D., (2011), Collaborative, cross-disciplinary learning and co-emergent innovation in informatics teams. International Journal of Earth System Informatics, 4(2), 55-68.

Summary of UCF CoM and Team Science

UCF Cognitive Sciences

CHALLENGES for UCF CoM to Help Advance Team Science

- UCF CoM CHALLENGE 1
  - Challenge in <u>defining what is meant</u> by cross-disciplinarity
  - *UCF CoM should help teams pursue the <u>appropriate form</u> of cross-disciplinary research..*
- UCF CoM CHALLENGE 2
  - Challenge in understanding <u>what is meant by team science</u>
  - *UCF CoM help researchers understand that there is a rich and robust scholarly literature on team performance that can improve team science effectiveness*
- UCF CoM CHALLENGE 3
  - Challenge in understanding <u>how to do</u> scientific teamwork
  - *UCF CoM should develop understanding of foundational concepts in teamwork to make scientific discoveries and develop new treatments in service of society.*
- UCF CoM CHALLENGE 4
  - Challenge in preparing researchers for the <u>team part</u> of team science initiatives
  - *UCF CoM should prepare to help researchers address issues at the beginning of the collaboration before there are any problems to resolve.*

The **Annual International Science of Team Science (SciTS)**

June 12-14, 2017, Clearwater Beach, FL

Conference is a forum to enhance our understanding of how best to engage in team science to meet society's needs (www.scienceofteamscience.org)

Thank You!

Questions or Comments?

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The Role of Bioinformatics in Life Sciences Research

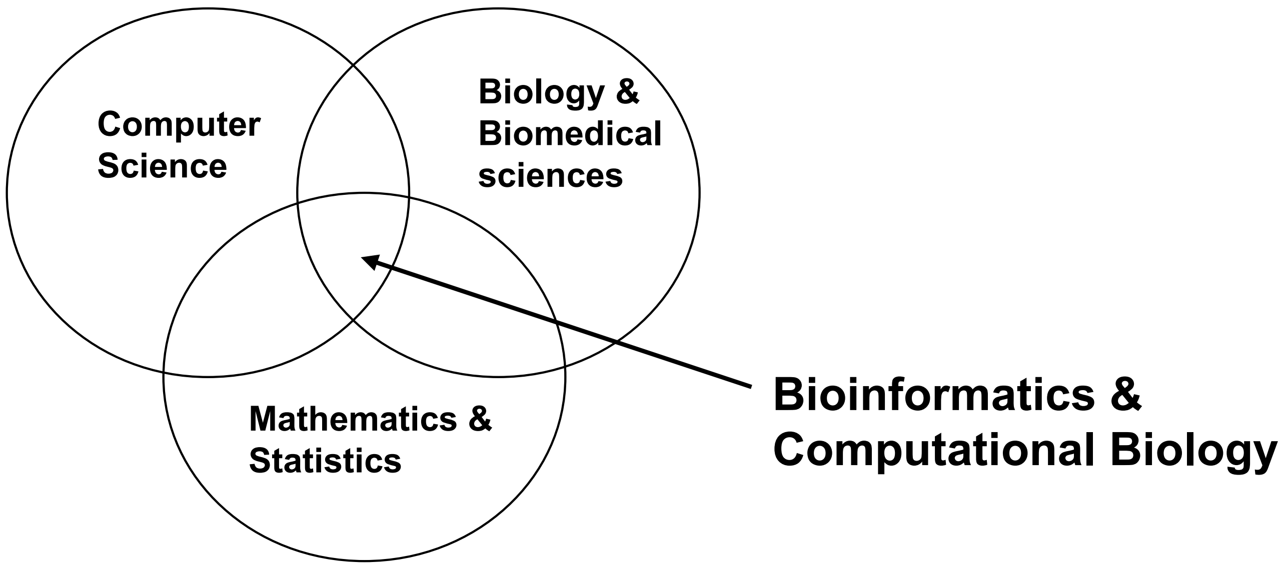
Shibu Yooseph
Professor
Department of Computer Science
Genomics and Bioinformatics Cluster lead

1. Introduction
2. Brief history
3. Bioinformatics at UCF

Bioinformatics

- *Development of computational methods and tools for analyzing biological data*

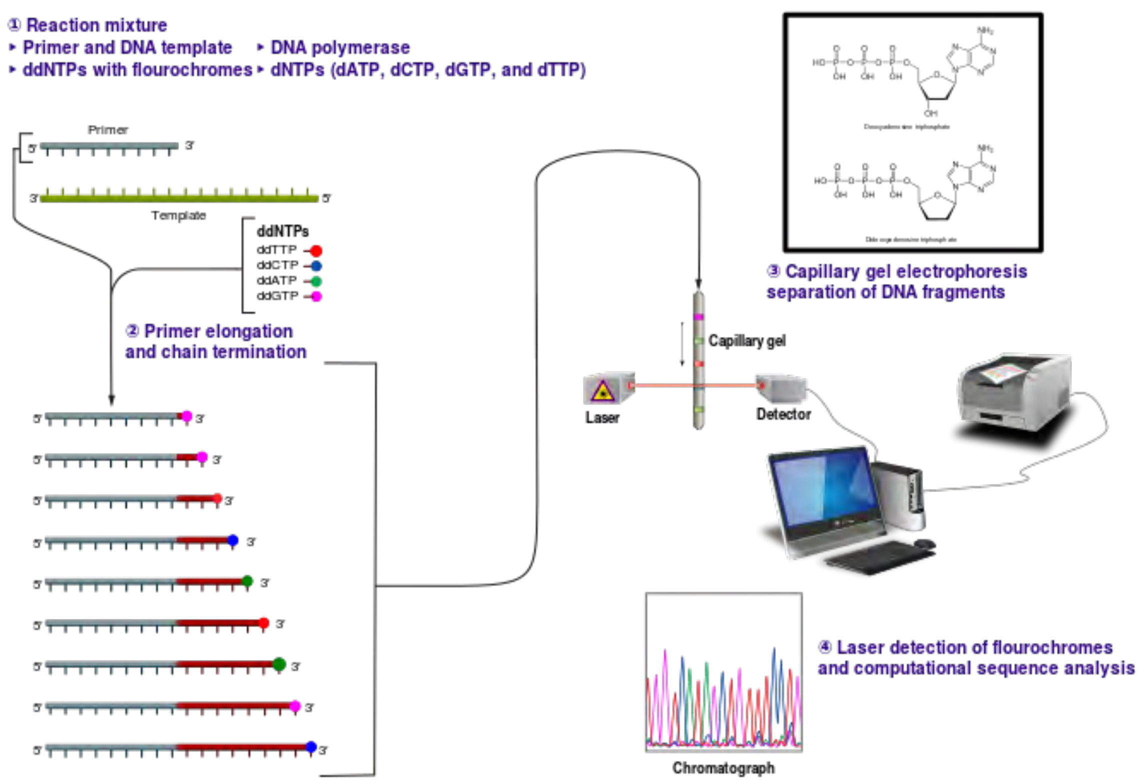
- Interdisciplinary science



Brief history of field

- 40+ years old
- Early work on biological sequence comparison and analysis
- Evolutionary biology and phylogenetics
- RNA structure prediction
- Protein structure prediction
- Biological sequence databases
- …

