Program Announcement
To DOE National Laboratories
LAB 02-13

Genomes to Life

Summary

DOE program announcement LAB 02-13 has evoked a number of questions from the research community about the expected role of simulations, computational science, mathematics, and computer science in prospective responses. In particular, questions have been posed about the balance in emphasis between work focused on the computational aims described in Goal 4 and work focused on the experimental biology aims described in Goals 1-3.

This addendum is to clarify that a central theme of the entire Genomes to Life program is to develop the necessary experimental and computational capabilities to enable a predictive understanding of the behavior of microbes and microbial communities of interest to DOE. To this end, proposals that integrate strong experimental biology and computational science research components are strongly encouraged. In such proposals, the leadership role may rest either with experimentation or with computation.

In particular, please note the modifications to the original program announcement.

The Office of Biological and Environmental Research (OBER) and the Office of Advanced Scientific Computing Research (ASCR) of the Office of Science (SC), U.S. Department of Energy (DOE), hereby announce their interest in receiving proposals for research that supports the DOE/OBER/ASCR Genomes to Life research program (http://www.doegenomestolife.org/). Genomes to Life is a basic research program whose results will directly contribute to progress in addressing DOE's energy, environmental, and national security missions.

This solicitation will support the establishment of 2 to 3 large, well integrated, multidisciplinary (e.g., biology, computer science, mathematics, engineering, informatics, biophysics, biochemistry) research teams. Proposers are strongly encouraged to include, where appropriate, partners from more than one national laboratory and from universities, private research institutions, and companies. Successful proposals will include a detailed management plan describing the responsibility of and relationship between all participating institutions and

investigators, a strategy for maximizing communication and exchange of information between investigators, a data and information management plan, and project milestones.

Up to $15 million is available in FY 2002. Contingent upon the availability of appropriated funds. It is anticipated that individual research teams will initially be funded at a level of $4 to 6 million per year. Proposals should also describe a scientifically justified scale-up plan to maximize technology development and research productivity.

National laboratories will only receive partial year operating funding during FY 2002 since awards will likely not be made until late in the third quarter of the fiscal year. Estimates should be provided for a level of operating funds that could be costed in FY 2002. Plans should also be included for purchase of requested equipment including a plan indicating which equipment purchases could be costed in FY 2002 for funds received in June or July 2002.

Research partners at universities and at private research institutions and companies will be funded directly by DOE but will be reviewed as part of the overall research proposal submitted by the lead national laboratories. To facilitate funding of non-laboratory research partners beginning in FY 2002, each proposal should include a complete set of forms as described in the instructions for Grant Application Guide and Forms at http://www.sc.doe.gov/production/grants/grants.html. This includes a:

- Signed Face Page Forms (DOE F 4650.2 (10-91))
- Budgets for each year, (using DOE F 4620.1),
- Budget Explanation
- Biographical Sketches (limit 2 pages per senior investigator)
- Description of Facilities and Resources
- Current and Pending Support for each senior investigator
- Other institutional forms as described.

DATES: Statements of intent to apply, including information on collaborators and areas of proposed research and technology development should be submitted by January 31, 2002.

Formal research proposals are due by 4:30 PM E.D.T. Tuesday April 2, 2002. THE DEADLINE FOR FORMAL PROPOSALS HAS BEEN EXTENDED TO APRIL 4, 2002. [Added March 29, 2002]

ADDRESS: Statements of intent to apply should be sent to Ms. Joanne Corcoran by email at joanne.corcoran@science.doe.gov with copies to Dr. David Thomassen at david.thomassen@science.doe.gov

and Dr. Walter Polansky at walt.polansky@science.doe.gov.

Formal proposals, referencing Program Announcement LAB 02-13, should be sent to: Ms. Joanne Corcoran, Office of Biological and Environmental Research, SC- 72, U.S. Department of Energy, 19901 Germantown Road, Germantown, MD 20874-1290; ATTENTION: LAB 02-13. This address must be used when submitting proposals by U.S. Postal Service Express, commercial mail delivery service, or when hand carried by the proposer.

