The overall mission of C-DEBI is to explore life beneath the seafloor and make transformative discoveries that advance science, benefit society, and inspire people of all ages and origins. Our plan to achieve this mission is described in this document across the following components of the Center:

I. Research
II. Education
III. Data Management and Knowledge Transfer
IV. External Partnerships
V. Diversity
VI. Management

I. RESEARCH

Overall Research Goal. Our primary research goal is to produce transformative, synergistic research through an inclusive collaborative culture that crosses disciplinary and institutional boundaries and is embedded throughout the Center’s activities.

Detailed Description
In Phase 1, C-DEBI focused primarily on the exploration and discovery of subseafloor ecosystems, with most studies concentrated at four major sites: Juan de Fuca Ridge flank, South Pacific Gyre, North Pond, and the Dorado Outcrop. In Phase 2 (2015-2020), C-DEBI will develop an integrated understanding of microbial subseafloor life covering and connecting the molecular, cellular, and ecosystem scales. Maintaining highly multidisciplinary and interdisciplinary approaches, C-DEBI will emphasize microbial ecology while ensuring that essential context is provided through studies and advances in geochemistry, hydrology, oceanography, and related disciplines. The three overarching research themes are (1) fluxes, connectivity, and energy; (2) activities, communities, and ecosystems; and (3) metabolism, survival, and adaptation. C-DEBI research projects target two distinct subseafloor biosphere environments—the igneous ocean crust and overlying sediments—that have historically been studied independently; field investigations of these environments are complemented by coordinated laboratory studies and ecosystem modeling activities. C-DEBI is led by five Co-PIs and five senior scientists from eight U.S. universities and research labs, but seeks to build and leverage scientific, educational, and technological partnerships with numerous other U.S. and international institutions (educational, research, outreach, engineering, not-for-profit). In addition, C-DEBI seeks to develop a community of multidisciplinary collaborators, to identify promising topics, and to develop new projects that will help to advance the Center's objectives.

Optimal Research Outcomes
1. Transfers of fluid, heat, solutes, carbon, and microbes are quantified within and between subseafloor biomes, and between the subseafloor and the overlying ocean; the nature of energy sources available to microbes in these ecosystems is determined; and the next generation of coupled fluid-energy-biochemical-microbial models is developed.
2. The composition of subseafloor microbial communities and the functional potential of these communities are illuminated, based on the diversity of metabolic activities and interactions with the physicochemical aspects of the system.
3. A ‘portfolio’ of selected model subseafloor organisms is built, and their physiological and genetic traits are characterized; in addition, these microorganisms are used to investigate energy and carbon use for growth and maintenance under kinetically limiting conditions and to determine rates of metabolism under specific conditions.
4. Field investigations at the four ‘major sites’ are largely completed and environmental data and samples are coupled with complementary laboratory experiments and numerical modeling across the three research themes.

5. The new C-DEBI senior scientists are integrated in all aspects of the Center, and cross-disciplinary and cross-institutional research training is thriving through our grants programs, thereby expanding the community of deep biosphere researchers, technologists, and educators.

**Targets and Actions**

1. Transfers of fluid, heat, solutes, carbon, and microbes are quantified within and between subseafloor biomes, and between the subseafloor and the overlying ocean; the nature of energy sources available to microbes in these ecosystems is determined; and the next generation of coupled fluid-energy-biochemical-microbial models is developed.
   a. Quantify transfers of fluid, heat, solutes, carbon, and microbes within and between subseafloor biomes, and between the subseafloor and the overlying ocean
      i. Carry out time-series observations and sampling at Juan de Fuca and North Pond to resolve the extent of natural variability (within and between biomes), determine environmental controls on crustal microbial community composition, and assess how this variability impacts flows and connections
      ii. Continue pioneering cross-hole tracer experiment in the ocean crust at Juan de Fuca, where preliminary data demonstrated, for the first time, a direct hydrogeologic connection between sites that are separated by hundreds of meters, and solute and dissolved gas travel-times of hundreds of meters to kilometers/year
      iii. Collect long-term samples and data loggers at the Dorado Outcrop and conduct additional surveys at this site of massive discharge of low-temperature ridge-flank hydrothermal fluid
   b. Determine the nature of energy sources available to microbes in these ecosystems
      i. Map the distributions of electron acceptors and electron donors regionally and globally as a function of depth at a range of spatial scales.
      ii. Quantify metabolic reaction energetics as well as fluxes of electron acceptors and donors by combining internally consistent thermodynamic data, available kinetic parameters, and reactive transport modeling
   c. Develop the next generation of coupled fluid-energy-biochemical-microbial models
      i. Combine existing physical and thermal models with rate constants for primary reactions and transport (advection and diffusion) that involve solutes in basement fluids; then attempt to couple these with microbial processes to increase the model complexity
      ii. Test, calibrate, and apply coupled geochemical-microbiological models to a variety of seafloor and subseafloor environments
   d. Publish 25 (in aggregate) papers in this research theme
   e. Publish 5 (in aggregate) method/instrument papers demonstrating new techniques and tools developed and/or applied in this research theme