DNA sequencing



Sanger Sequencing

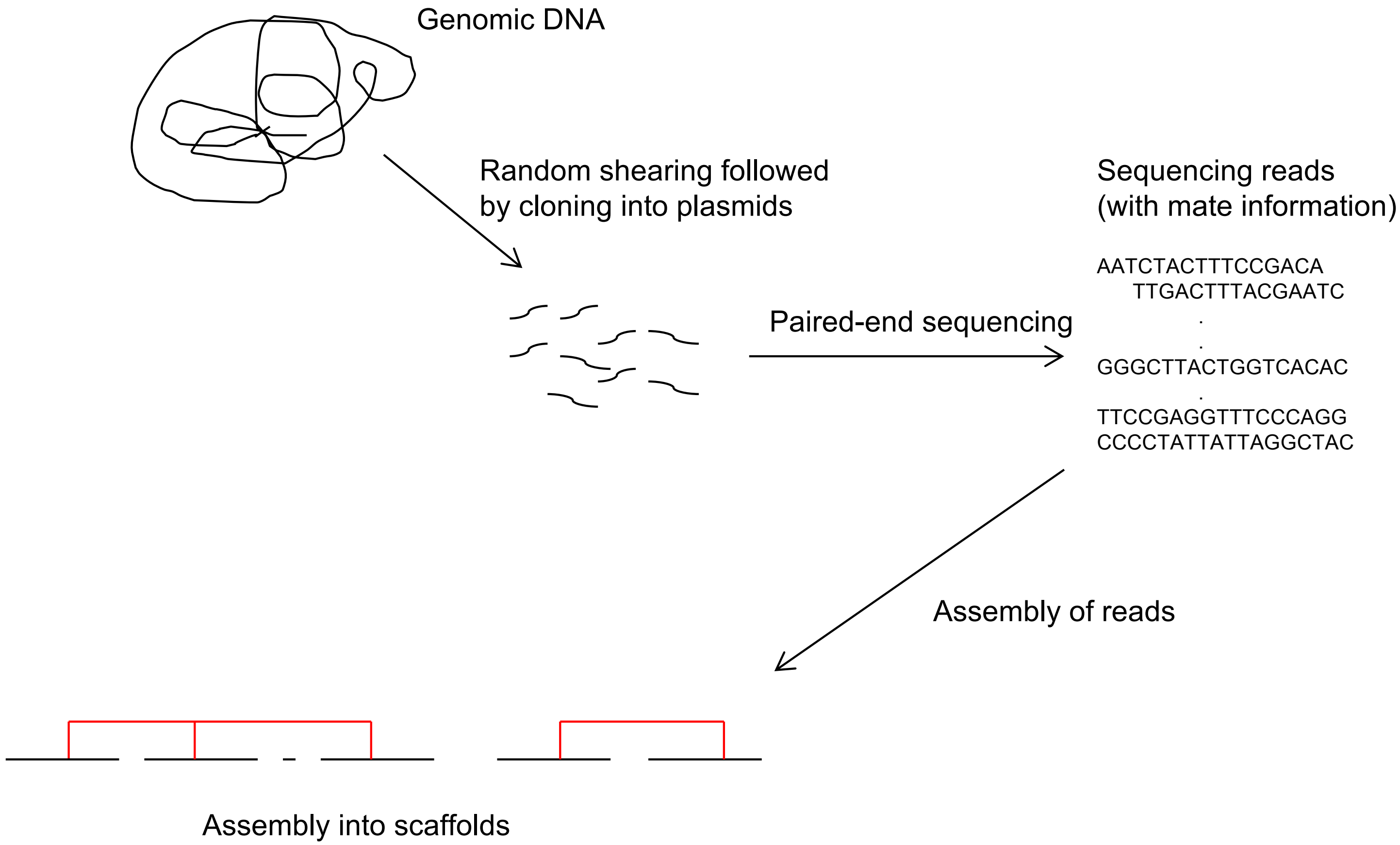
https://en.wikipedia.org/wiki/Sanger_sequencing