Individual national laboratories may not submit more than one proposal though individual proposals may include representatives from multiple national laboratories and an individual national laboratory may be represented on more than on proposal.

For general information, contact Dr. David Thomassen, telephone: (301) 903- 9817, E-mail: david.thomassen@science.doe.gov, Office of Biological and Environmental Research, SC-72, U.S. Department of Energy, 19901 Germantown Road, Germantown, MD 20874-1290

and Dr. Walter Polansky, telephone: (301) 903-5800, E-mail: walt.polansky@science.doe.gov, Office of Advanced Scientific Computing Research, SC-31, U.S. Department of Energy, 19901 Germantown Road, Germantown, MD 20874- 1290.

A complementary request for applications from university led teams will be issued in January 2002.

Research Focus

The Genomes to Life research program will cut across components of each of the goals described in the Genomes to Life program plan, available on the web at http://www.doegenomestolife.org/. Proposers should refer to the program plan for additional information on the overall organization of the Genomes to Life program. Individual proposals should address one or more of the individual research elements described below.

Microbes of Interest to DOE. The initial focus of Genomes to Life should be on microbes (including fungi) directly relevant to DOE mission needs in energy (cleaner energy, biomass conversion, carbon sequestration), bioweapons defense (biothreat

agents or their close relatives), or the environment (cleanup of metals and radionuclides at DOE sites). Research in Goals 1 and 2 should take advantage of and focus on microbes whose complete DNA sequence is already known. Research in Goal 3 should focus on microbes or microbial communities of interest to, directly relevant to, or that would contribute substantially to an ability to address DOE mission needs. Selected, well-justified research using yeast may also be appropriate as a means of quickly generating data that addresses the needs of this solicitation and of the Genomes to Life Program. However, the use of yeast as a long-term research focus is not encouraged.

Data and Other Results. Any data and results that are generated through the investigations into goals 1 through 4 that are appropriate to share with the broader community should be provided in timely, open, and machine-readable format where possible. Microbial DNA sequence data will be publicly released according to the "Data Release Requirements: Microbial Genome Sequencing Projects" (http://www.sc.doe.gov/production/ober/EPR/data.html). Plans should be included that describe the procedures and policies the teams will institute to make the data and results available and interoperable with other significant sources of relevant data. Any code development should be open source. Teams should be amenable to the adoption of open data standards and interoperability requirements, as they evolve and specified by the Genomes to Life program.

Goal 1 -- Identify and Characterize the Molecular Machines of Life – the Multiprotein Complexes that Execute Cellular Functions and Govern Cell Form

Current structural genomics or proteomics efforts generally focus on individual proteins, either one at a time or at a genomic scale, or as pairs of interacting proteins. An initial focus of the Genomes to Life program will be to develop and implement research strategies and technologies that will enable the systematic identification, characterization, and, eventually, understanding of all the multi protein molecular machines in an organism. A research plan should be described that will lead, within five years, to the development of the capability to measure and characterize thousands of molecular machines per year. The initial focus of this research should be on microbial processes with application to DOE needs (see section on Microbes of Interest to DOE). The research plan should describe how the proposed research and technology and computational tool development will, within the next four to six years, enable at least 80% of the molecular machines in a single microbe to be identified and characterized within a single year.

An overarching goal of the Genomes to Life program is to develop computational tools, based on experimental data, that enable us to predict the functions and

behaviors of complex biological systems beginning with genome sequence data. In the context of Goal 1, computational tools are needed to predict the inventory of molecular machines, and the functions of those machines, likely to be found in a microbe whose DNA sequence is known. This could include development of computational modeling tools, including high performance implementations of techniques analogous to Rosetta-type algorithms and threading programs to characterize the molecular machinery on the scale of complete microbial organisms. Significant effort should be devoted to the development of high- precision computational models able to identify the principal components and functions of characterized molecular machines. These computational approaches will also provide an important future interface with the projected increases in the rate of protein structure determination to understand the molecular details of protein interactions in molecular machines.