2. The composition of subseafloor microbial communities and the functional potential of these communities are illuminated, based on the diversity of metabolic activities and interactions with the physicochemical aspects of the system.
   a. Determine community composition, functional potential, and patterns of natural selection in subseafloor ecosystems
      i. Quantify the number, diversity, and relative abundances of microbes at multiple taxonomic levels—from domain to “species-level” operational taxonomic units (OTUs), ecotypes, and oligotypes
      ii. Determine the functional potential embodied in these communities
      iii. Integrate data on community composition and microbial activities to identify how sources of energy and microbial interactions drive natural selection in subseafloor ecosystems
b. Determine metabolic activity of subseafloor microbial communities
   i. Document actual rates of *in situ* activities using gene expression in sediment and rock samples
   ii. Identify potential activities in laboratory experiments using subseafloor samples incubated with isotope-labeled substrates
   iii. Closely examine microbe-mineral interactions in conjunction with activity measurements in situ incubations and laboratory microcosms

c. Advance understanding of subseafloor microbe-virus interactions
   i. Integrate correlation network techniques using subseafloor archaeal, bacterial, microeukaryote, and viral diversity datasets combined with microbial activity measurements
   ii. Incorporate the isotopic and diversity datasets collected as part of 2.a. and 2.b. to develop a food web model in combination with statistical diversity-based networks

d. Publish 25 (in aggregate) papers in this research theme

e. Publish 5 (in aggregate) method/instrument papers demonstrating new techniques and tools developed and/or applied in this research theme

3. A ‘portfolio’ of selected model subseafloor organisms is built, and their physiological and genetic traits are characterized; in addition, these microorganisms are used to investigate energy and carbon use for growth and maintenance under kinetically limiting conditions and to determine rates of metabolism under specific conditions.
   a. Isolate and characterize novel bacteria and archaea from diverse subseafloor habitats
      i. Enrich subseafloor bacteria and archaea from sediment, crustal fluids, and rock samples, using, among others, plugged flow, chemostat, and hanging sponge reactors
      ii. Fully characterize novel organisms, including their genomes
      iii. Interrogate their abundance and activity in the original sample to help infer their ecological roles
   b. Examine fundamental physiology of subseafloor microbes under conditions of low growth rates and low energy flux
      i. Use long-term chemostat-like culturing systems to study the coupling of catabolism and growth in the *Chloroflexi*
      ii. Use down-flow hanging sponge bioreactors to explore the molecular and physiological underpinnings of the hypothesis that archaea may be low-energy specialists and well adapted to the energetic extremes that define many subseafloor environments
   c. Perform adaptive evolution and long-term survival experiments with subseafloor microbes to characterize molecular genetic signatures associated with particular phenotypes
      i. Use subseafloor isolates to determine the genotypic, phenotypic, and biochemical and physiological bases for metabolic traits
      ii. Develop genetic markers for model organisms to be used in competition experiments
   d. Publish 25 (in aggregate) papers in this research theme
   e. Publish 5 (in aggregate) method/instrument papers demonstrating new techniques and tools developed and/or applied in this research theme

4. Field investigations at the four ‘major sites’ are largely completed and environmental data and samples are coupled with complementary laboratory experiments and numerical modeling across the three research themes.
   a. Additional (and final) C-DEBI research cruises to North Pond, Juan de Fuca, and Dorado Outcrop are scheduled
      i. Collect samples for laboratory analyses and experiments
      ii. Collect environmental data for use in experiments and ecosystem modeling
   b. Convene workshops and conference sessions
      i. Develop approaches to integrate results from field, lab, and modeling studies
ii. Present synthesis results from major field sites