First draft of the human genome published in 2001

Venter et al, *Science* 2001

Lander et al, *Nature* 2001

Whole Genome Shotgun (WGS) sequencing



Genome Assembly

Genome Sequence

```
GTTAGACGTTGCGCTGGCTGCATCCTGCCCACCTCACCCGCACCTGACACCTTCTAGCCTGAGTCTTGCT
CAGTGATCTAGACGCGTGCCCTGTGTCTTGTAAGGCCCGGACTGTGAGAACGCCAGCCGGACCGACGCAG
ATAGAGCGGCAATTCGGACCGGTTTCGACCGGCACCGGAAGGTCGCATCAGGTGCTGGAAGGACGCATCT
TGGCAGTCTCTCGCGAGAGCAAGTCAGTAGATTCCAACAACTCCGTCCCAGGAGCGCCGAACCGAGTCTC
Gene 1 →  GTTCGCCAAGCTGCGCGAACCGCTTGAGGTTCCGGGCCTGCTCGAAGTGCAGACGGATTCCTTCGAGTGG
CTGATCGGCTCGGACCGCTGGCGCTCGAAGGCAGTCGACCGCGGCGACATCAACCCGGTCGGTGGCCTCG
AAGAGGTCCTCGCCGAGCTGTCGCCGATCGAGGACTTCGCCGGCACCCTGTCGCTGAGCTTCTCCGACCC
GCGCTTCGACGAGGTCAAGGCTCCCGTCGACGAGTGCAAGGAAAAGGACCAGACGTACGCGGCCCCGCTG
TTCGTCACGGCTGAGTTCATCAACAACACCACCGGCGAGATCAAGAGCCAGACGGTCTTCATGGGTGACT
TCCCGATGATGACCGAAAAGGGCACCTTCATCATCAACGGCACCGAGCGCGTCGTCGTCTCGCAGCTCGT