Milestones of progress and success should be included as part of the research plan. Pilot studies that test and compare several different research and technology strategies are encouraged along with a decision plan to choose and expand the most promising strategies.

Understanding the role that these molecular machines play within an organism will require information on both the interactions of molecular machines and on the physical and temporal location and behavior of molecular machines within cells. Research plans should be described that will lead to high-throughput strategies, technologies, and computational tools for achieving these goals. Investigators conducting research on these goals should describe how they will work in close collaboration with or maintain a detailed awareness of the progress of investigators who are developing high-throughput strategies for identifying molecular machines. Pilot studies that test and compare several different research and technology strategies are encouraged along with a decision plan to choose and expand the most promising strategies.

Experimental research is not being requested to determine the three-dimensional, high resolution structure of individual proteins or multi protein molecular machines. As the number of high resolution protein structures in the Protein Data Bank increases dramatically over the next five years, that information will serve as an important starting point for characterizing the molecular details of protein- protein interactions within and between individual molecular machines.

Goal 2 -- Characterize Gene Regulatory Networks

Understanding the structure and function of an organism's molecular machines is a limited, though substantial, first step towards a predictive understanding of the organism's complex functions. This will only come by understanding the complex gene regulatory networks that govern the coordinated formation and behavior of molecular machines and their individual protein subunits. A goal of Genomes to Life is develop large-scale research strategies, technologies, and computational tools needed to identify all the components of gene regulatory networks with an initial focus on cis-acting regulatory sequences. Although the principal focus should be on microbial processes with application to DOE needs (see section on Microbes of Interest to DOE), these studies will likely benefit from comparative genomics approaches that may cross species.

Again, an overarching goal of the Genomes to Life program is to develop computational tools, based on experimental data, that enable us to predict the functions and behaviors of complex biological systems beginning with genome sequence data. In the context of Goal 2, computational tools are needed to predict regulatory networks for the molecular machines and their component proteins identified in Goal 1. A major goal is to be able to predict and reconstruct regulatory networks for molecular machines, metabolic pathways, or entire organisms beginning with knowledge of the organism's DNA sequence. Determination and verification of regulatory interactions will be enabled by the development of the integrated computational approaches assembling many types of experimental information together with relevant computational algorithms.

These studies should be closely integrated with genome-scale proteomics efforts or efforts to identify all of an organisms's molecular machines and their dynamic behavior within cells. Pilot studies that test and compare several different research and technology strategies are encouraged along with a decision plan to choose and expand the most promising strategies.

Goal 3 -- Characterize the Functional Repertoire of Complex Microbial Communities in their Natural Environments at the Molecular Level.

Understanding the structure and functional capabilities and diversity of complex microbial communities is key to using the diverse functions and capabilities of microbes to address DOE mission needs. However, the majority of microbes of importance and interest to DOE have not been isolated, purified, and cultured. An initial goal of Genomes to Life is to use high throughput DNA sequencing and computational approaches to determine the genetic and functional diversity of individual uncultured microorganisms and of microbial communities. It is anticipated that the majority of high throughput DNA sequencing required for this Goal will be

conducted at the DOE Joint Genome Institute. An estimate of the amount of DNA sequencing that will be required should be included as part of the proposal. Funds for high throughput DNA sequencing should not be included as part of the budget request for individual proposals as funds will be provided directly to the Joint Genome Institute for Genomes to Life sequencing needs.

The organisms and microbes chosen for sequencing should be chosen to help make an initial determination of:

- The extent and patterns of phylogenetic and genetic diversity in microbial communities from different environments.
- Whether microbial communities conserve metabolic function in spite of extensive individual phylogenetic diversity and whether a microbial community's metabolic functions correlate with the physical properties of its environmental niche.
- Improvements in the ability to infer the metabolic, physiologic, and behavioral characteristics of a microbe or microbial community from its DNA sequence (including improvements in the ability to infer gene function from DNA sequence).