5. The new C-DEBI senior scientists are integrated in all aspects of the Center, and cross-disciplinary and cross-institutional research training is thriving through our grants programs, thereby expanding the community of deep biosphere researchers, technologists, and educators.
   a. Provide substantial research funds to the 5 Co-Investigator labs as well as to the 5 new senior scientist labs
   b. Award $1M in research grants/fellowships annually (for the first 3.5 years) to predominantly graduate students, postdoctoral scholars, and other junior researchers through annual RFPs

II. EDUCATION

Vision for the C-DEBI Education Program
To bring C-DEBI research and the role of subseafloor microbes to the forefront by increasing microbiology literacy in the general public, engaging and retaining students in STEM fields, and training the next generation of subseafloor researchers. In our K-12 and general public activities, we rely heavily on partnerships with established organizations for whom these are the core target audiences. At the undergraduate level, we focus heavily on community college students and students from underrepresented minorities, because we see a myriad opportunities for some of the highest educational impact. Our most established education entity targets graduate students and beyond; here, our vision is to provide training in state-of-the-art technologies and instrumentation, together with mentoring in science communication, proposal preparation, project management, and other aspects of professional development.

Our core objectives in K-12 education/general public are to:
1.1. introduce C-DEBI content (e.g., the subseafloor biosphere, extreme microbiology, science and technology) into K-12 classrooms through professional development workshops for educators;
1.2. provide hands-on science opportunities for students to engage them in microbiology and oceanography; and
1.3. engage the general public in discovery science using public seminars, outreach activities, and social media.

Our core objectives in undergraduate education are to:
2.1. attract early and potentially undecided undergraduate students into STEM majors and strengthen their interest and passion for science and research; and
2.2. provide cutting-edge university research opportunities, especially for community college students and members of underrepresented minorities.

Our core objectives in graduate and postdoctoral education are to:
3.1. train and nurture the next generation of subseafloor researchers; and
3.2. provide professional development opportunities to allow them to expand their transferable skills.

The K-12 and General Public Education Program
For Objective 1.1, our approach centers on in-person and online professional development workshops with K-12 (and some community college) educators. These workshops are a mechanism to expose and engage instructors to C-DEBI content at a national level. C-DEBI provides numerous resources, including presentations by faculty and post-doctoral scholars, small group discussions between these researchers and the workshop participants, and guidance to publically accessible data of C-DEBI interest. At each workshop, educators also work together to develop lesson plans and activities that are then published on our webpage. To encourage educators to continue developing C-DEBI material, we offer small grants for past C-DEBI participants. Outcomes and effectiveness are measured in the number
and types of C-DEBI educational resources developed in addition to the number of participating educators. We survey all participants to further improve the workshops. C-DEBI’s external evaluator conducts comprehensive surveys of past participants to assess if C-DEBI materials were incorporated into the classroom and are still being used.

For Objective 1.2, our approach is to leverage our resources by partnering with existing organizations across the country that focus specifically on ocean science education and hands-on activities for students (e.g., SeaGrant, Deep Earth Academy). The outcomes, specifically student impact and program effectiveness, are measured via pre- and post-program surveys conducted by the C-DEBI external evaluator. We also collaborate with the Monterey Bay Aquarium Research Institute (MBARI) every two years on their EARTH workshop, which exposes educators to publicly accessible, near-real time data. In Phase 2 of C-DEBI, Education, Outreach, and Diversity Director Schroeder will work closely with these and other partnering organizations to formalize programs and disseminate program implementation via peer-reviewed educational journals.

For Objective 1.3, our approach relies heavily on the C-DEBI community to participate in outreach events in their region. We facilitate this by disseminating C-DEBI information via social media such as our C-DEBI newsletter, Twitter, Facebook, etc. We determine success of bringing C-DEBI to the public—measurable outcomes—by tracking the number of C-DEBI researchers who lead outreach activities, the number of participants in those activities, and the number of individuals reached through C-DEBI social media venues. In Phase 2, C-DEBI researchers (particularly those awarded one of our EOD grants) will be encouraged to publish their results in peer-reviewed journals (e.g., Journal of College Science Teaching, Journal of Geoscience Education) to further distribute C-DEBI educational material.