CCGTTCGCCCGGTGTGTACTTCGACGAGTCCATCGACAAGGCCACCGAGAAGACCCTGCACAGCGTCAAG
GTCATCCCGGGCCGTGGCGCCTGGCTGGAGTTCGACGTCGACAAGCGCGACACCGTCGGTGTCCGCATCG
ACCGCAAGCGCCGCCAGCCGGTCACCGTGCTGCTGAAGGCGCTCGGCTGGACCAACGAGCAGATCCGCGA
GCGCTTCGGCTTCTCCGAGATCATGATGGGCACCCTCGAGAAGGACCCGACCGCCGGTCCCGACGAGGCG
CTGCTGGACATCTACCGGAAGCTGCGCCCGGGCGAGCCCCCGACCAAGGAGTCGGCGCAGACCCTGCTGG
AGAACCTGTTCTTCAAGGAGAAGCGTTACGACCTGGCCCGGGTGGGCCGGTACAAGGTCAACAAGAAGCT
GGGCCTGCACGACGGCAACCCGGCTCAGGTGACCGCGACGACGCTGACCGAAGAGGACATCGTCGCCACC
Gene 2 →  ATCGAGTACCTGGTGCGCCTGCACGACGGTGACACCAAGATGACCGCTCCCGGCGGCGTCGAGGTCCCCG
TCGAGGTCGACGACATCGACCACTTCGGCAACCGTCGTCTGCGTACCGTGGGCGAGCTGATCCAGAATCA
GATCCGGGTCGGCCTCTCGCGTATGGAGCGCGTCGTCCGCGAGCGCATGACCACGCAGGACGTCGAGGCG
ATCACCCCGCAGACCCTGATCAACATCCGTCCCGTCGTGGCGGCGATCAAGGAGTTCTTCGGCACGTCGC
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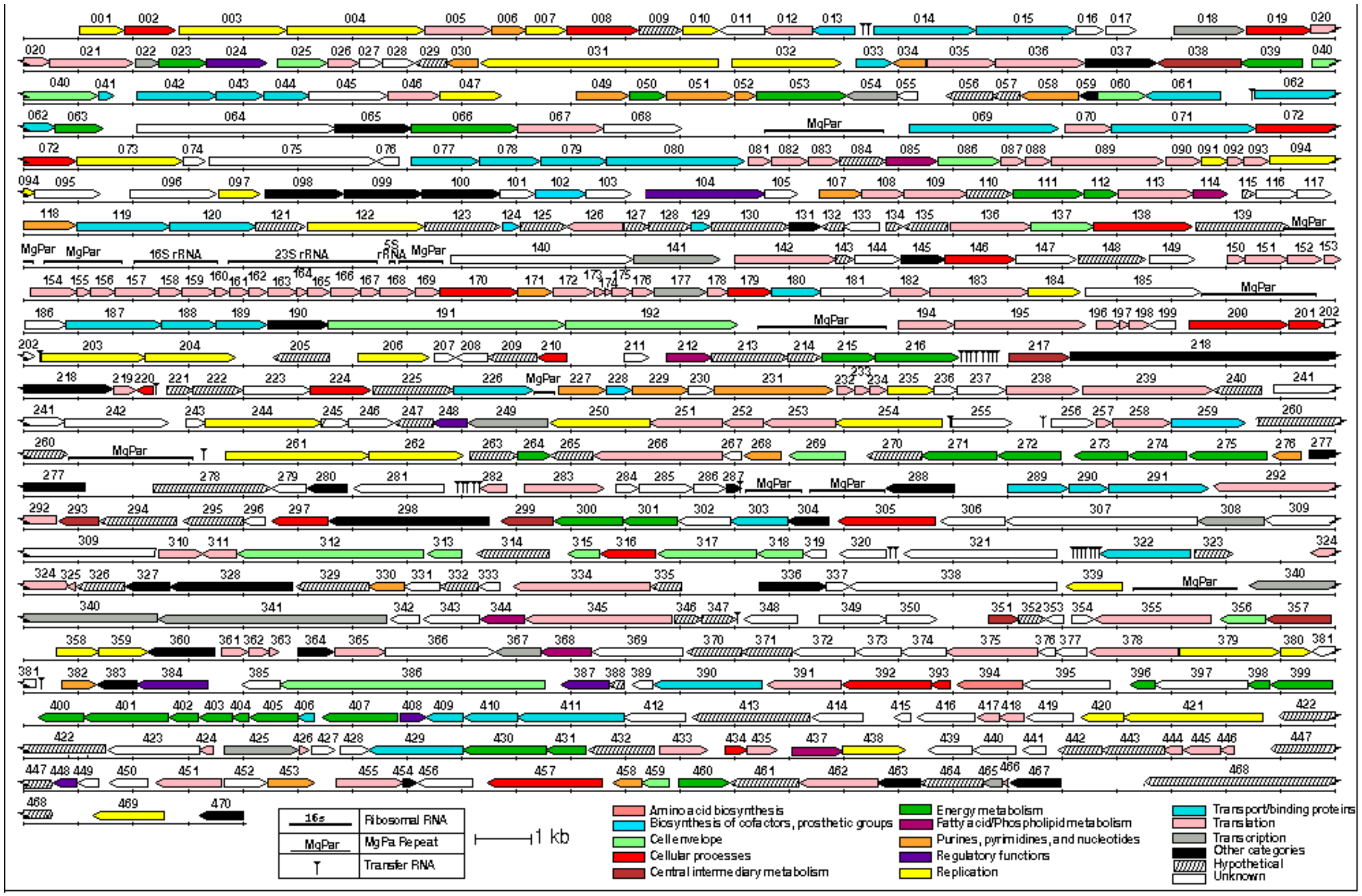