Just as development of computational tools to predict the inventory, functions, and regulation of molecular machines from genome sequence data is a key part of Goals 1 and 2, development of computational tools to predict the metabolic, physiologic, and behavioral characteristics of microbial communities from community DNA sequence data is a key part of Goal 3. It is expected that some of the computational tools developed will be executed on existing computer resources with little need for additional computational power. However, special consideration will be given to the development of computational tools that can be ported across high-performance computing environments, including computing capabilities that are not yet available but are expected soon.

A scientific and experimentally-based strategy for selecting the microbes and microbial communities proposed for analysis should be provided. Estimates of the number and diversity of uncultured microbes and microbial communities chosen for sequencing during the first three years of the project should be made. A strategy for estimating the degree of sequence coverage for DNA isolated from microbial communities should be provided.

Goal 4 -- Develop the Computational Methods and Capabilities to Advance Understanding of Complex Biological Systems and Predict their Behavior.

Computational capabilities, including data management, modeling of complex biological systems, and prediction of biological responses, underpin all of Genomes to Life. In particular, the needs include:

- Computational research on analysis and modeling of the structure and function of molecular machines, as integrated with the research to be conducted under Goal 1 above, with an emphasis on the interactions among the proteins and other molecules that make up these machines. This could also include investigations into prediction of functions of the molecular machines through the use of consensus groupings or proxies, such as analogs to "Rosetta" or threading-type methods used for predicting the structure of single proteins.
- Computational research on models and simulations of metabolic pathways, regulatory networks, and whole-cell functions, as integrated with the research to be conducted under Goal 2 above. This may include computational tools to integrate data from a wide variety of high-throughput experimental data, such as mass spectrometry, protein arrays, cross linking, and Nuclear Magnetic Resonance data with other biological data, such as genome annotation and experimental genetic data, such as results from knockout experiments.
- Computational research in support of sequencing environmental samples to be conducted under Goal 3 above. Computational tools will be needed to analyze the output of the simultaneous sequencing of multiple organisms. This will include a need to infer properties of the environmental sample, such as the presence or absence of both certain classes of organisms and certain functional capabilities, such as particular metabolic pathways.
- Computational research in support of biological databases and database tool development. Any proposals for subprojects to augment or develop databases will be judged primarily on the degree that they contribute to the successful completion of the team's research conducted as part of Goals 1, 2, and 3 above. The subprojects will also be judged on the predicted utility of the database and tools to the broader community and to the degree that the tools contribute to the broader goal of database interoperability.
- It is expected that some of the computational tools developed in Goal 4 will be executed on existing computer resources with little need for additional computational power. Other tools may require particularly compute-intensive resources. Special consideration will be given to the development of computational tools that can be ported across high-performance computing environments, including computing capabilities that are not yet available but are expected soon. Appropriate attention should be paid to attributes such as modularity, interoperability, and scalability.

Submission Information

These large, multi investigator proposals will be reviewed as individual research projects consisting of several individual subprojects. The research description (see description of Narrative below) for individual subprojects should be no more than 20 pages each, exclusive of attachments. The combined research descriptions for all individual subprojects for each proposal should be no more than 100 pages, exclusive of attachments. In addition, each proposal should contain a project overview, not to exceed 20 pages, that contains an overall project summary, research integration plan, management plan, data and information management plan, and a communication plan. Each research team should identify a single scientific coordinator or point of contact for its proposal

Each subproject description must contain an abstract or project summary on a separate page with the name of the proposer, mailing address, phone, FAX, and E- mail listed. Each subproject or project must include letters of intent from outside collaborators briefly describing the intended contribution of each to the research and short curriculum vitaes, consistent with NIH guidelines, for all principal investigators and any co-PIs.

DOE policy requires that potential proposers adhere to 10 CFR Part 745 "Protection of Human Subjects" (if applicable), or such later revision of those guidelines as may be published in the Federal Register.