The Undergraduate Education Program

For both Objectives (2.1, 2.2), our approach focuses on several carefully coordinated courses and activities developed by C-DEBI or incorporated into C-DEBI. These are our Global Environmental Microbiology (GEM) field course for early undergraduate students (including community college students), our Community College Research Internship for Scientific Engagement (CC-RISE), an NSF REU site: Community College Cultivation Cohort (C4), and the Genomics and Geobiology Undergraduate Research Experience (GGURE). All four of these avenues help steer undergraduate students into STEM majors and, hopefully, into careers in science. The research opportunities noted in Objective 2.2 are provided through CC-RISE, C4, and GGURE, targeting community college students and students of underrepresented minorities.

Similar measurable outcomes apply to all four of these undergraduate opportunities. Students will: 1) develop scientific literacy skills and be able to comprehend and discuss scientific papers, 2) analyze and evaluate scientific data, 3) learn presentation skills to clearly and accurately explain their research and its broader significance, and 4) engage with scientists (i.e., network) and thereby become immersed in the research culture. In the research-based activities, students will also learn 1-2 advanced laboratory techniques, be exposed to a broad range of complementary techniques, and learn to develop testable hypotheses around research questions. Assessments (pre and post) are conducted by the C-DEBI external evaluator. We determine success of our program activities by tracking former participants into graduate school and STEM careers. Our long-term objectives are: 1) facilitate the successful transition from a 2-year institution to a 4-year university for community college students with interest in STEM majors and futures by providing resources and contacts after the program ends and 2) attract and retain students in STEM majors, have them earn a degree in a STEM major, and continue on to graduate school and/or STEM careers.

The Graduate Student and Postdoctoral Education Program

For Objective 3.1, we provide training by truly involving graduate students and postdoctoral researchers in the C-DEBI community at various levels. Through our fellowship program, we fund 10-15 graduate students and postdoctoral researchers annually. At the C-DEBI Annual Meeting, half of all attendees are fellows and they present their funded research findings at the meeting. Students and
postdoctoral researchers also participate in the C-DEBI Networked Speaker Series. The C-DEBI Networked Speaker Seminar Series is an opportunity for C-DEBI graduate students and postdocs to interact with the larger community. Speakers are nominated by the community and selected by ExCom. The speaker gives a live, 30-minute web seminar, followed by a Q&A. The seminars are recorded for those unable to attend and C-DEBI hosts ~3/year.

For Objective 3.2, we have a two-fold approach to providing professional development opportunities to C-DEBI graduate students and postdoctoral researchers. First, we host activities for C-DEBI graduate students and postdoctoral researchers. We hold an all-day workshop during the C-DEBI Annual Meeting, with topics ranging from science communication to applying for jobs outside of academia. Participants complete an evaluation post-event and these evaluations help guide future workshops. Second, we encourage fellows to incorporate outreach into their research. As part of the fellowship program, applicants must include a Broader Impacts statement. Fellows gain experience writing broader impact statements and are also required to participate in their proposed Broader Impact activity, ranging from developing a hands-on lesson at an Informal Science Education center to mentoring a community college student. Fellows will coordinate with the C-DEBI EOD Director, Stephanie Schroeder, to ensure the activity is purposeful and relevant to C-DEBI outreach. Resulting products will be made available on the C-DEBI webpage. In addition, Schroeder sends out weekly emails to C-DEBI graduate students and postdoctoral researchers with information on various professional development and funding/employment opportunities.