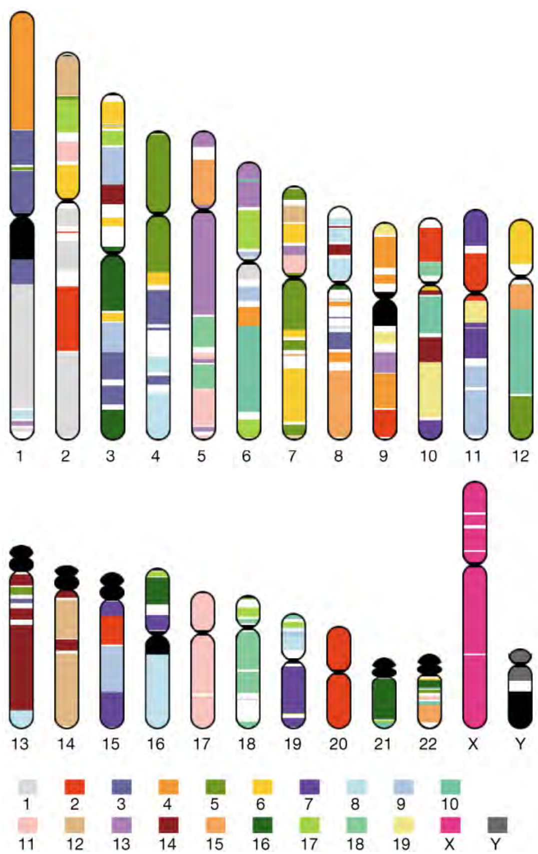
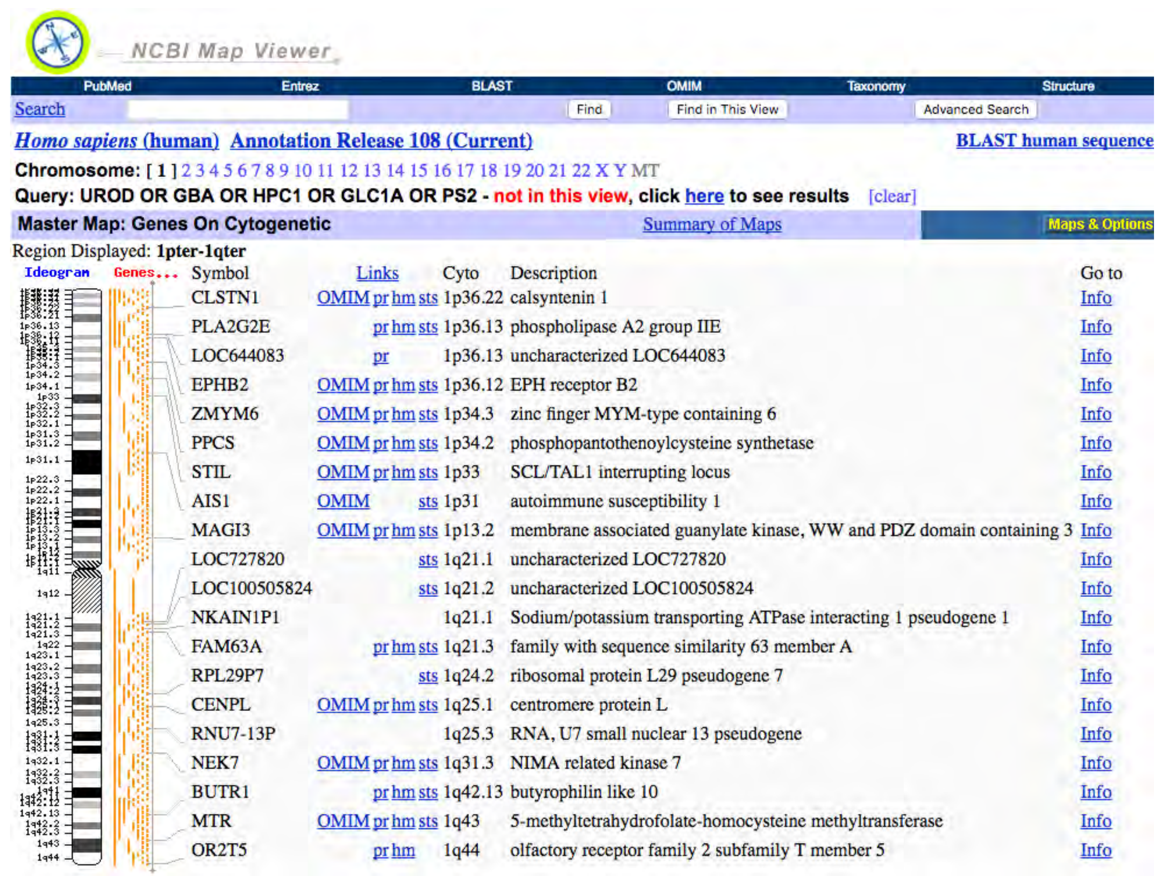
Genome Annotation

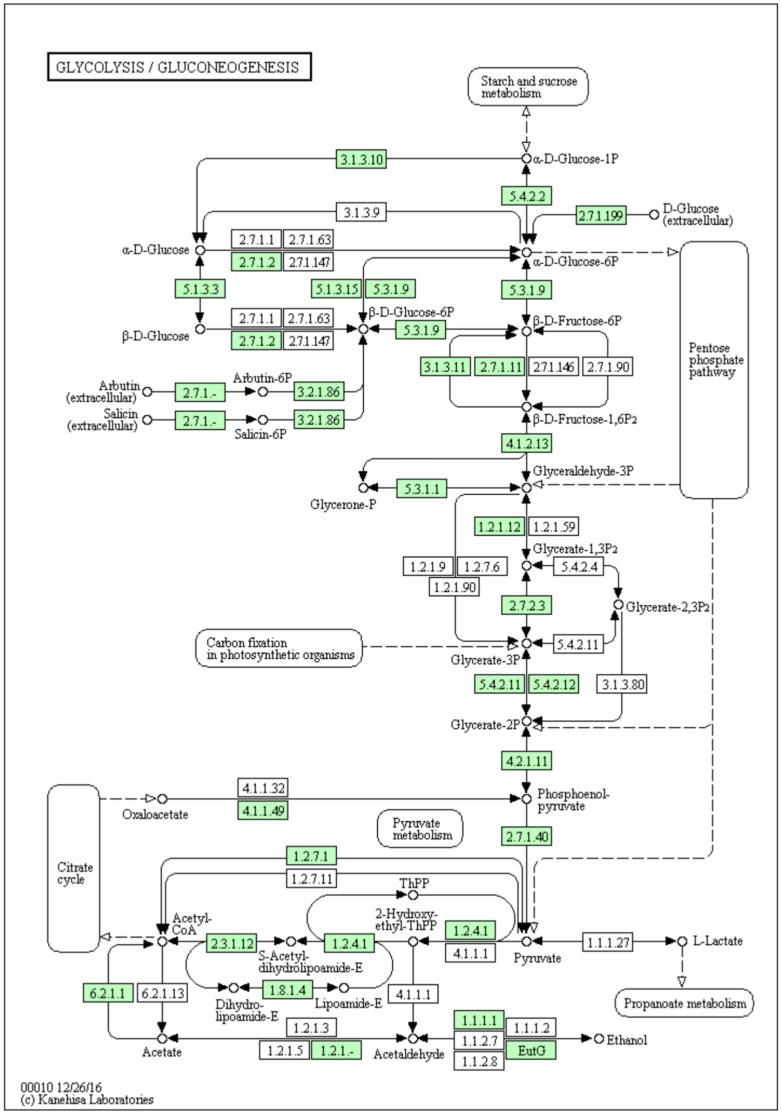


Genomes

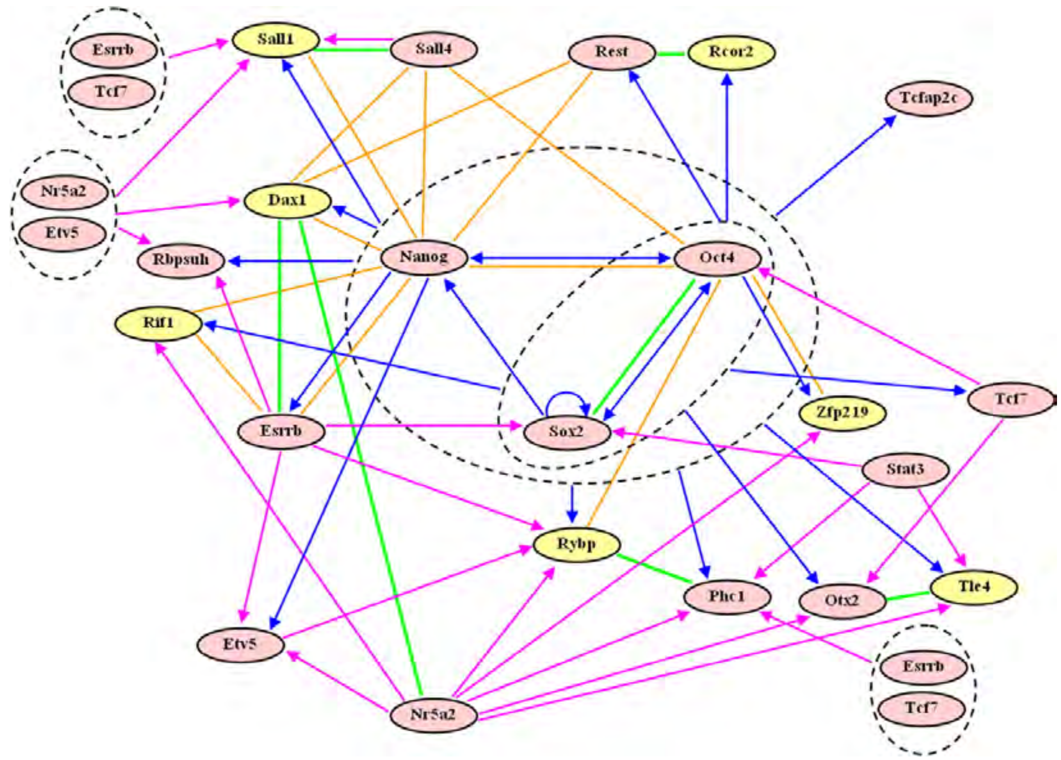




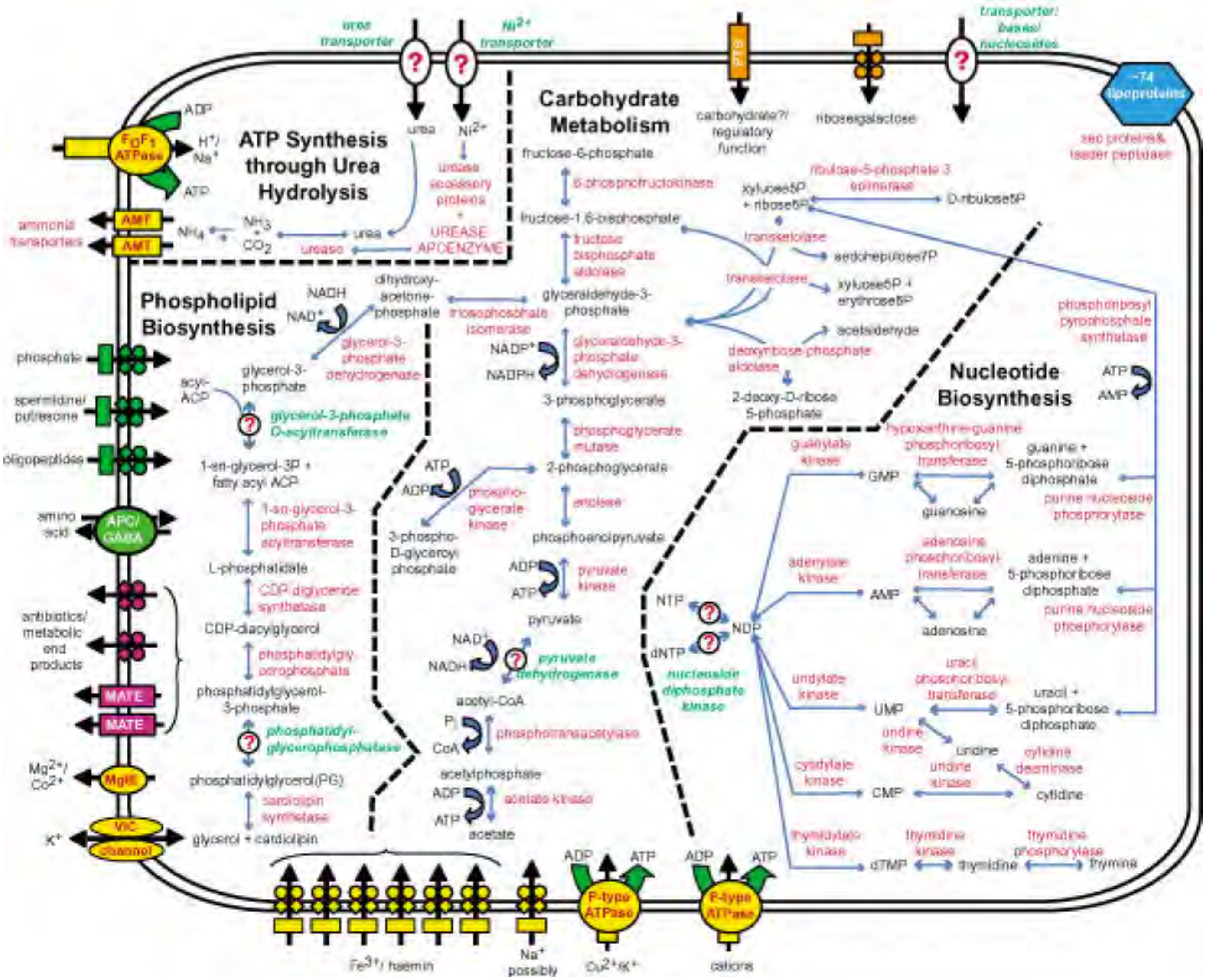
Human genome: 3 billion base pairs (haploid)



Biochemical processes



Gene regulatory networks



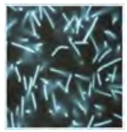
Cellular metabolism

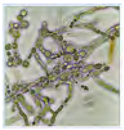
Metagenomics

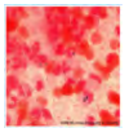
Microbial communities


Escherichia coli


Cyanobacteria

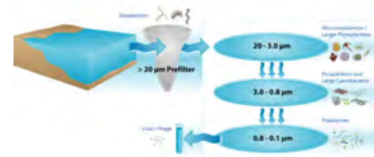

Methanopyrus


Mucor circinelloides

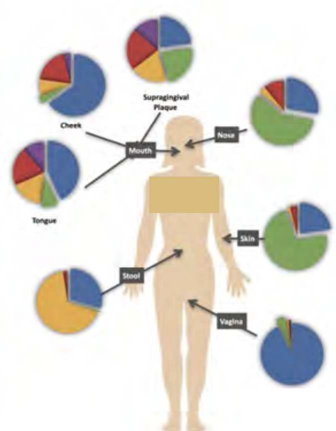

Staphylococcus aureus

http://archives.microbeworld.org/resources/gallery.aspx

Global Ocean Sampling



Human Microbiome



"Reference" human (70kg)
#human cells ~ 30 x 10^{12}

#bacterial cells ~ 39 x 10^{12}