Any recipient of an award from the Office of Science, performing research involving recombinant DNA molecules and/or organisms and viruses containing recombinant DNA molecules shall comply with the National Institutes of Health "Guidelines for Research Involving Recombinant DNA Molecules," which is available via the World Wide Web at: http://www.niehs.nih.gov/odhsb/biosafe/nih/rdna-apr98.pdf, (59 FR 34496, July 5, 1994), or such later revision of those guidelines as may be published in the Federal Register.

Other useful web sites include:

MCP Home Page – http://microbialcellproject.org

Microbial Genome Program Home Page - http://www.science.doe.gov/production/ober/microbial.html

DOE Joint Genome Institute Microbial Web Page - http://www.jgi.doe.gov/JGI_microbial/html/

GenBank Home Page - http://www.ncbi.nlm.nih.gov/

Human Genome Home Page - http://www.ornl.gov/hgmis

Genomes to Life Home Page - http://www.doegenomestolife.org/

The instructions and format described below should be followed. Reference Program Announcement LAB 02-13 on all submissions and inquiries about this program.

OFFICE OF SCIENCE
GUIDE FOR PREPARATION OF SCIENTIFIC/TECHNICAL PROPOSALS
TO BE SUBMITTED BY NATIONAL LABORATORIES

Proposals from National Laboratories submitted to the Office of Science (SC) as a result of this program announcement will follow the Department of Energy Field Work Proposal process with additional information requested to allow for scientific/technical merit review. The following guidelines for content and format are intended to facilitate an understanding of the requirements necessary for SC to conduct a merit review of a proposal. Please follow the guidelines carefully, as deviations could be cause for declination of a proposal without merit review.

1. Evaluation Criteria

Proposals will be subjected to formal merit review (peer review) and will be evaluated against the following criteria which are listed in descending order of importance:

1. Scientific and/or technical merit of the project
2. Appropriateness of the proposed method or approach
3. Competency of the personnel and adequacy of the proposed resources
4. Reasonableness and appropriateness of the proposed budget
5. The robustness of the organizational framework and its coordination plan.

The evaluation will include program policy factors such as the relevance of the proposed research to the terms of the announcement, the uniqueness of the proposer's capabilities, and demonstrated usefulness of the research for proposals in other DOE Program Offices as evidenced by a history of programmatic support directly related to the proposed work.

2. Summary of Proposal Contents

Proposal Cover Page
Table of Contents
Field Work Proposal (FWP) Format (Reference DOE Order 5700.7C) (DOE ONLY)
Abstract

Budget and Budget Explanation for submitting laboratory
Budget and Budget Explanation for any collaborating organizations
Narrative
Literature Cited
Other support of investigators
Biographical Sketches
Description of facilities and resources
Appendix

2.1 Number of Copies to Submit

An original and 14 copies of the formal proposal/FWP must be submitted.

3. Detailed Contents of the Proposal

Proposals must be readily legible, when photocopied, and must conform to the following three requirements: the height of the letters must be no smaller than 10 point with at least 2 points of spacing between lines (leading); the type density must average no more than 17 characters per inch; the margins must be at least one-half inch on all sides. Figures, charts, tables, figure legends, etc., may include type smaller than these requirements so long as they are still fully legible.

3.1 Proposal Cover Page

The following proposal cover page information may be placed on plain paper. No form is required.

- Title of proposed project
- SC Program announcement title
- Name of laboratory
- Name of principal investigator (PI)
- Position title of PI
- Mailing address of PI
- Telephone of PI
- Fax number of PI
- Electronic mail address of PI
- Name of official signing for laboratory*
- Title of official
- Fax number of official
- Telephone of official
- Electronic mail address of official
- Requested funding for each year; total request

- If other institutions are participating in the project, include a table listing institutions, lead investigator at that institution and requested funding for each institution at this point on the cover page.
- Use of human subjects in proposed project: If activities involving human subjects are not planned at any time during the proposed project period, state "No"; otherwise state "Yes", provide the IRB Approval date and Assurance of Compliance Number and include all necessary information with the proposal should human subjects be involved.
- Use of vertebrate animals in proposed project: If activities involving vertebrate animals are not planned at any time during this project, state "No"; otherwise state "Yes" and provide the IACUC Approval date and Animal Welfare Assurance number from NIH and include all necessary information with the proposal.
- Signature of PI, date of signature
- Signature of official, date of signature*

  *The signature certifies that personnel and facilities are available as stated in the proposal, if the project is funded.