Objectives, Metrics & Mechanisms for the C-DEBI Education Program

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<tr>
<th>Objective</th>
<th>Metric</th>
<th>Mechanisms/Partners</th>
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<tbody>
<tr>
<td>1.2</td>
<td>Develop and conduct activities and programs for K-12 classrooms</td>
<td>High school class visits to C-DEBI institutions, ROV activities partnered with the Wrigley Institute for Environmental Studies, SeaGrant Summer Marine Camp, and guest speakers/lecturers in classrooms or special events</td>
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<tr>
<td>1.1</td>
<td>Award K-16 teacher grants to support K-16 teachers who have attended a C-DEBI teacher training program</td>
<td>K-16 instructors</td>
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<td>1.1, 3.2</td>
<td>Create collaborations between C-DEBI science participants and teachers in professional development activities</td>
<td>C-DEBI community college instructor workshop, MBARI EARTH workshop</td>
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<tr>
<td>1.1, 1.3</td>
<td>Present at informal science events or national education conferences</td>
<td>General public, educators</td>
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<tr>
<td>1.3</td>
<td>Communicate the deep biosphere in general audience, non-scientific publications</td>
<td>Popular science literature</td>
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<tr>
<td>2.1, 2.2</td>
<td>Incorporate deep biosphere content in C-DEBI and partner post-secondary programs</td>
<td>Global Environmental Microbiology (GEM) summer course, Community College Research Internship for Scientific Engagement (CC-RISE), Community</td>
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C-DEBI Strategic Implementation Plan 2015-2020
III. DATA MANAGEMENT AND KNOWLEDGE TRANSFER

Overall Data Management and Knowledge Transfer Goal. Our data management and knowledge transfer goal is to implement effective mechanisms and pathways to facilitate the exchange and application of knowledge, expertise, physical resources, and novel methods and technologies within the STC and between the STC and the broader community. The overall data management plan is in place to 1) assure all data generated from the STC are deposited in publically accessible data repositories (see details in our Data Management Plan), 2) efficiently allow STC researchers tools and computational resources that allow them to efficiently perform data analysis, and 3) develop and maintain a data portal for visualization and hypothesis generation from the STC data.

Detailed Description

C-DEBI facilitates the exchange of knowledge, expertise, intellectual and physical resources, experimental methods, and application of new technologies within its diverse community and between the STC and the community at large. This commitment is demonstrated through open access of all new discoveries, sensors, samplers, and platforms. This access has many avenues including but not limited to the distribution of information through teleconferences, our website, workshops, meetings, newsletters, presentations, technical documents, peer-reviewed publications, educational activities and outreach events. C-DEBI is also committed to mentoring students and scientists of all ages, including the exchange of personnel among laboratories and professional development.

The overarching objective of Data Management and Integration (DMI) and Knowledge Transfer (KT) to disseminate C-DEBI scientific discoveries and technical advances both to the scientific community and broader population has not changed; however, the emphasis is changing as the STC changes from a growth phase to a nurturing phase with the successful renewal proposal. As such, our DMI and KT goals include (1) implementing effective mechanisms to facilitate intellectual exchanges between institutions of various types, (2) maintaining worldwide access to C-DEBI data and information, (3) nurturing a new generation of C-DEBI researchers, (4) developing and make available targeted
education, public outreach, and community interactions, and (5) promoting economic growth through technology development.

**Optimal Data Management and Knowledge Transfer Outcomes**
1. Innovations are imported/exported/shared and partnerships are developed with other fields, research institutions, industry and government.
2. New innovation in the field is communicated through web tools, publications, media, presentations, and educating the next generation of researchers and ocean stewards.

**Targets and Actions**
1. Innovations are imported/exported/shared and partnerships are developed with other fields, research institutions, industry and government.
   a. Publish and promote scholarly activity via 10 publications per year
   b. Continue to develop research collaborations through networking at 2-3 interdisciplinary meetings and talks/posters/exhibition at 2-3 conferences per year
   c. Lead 3 C-DEBI-focused meetings or special sessions at national or international meetings per year
   d. Enhance, develop, or commercialize tools, analytical capabilities, software products, sensors and platforms (2 per year)
2. New innovation in the field is communicated through web tools, publications, media, presentations, and educating the next generation of researchers and ocean stewards.
   a. Continue to ensure all data generated through the STC are in stable public data repositories within 2 years of generation (or for graduate students upon defense of the dissertation or thesis)
   b. Continue to develop web-based data portal bringing data together from various repositories for synthesis efforts
   c. Train researchers in new tools for data analysis by producing 3 webinars on data analysis tools per year and 2 small workshops for data analysis
   d. Engage 20 new undergraduates per year to the fields of microbiology and oceanography and mentor 10 graduate students per year in C-DEBI fields
   e. Communicate with the public through non-scientific journals via social and journalistic media (5 significant contributions per year)

IV. EXTERNAL PARTNERSHIPS

**Overall External Partnerships Goal.** Our external partnership goal is to engage and support cross-disciplinary and cross-institutional partnerships that facilitate, augment and expand the education, training and research opportunities of Center participants.