Sender et al., 2016

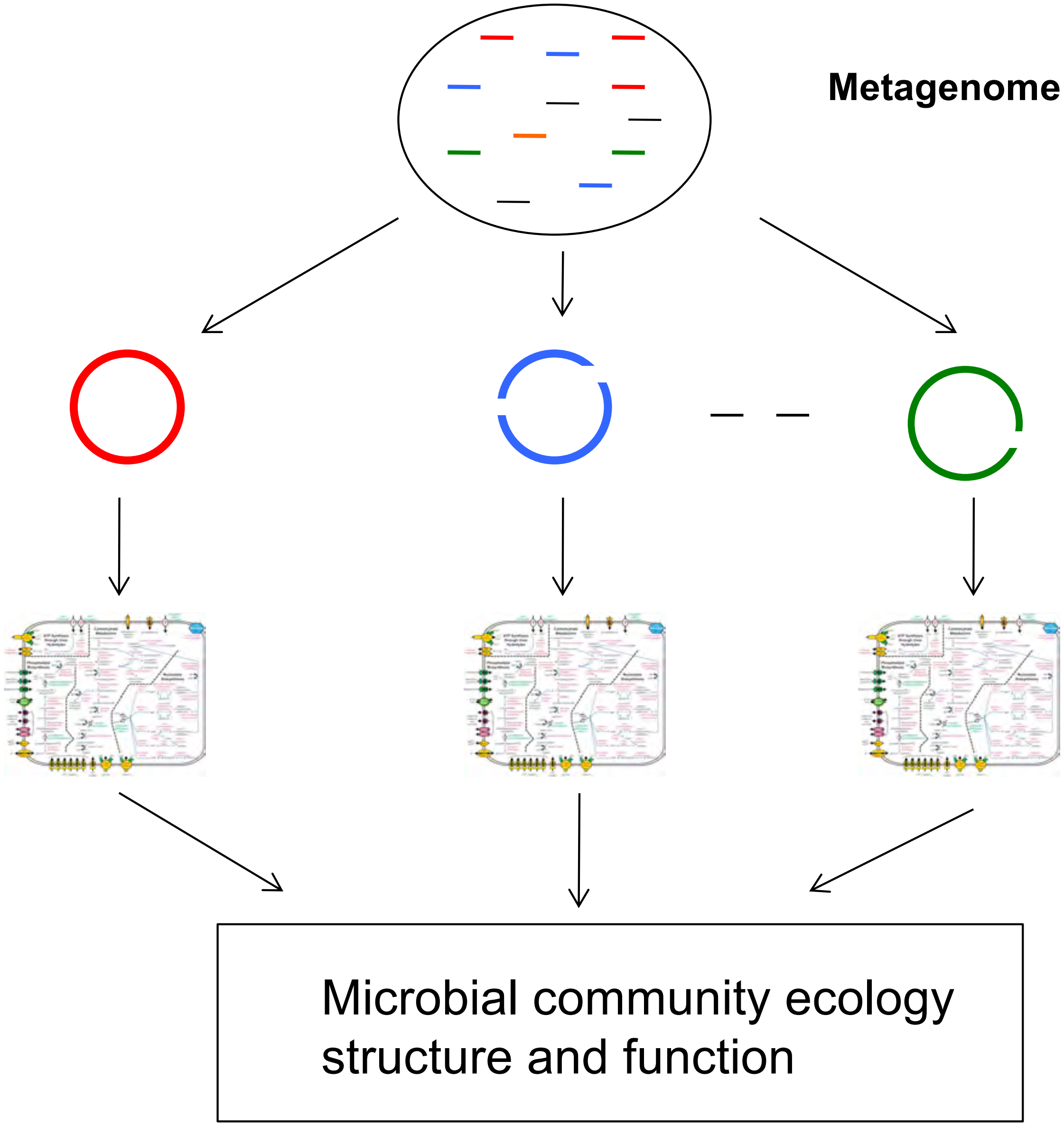
Gut microbiome ↔

Gut-brain axis
Appetite
Stress and Anxiety
Behavior
Neurophysiology
Depression

Host health and immunity
Essential nutrients
Vitamins
Short-Chain Fatty Acids
Secondary Bile Acids
Detoxification
Diet dependency
Development of immune system
Intestinal barrier function

Disease association
Metabolic disorders
Infections
Inflammatory/Autoimmune
Cardiovascular disease
Cancer
Liver disease
Renal disease

Metagenomics

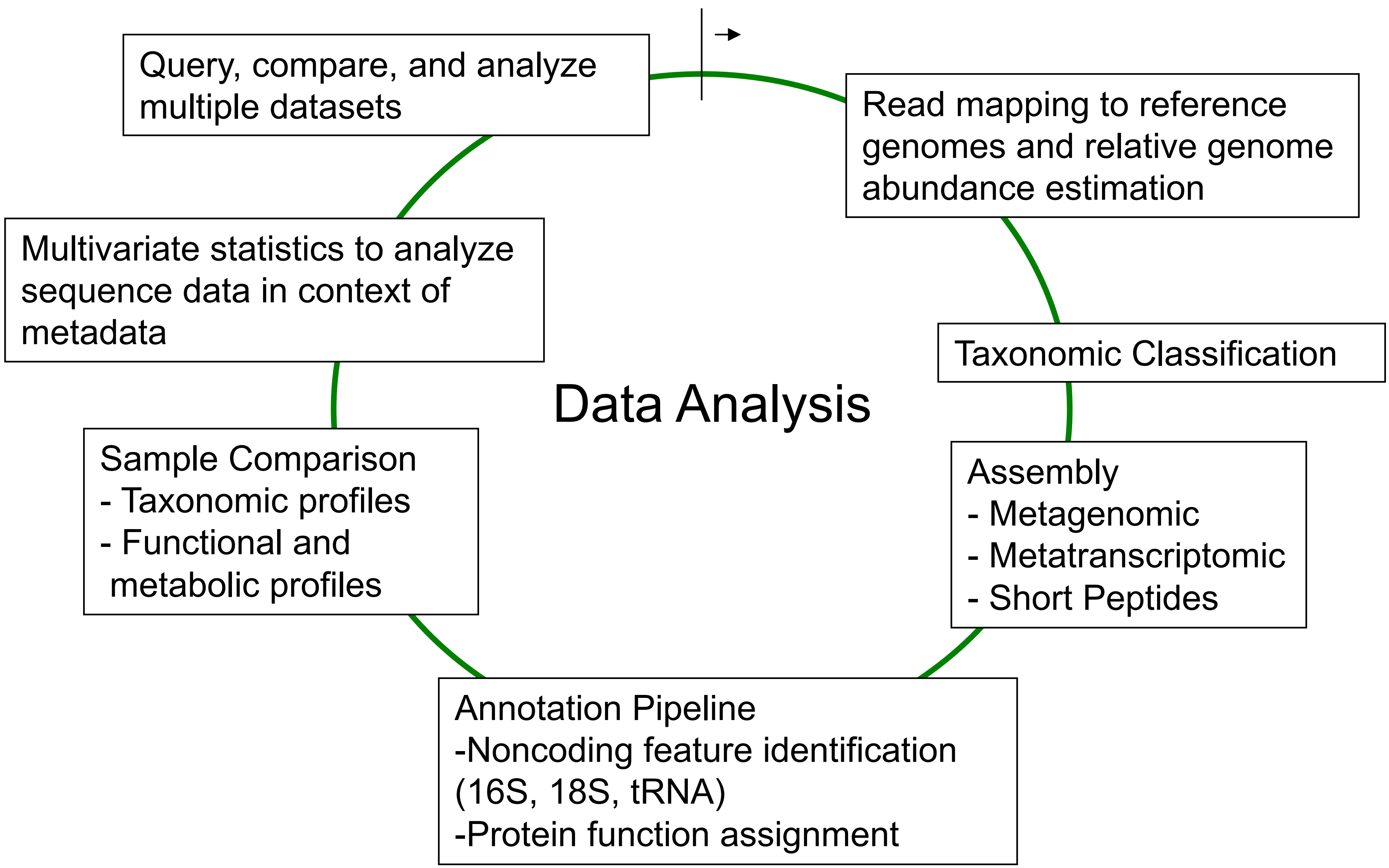


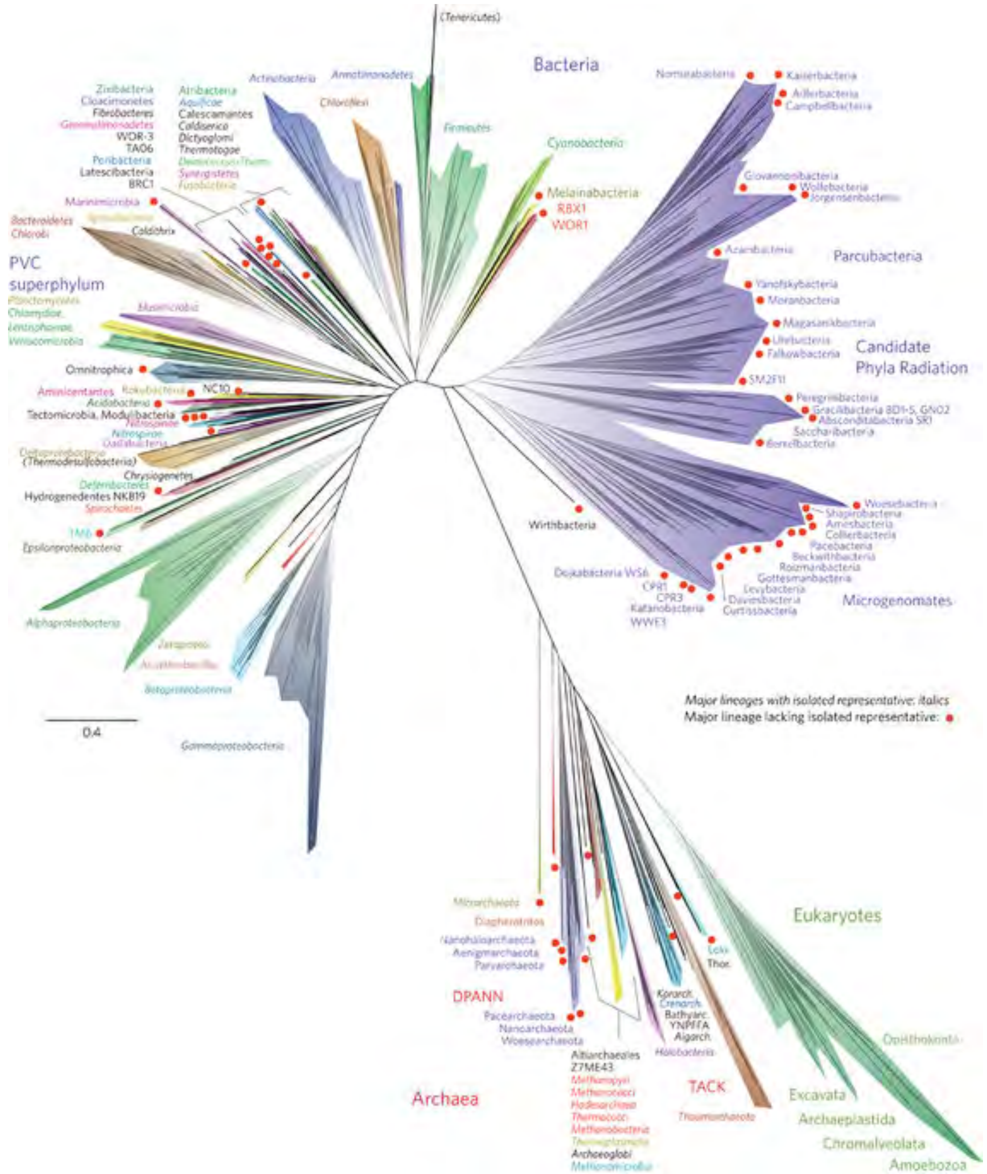
Metagenome from collection of organisms

Taxonomic binning
Genome reconstruction

Metabolic and functional reconstruction

High-throughput Data Analysis





Tree of Life

Hug *et al.*, *Nature Microbiology 2016*

Measurements of biological systems ’-Omics’ data

- Genome
- Transcriptome
- Proteome
- Metabolome