3.2 Table of Contents

Provide the initial page number for each of the sections of the proposal. Number pages consecutively at the bottom of each page throughout the proposal. Start each major section at the top of a new page. Do not use unnumbered pages and do not use suffices, such as 5a, 5b.

3.3 Field Work Proposal Format (Reference DOE Order 5700.7C) (DOE ONLY)

The Field Work Proposal (FWP) is to be prepared and submitted consistent with policies of the investigator's laboratory and the local DOE Operations Office. Additional information is also requested to allow for scientific/technical merit review.

Laboratories may submit proposals directly to the SC Program office listed above. A copy should also be provided to the appropriate DOE operations office.

3.4 Abstract

Provide an abstract of no more than 250 words. Give the broad, long-term objectives and what the specific research proposed is intended to accomplish. State the hypotheses to be tested. Indicate how the proposed research addresses the SC scientific/technical area specifically described in this announcement.

3.5 Budget and Budget Explanation

A detailed budget is required for the entire project period, which normally will be three years, and for each fiscal year. It is preferred that DOE's budget page, Form 4620.1 be used for providing budget information*. Modifications of categories are permissible to comply with institutional practices, for example with regard to overhead costs.

A written justification of each budget item is to follow the budget pages. For personnel this should take the form of a one-sentence statement of the role of the person in the project. Provide a detailed justification of the need for each item of permanent equipment. Explain each of the other direct costs in sufficient detail for reviewers to be able to judge the appropriateness of the amount requested.

An overall project budget should be provided in addition to individual budgets for each subproject. Individual budgets should also be provided for each research partner from a different institution to facilitate direct funding of research institution.

Further instructions regarding the budget are given in section 4 of this guide.

* Form 4620.1 is available at web site:
http://www.sc.doe.gov/production/grants/forms.html

3.6 Narrative

The narrative comprises the research plan for the project and should contain the following subsections:

Background and Significance: Briefly sketch the background leading to the present proposal, critically evaluate existing knowledge, and specifically identify the gaps that the project is intended to fill. State concisely the importance of the research described in the proposal. Explain the relevance of the project to the research needs identified by the Office of Science. Include references to relevant published literature, both to work of the investigators and to work done by other researchers.

Preliminary Studies: Use this section to provide an account of any preliminary studies that may be pertinent to the proposal. Include any other information that will help to establish the experience and competence of the investigators to pursue the proposed project. References to appropriate publications and manuscripts submitted or accepted for publication may be included.

Research Design and Methods: Describe the research design and the procedures to be used to accomplish the specific aims of the project. Describe new techniques and methodologies and explain the advantages over existing techniques and methodologies. As part of this section, provide a tentative sequence or timetable for the project.

Subcontract or Consortium Arrangements: If any portion of the project described under "Research Design and Methods" is to be done in collaboration with another institution, provide information on the institution and why it is to do the specific component of the project. Further information on any such arrangements is to be given in the sections "Budget and Budget Explanation", "Biographical Sketches", and "Description of Facilities and Resources".

3.7 Literature Cited

List all references cited in the narrative. Limit citations to current literature relevant to the proposed research. Information about each reference should be sufficient for it to be located by a reviewer of the proposal.

3.8 Other Support of Investigators

Other support is defined as all financial resources, whether Federal, non-Federal, commercial or institutional, available in direct support of an individual's research endeavors. Information on active and pending other support is required for all senior personnel, including investigators at collaborating institutions to be funded by a subcontract. For each item of other support, give the organization or agency, inclusive dates of the project or proposed project, annual funding, and level of effort devoted to the project.

3.9 Biographical Sketches

This information is required for senior personnel at the laboratory submitting the proposal and at all subcontracting institutions. The biographical sketch is limited to a maximum of two pages for each investigator.