**Detailed Description**
Partnerships among individuals, institutes, organizations, and programs are the core of C-DEBI research and educational efforts. One of the strengths of these partnerships is the quality and broad appeal of publications. C-DEBI has a range of cross-disciplinary and cross-institutional collaborations that have transformed our view of subsurface microbial conditions, activity, and mechanisms within the hydrologic and geochemical context of fluid flow within the oceanic crust. Another strength of C-DEBI partnerships is the web of interaction of C-DEBI community within other organizations and programs and the joint efforts of these organization and programs in collaboration with C-DEBI to promote and facilitate synergistic research objectives. These partners also extend to education and diversity efforts, leading to a community of junior scientists that are engage in cross-disciplinary and cross-institutional training activities and exchanges.

C-DEBI Strategic Implementation Plan 2015-2020
Optimal External Partnerships Outcomes
1. Strong cross-disciplinary research projects and strong cross-institutional programs are demonstrated in all aspects of Center activities, including publications, presentations, proposals, educational exchanges, and educational programs.
2. Partnerships are developed with other fields, research organizations, industry, government, and foundations.

Targets and Actions
1. Strong cross-disciplinary research projects and strong cross-institutional programs are demonstrated in all aspects of Center activities, including publications, presentations, proposals, educational exchanges, and educational programs.
   a. Publish 5 (in aggregate) cross-disciplinary papers per each of the three research themes with support from calls for small research and travel grants to facilitate the interaction of dispersed Center researchers
   b. Submit 2 cross-disciplinary and cross-institutional proposals per year
   c. Support 2 interdisciplinary workshops or meetings in concert with other national programs
   d. Fund 10 graduate students, postdoctoral fellows and C-DEBI community scientists in their pursuit of generating data or developing cross-discipline techniques and tools to further Center objectives
   e. Provide the funds that allow 3 student/researchers per year the opportunity to participate in research expeditions or travel to another institution to expand the scope of their education/research in the use of novel techniques and tools

2. Partnerships are developed with other fields, research organizations, industry, government, and foundations.
   a. Build 10 (total) partnerships by networking at interdisciplinary meetings, developing industrial and governmental partners, and targeting partnerships and interactions for new applications of existing or budding technologies
   b. Develop documents and materials that highlight significant results through C-DEBI research, education, and diversity programs suited to specific organizations, foundations, and programs to form the basis of a dialogue between C-DEBI and that organization to further fiscal and research needs

V. DIVERSITY

It should be clearly stated that our diversity initiatives are not stand-alone entities, but rather, that they are intimately coupled to our research and education programs. This is particularly true in our undergraduate education, where we specifically target community colleges and students from underrepresented minorities. The diversity programs in Phase 2 will be led by a new Director (search now ongoing), who will work closely with C-DEBI’s Education, Outreach & Diversity Managing Director Schroeder, USC’s Vice Dean for Diversity (Dr. George Sanchez), and C-DEBI leadership to further develop our diversity program.

Overall Diversity Goal. Our diversity goal is to implement programs that introduce C-DEBI research and findings to members of underrepresented groups and strengthen the STEM pipeline.

Detailed Description
Through its academic programs, C-DEBI promotes inclusion and retention among underrepresented groups, including women, first-generation college, and low-income students. With a strong base
established to increase STEM diversity at all levels, we are developing and exporting distinctive, in-depth education and research experiences that encourage historically underserved students. These initiatives will be targeted toward three primary sectors: 1) pre-college; 2) undergraduate and community college populations; and 3) early-career and established scientists.

**Increasing Diversity at the Undergraduate, Graduate, and Post-Doctoral Levels**

Our two main objectives are to: 1) increase the diversity, especially underrepresented minorities, of C-DEBI graduate students and post-doctoral scholars; and 2) help minority undergraduate students (in community colleges and at USC), who are interested in STEM majors, develop a path to a career in a STEM field.