- ..

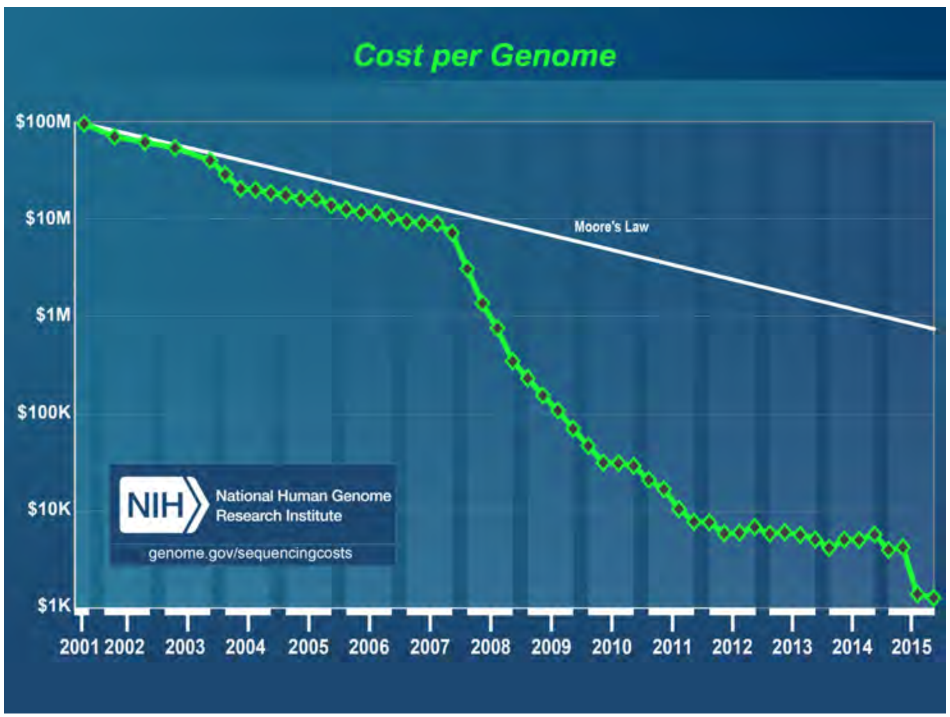
The field of bioinformatics plays a crucial role in data analysis and interpretation

Sequencing technology

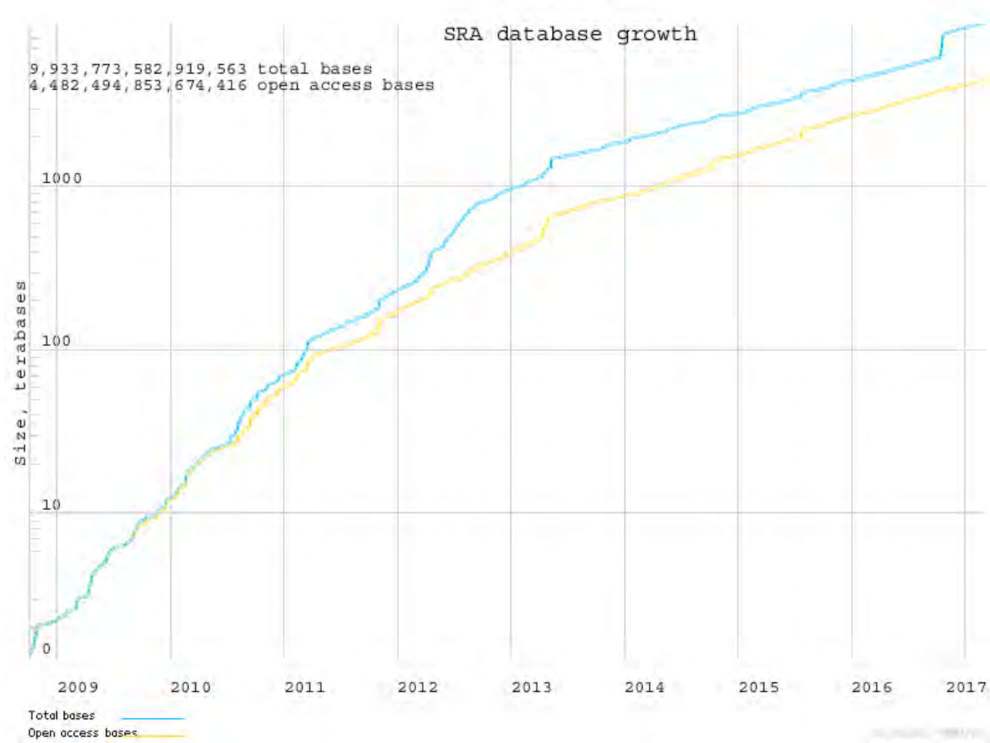
High throughput
Cost effective

→ Lots of data!

Petabase scale 10^{15}



https://www.genome.gov/sequencingcosts/



https://trace.ncbi.nlm.nih.gov/Traces/sra/sra.cgi?

Big data field Efficient algorithms and tools are crucial

Bioinformatics and *Team Science*: Examples

- Human Genome Project
- Human Microbiome Project
- The Cancer Genome Atlas Project
- ENCODE Project
- ..

Bioinformatics at UCF

- Several current faculty do research in Bioinformatics and Computational Biology
  - CS, BioMed, Statistics, etc.

- Genomics and Bioinformatics Cluster
  - Hiring faculty this year
  - Setting up NGS lab and computational infrastructure
  - Biological Sciences building