3.10 Description of Facilities and Resources

Describe briefly the facilities to be used for the conduct of the proposed research. Indicate the performance sites and describe pertinent capabilities, including support facilities (such as machine shops) that will be used during the project. List the most important equipment items already available for the project and their pertinent capabilities. Include this information for each subcontracting institution, if any.

3.11 Appendix

Include collated sets of all appendix materials with each copy of the proposal. Do not use the appendix to circumvent the page limitations of the proposal. Information should be included that may not be easily accessible to a reviewer.

Reviewers are not required to consider information in the Appendix, only that in the body of the proposal. Reviewers may not have time to read extensive appendix materials with the same care as they will read the proposal proper.

The appendix may contain the following items: up to five publications, manuscripts (accepted for publication), abstracts, patents, or other printed materials directly relevant to this project, but not generally available to the scientific community; and letters from investigators at other institutions stating their agreement to participate in the project (do not include letters of endorsement of the project).

4. Detailed Instructions for the Budget

(DOE Form 4620.1 "Budget Page" may be used)

4.1 Salaries and Wages

List the names of the principal investigator and other key personnel and the estimated number of person-months for which DOE funding is requested. Proposers should list the number of postdoctoral associates and other professional positions included in the proposal and indicate the number of full-time-equivalent (FTE) person-months and rate of pay (hourly, monthly or annually). For graduate and undergraduate students and all other personnel categories such as secretarial, clerical, technical, etc., show the total number of people needed in each job title and total salaries needed. Salaries requested must be consistent with the institution's regular practices. The budget explanation should define concisely the role of each position in the overall project.

4.2 Equipment

DOE defines equipment as "an item of tangible personal property that has a useful life of more than two years and an acquisition cost of $25,000 or more." Special purpose equipment means equipment which is used only for research, scientific or other technical activities. Items of needed equipment should be individually listed by description and estimated cost, including tax, and adequately justified. Allowable items ordinarily will be limited to scientific equipment that is not already available for the conduct of the work. General purpose office equipment normally will not be considered eligible for support.

4.3 Domestic Travel

The type and extent of travel and its relation to the research should be specified. Funds may be requested for attendance at meetings and conferences, other travel associated with the work and subsistence. In order to qualify for support, attendance at meetings or conferences must enhance the investigator's capability to perform the research, plan extensions of it, or disseminate its results. Consultant's travel costs also may be requested.

4.4 Foreign Travel

Foreign travel is any travel outside Canada and the United States and its territories and possessions. Foreign travel may be approved only if it is directly related to project objectives.

4.5 Other Direct Costs

The budget should itemize other anticipated direct costs not included under the headings above, including materials and supplies, publication costs, computer services, and consultant services (which are discussed below). Other examples are: aircraft rental, space rental at research establishments away from the institution, minor building alterations, service charges, and fabrication of equipment or systems not available off-the-shelf. Reference books and periodicals may be charged to the project only if they are specifically related to the research.

a. Materials and Supplies

The budget should indicate in general terms the type of required expendable materials and supplies with their estimated costs. The breakdown should be more detailed when the cost is substantial.

b. Publication Costs/Page Charges

The budget may request funds for the costs of preparing and publishing the results of research, including costs of reports, reprints page charges, or other journal costs (except costs for prior or early publication), and necessary illustrations.

c. Consultant Services

Anticipated consultant services should be justified and information furnished on each individual's expertise, primary organizational affiliation, daily compensation rate and

number of days expected service. Consultant's travel costs should be listed separately under travel in the budget.

d. Computer Services

The cost of computer services, including computer-based retrieval of scientific and technical information, may be requested. A justification based on the established computer service rates should be included.

e. Subcontracts

Subcontracts should be listed so that they can be properly evaluated. There should be an anticipated cost and an explanation of that cost for each subcontract. The total amount of each subcontract should also appear as a budget item.

4.6 Indirect Costs

Explain the basis for each overhead and indirect cost. Include the current rates.