For Objective 1, our approach focuses heavily on recruiting strategies. For Phase 2, C-DEBI has budgeted $1 million annually for the grants and fellowships program. We will encourage and solicit applications from underrepresented minorities more explicitly than we did in Phase 1. This will require us to expand our recruiting strategy, including targeting alumni of specific minority groups and organizations (e.g., Western Washington’s Minorities in Marine Sciences (MIMSUP) and Hampton University’s Multicultural Students at Sea Together (MAST)). We will also more directly engage USC’s Vice Dean for Diversity (Dr. Sanchez) to develop recruiting strategies, and we will include EOD Managing Director Schroeder on the Executive Committee. Lastly, as we reconstitute our External Advisory Board for Phase 2, we plan to include 1-2 members with expertise in this area.

Regarding measurable outcomes for Objective 1, it should be noted that we’re dealing with relatively small numbers of C-DEBI graduate students and post-doctoral scholars. Hence, statistical assessment is problematic at best. However, C-DEBI is committed to increasing diversity across all participating groups. We strongly believe that increasing diversity in undergraduate STEM majors, especially in C-DEBI disciplines like microbiology, geoscience, and oceanography, will lead naturally to more diversity at higher levels—but the response takes time. In addition, as noted above, we will actively recruit for more diversity in our graduate student and post-doctoral scholar applicant pools. C-DEBI will certainly continue its detailed assessment of the numbers of underrepresented minorities among our graduate students and post-doctoral scholars and the racial/ethnic/gender breakdown. We will also track and assess changing trends (both positive and negative) in general and specific areas of C-DEBI programs and activities.

For Objective 2, our approach couples research opportunities with mentoring in other essential skills for a career in a STEM field. Our undergraduate programs are directly (GGURE) or opportunistically (GEM, CC-RISE, C4) diversity programs. The research-focused ones (GGURE, CC-RISE, C4) have similar frameworks; here, we briefly highlight the GGURE program. Students will participate in either an academic (12-14 hours/week) or summer (35 hours/week) program at USC that centers on a high quality research experience, complemented by preparation for graduate school or direct employment in a STEM field. In addition to performing research under the guidance of their faculty mentor, students participate in journal clubs, scientific seminars, meetings on transitioning to graduate school, and applying for internships and jobs in STEM fields. The GGURE Program—as well as CC-RISE and C4—will demystify the research process and help students to understand that they can make fundamental contributions to the research enterprise.

The strategies for measuring outcomes for GGURE students are analogous to those for the CC-RISE and C4 students. As with most C-DEBI programs, we track our participants for several years after completion of a funded activity. Whether students were successful and whether objectives were met is, and will continue to be, assessed in three ways: 1) through the use of a modified version of an Individual Development Plan that all GGURE participants will create, starting in 2016; 2) through formal, twice-annual assessments conducted by our outside evaluator; and 3) through informal assessments performed during monthly meetings, where the program directors directly query program participants.

**Optimal Diversity Outcomes**
1. The diversity of participants in all levels of C-DEBI from undergraduate, graduate, and postdoctoral to participating researchers and staff is increased.
2. Programs that target underrepresented students and engage them in STEM fields are developed and implemented.
3. Partnerships are initiated with other organizations, institutions, programs, or informal science centers that target underrepresented students and engage them in STEM fields of study.

**Targets and Actions**
1. The diversity of participants in all levels of C-DEBI from undergraduate, graduate, and postdoctoral to participating researchers and staff is increased.
   a. Promote C-DEBI research opportunities to diverse audiences through 4 different partners (e.g., Western Washington’s Minorities in Marine Sciences (MIMSUP) and Hampton University’s Multicultural Students at Sea Together (MAST)) each year to increase the diversity of graduate students and postdoctorals across the center
2. Programs that target underrepresented students and engage them in STEM fields are developed and implemented.
   a. Develop or expand programs each year to attract underrepresented students into STEM fields
   b. Assess measurable outcomes of program effectiveness using formative and summative evaluations of Very Good or Excellent (4 or 5 out of 5) conducted internally by C-DEBI education staff and by an external evaluator for all programs
3. Partnerships are initiated with other organizations, institutions, programs, or informal science centers that target underrepresented students and engage them in STEM fields of study.
   a. Introduce C-DEBI science with appropriate resources and training to 1 institution and/or educator that primarily serves underrepresented groups

**VI. MANAGEMENT**

**Overall Management Goal.** Our leadership and management goal is to envision and enable the Center’s mission through inclusive and transparent decision-making; inspire Center members; and facilitate collaborative effort and guide all participants in the center via a cross-disciplinary and multi-institutional ethics program to instruct them on ethical and responsible conduct of scientific research.