  - Goal: to build a strong research and academic program in genomics and bioinformatics

Bioinformatics at UCF: Project design and implementation

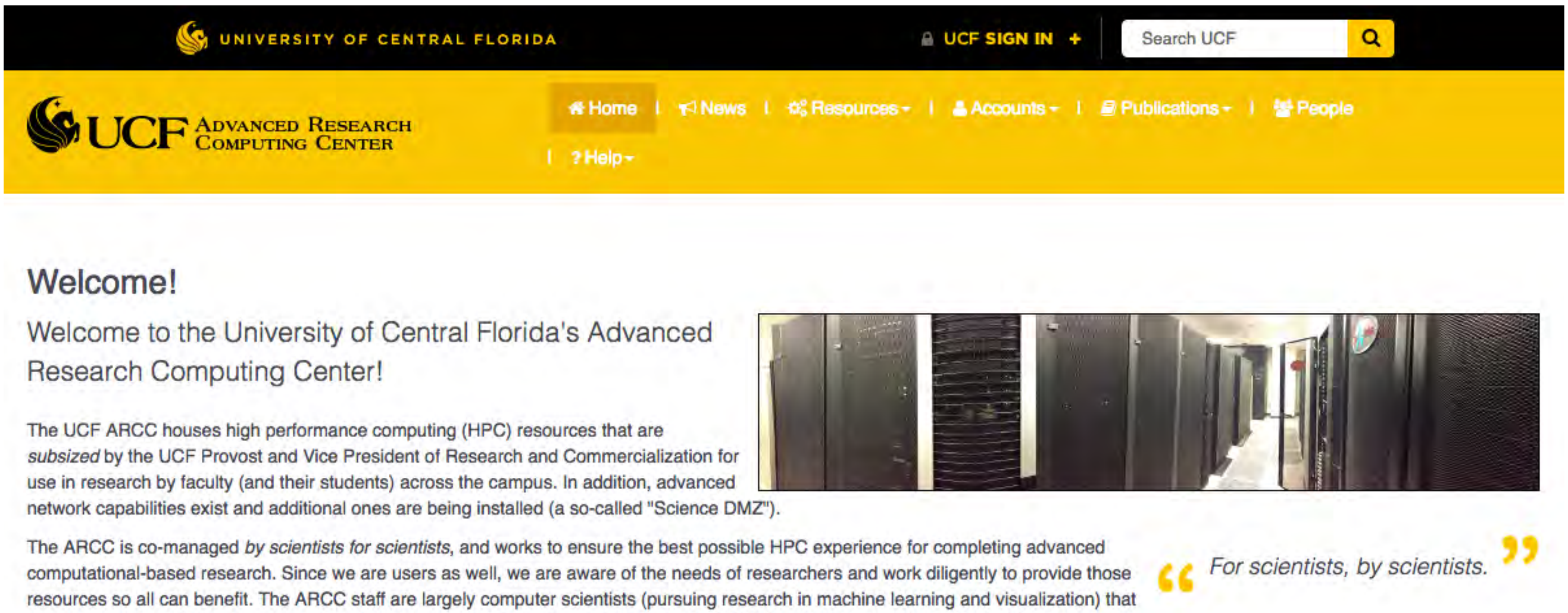
- Reach out to bioinformatics faculty on campus
  - Team science
- Collaboration vs Service

Bioinformatics at UCF: Project design and implementation

- Engage collaborators at beginning of project
  - Experimental design: hypotheses being tested, samples being collected
  - Power calculations (#samples needed for study)
  - Data analysis plans
  - Novel method development

Bioinformatics at UCF: Project design and implementation

- Computing infrastructure (HPC system)



- Stokes system
  - 3000+ cores, 240 TB storage

Bioinformatics at UCF: Project design and implementation

- Access to computing and storage
  - Stokes system (Paul Wiegand)
  - Genomics and Bioinformatics server (Yooseph)
- Software tools