**Detailed Description**
A fundamental challenge for C-DEBI leadership is to maintain trust and support among a diverse and interdisciplinary community of scientists, educators, and technologists. Maintaining confidence in STC leadership, throughout the existence of the Center, is essential if busy STC participants are to retain a willingness to allocate some of their limited time for advisory, review, and collaborative activities. STC leaders will also need to assure that there are robust opportunities for inter-institutional and cross-disciplinary exchanges and training, and help to secure external resources in support of ongoing and future STC activities. In addition, the Center will maintain a rigorous ethics training system for all C-DEBI participants and an Ethics Panel overseeing policies and procedures. Finally, STC leadership needs to remain focused on the critical goal that motivated formation of C-DEBI in the first place: creating a vibrant, innovative, and focused community, who will work together to achieve what cannot be accomplished by individuals working alone, to transform the nature of deep biosphere research.

**Optimal Management Outcomes**
1. The decision-making process is defined, transparent and effective leading to a high degree of confidence, ownership, and engagement by STC participants in the Center.
2. Communication is effective in facilitating the exchange of science, education of students, and promotion of other C-DEBI activities and opportunities.

3. STC participants are engaged in cross-Center training and collaboration.

4. Community commitment to an environment promoting high ethical standards in the conduct of research is maintained.

5. Strategies, tools, and resources are developed for sustainability of C-DEBI activities.

**Targets and Actions**

1. The decision-making process is defined, transparent and effective leading to a high degree of confidence, ownership, and engagement by STC participants in the Center.
   a. Hold weekly administration meetings as well as weekly ExCom meetings and an annual ExCom face-to-face retreat to enable clear and effective management of the Center.
   b. Survey the community every 1-2 years to establish effectiveness of leadership teams, decision making, and Center engagement with 70% of respondents rating leadership as being “clear/effective” or “very clear/effective”.
   c. Invite the evaluation of Center research, education, diversity, and knowledge transfer management annually by the External Advisory Board (typically in conjunction with the C-DEBI annual meeting) for feedback and suggestions to the Director to improve the integration of C-DEBI programs and activities.
   d. Update the C-DEBI Operations Manual annually to elucidate the functions of key individuals and groups and main research, education, outreach, and administration activities, programs, operations and procedures and post on the website with the Annual Report and Strategic Implementation Plan.

2. Communication is effective in facilitating the exchange of science, education of students, and promotion of other C-DEBI activities and opportunities.
   a. Regularly update the comprehensive website at www.darkenergybiosphere.org with research and education portals and resources.
   b. Distribute biweekly newsletters to C-DEBI community (participants and affiliates) to highlight recent and upcoming C-DEBI research and education programs and events and other relevant/partner activities and opportunities.
   c. Continue to improve the private login site for internal documents and community reporting.
   d. Solicit 3 nominations for each season of the videoconferenced Networked Speaker seminar series to present early career scientist research to the C-DEBI community.
   e. Maintain protocol/procedure for issuance and usage of C-DEBI contributed publication numbers and of logo and branding information.

3. STC participants are engaged in cross-Center training and collaboration.
   a. Organize 5-7 C-DEBI-specific opportunities annually for collaboration and training and entrain new membership (e.g., Center-wide Annual Meetings, Research Theme Workshops, and Exchange Grants).
   b. Support 4-6 research and professional development opportunities annually specifically for graduate students and postdoctorals (e.g., workshops at Annual Meetings, professional development webinars, and fellowships and networking activities in Research and Education sections above).

4. Community commitment to an environment promoting high ethical standards in the conduct of research is maintained.
   a. Require 100% of participants complete ethics training within these standards.
   b. Ethics Panel composed of Research, Education, ExCom and Postdoctoral representatives resolves complaints regarding C-DEBI administration, funding and scientific conduct in a timely manner.
(within 6 months of being presented to C-DEBI)

5. Strategies, tools, and resources are developed for sustainability of C-DEBI activities.
   a. Secure $3M annually (beyond initial STC funding) in support of C-DEBI activities