Directorate for Biological Sciences
Division of Integrative Biology and Neuroscie
Integrative Animal Biology

Proposal Classification Form
PI: Wooley, John / Proposal Number: 0350752

CATEGORY I: INVESTIGATOR STATUS (Select ONE)

- ☐ Beginning Investigator - No previous Federal support as PI or Co-PI, excluding fellowships, dissertations, planning grants, etc.
- ☐ Prior Federal support only
- ☐ Current Federal support only
- ☑ Current & prior Federal support

CATEGORY II: FIELDS OF SCIENCE OTHER THAN BIOLOGY INVOLVED IN THIS RESEARCH (Select 1 to 3)

☐ Astronomy	☑ Engineering	☐ Psychology
☐ Chemistry	☐ Mathematics	☐ Social Sciences
☑ Computer Science	☐ Physics	☐ None of the Above
☐ Earth Science		

CATEGORY III: SUBSTANTIVE AREA (Select 1 to 4)

☐ BEHAVIORAL STUDIES	☐ Keystone Species	☐ Agricultural Ecology
☐ BIOENGINEERING	☐ COMPARATIVE APPROACHES	☐ ENDOCRINE DISRUPTORS/ ENVIRONMENTAL ENDOCRINOLOGY
☐ BIOGEOGRAPHY	☐ COMPUTATIONAL BIOLOGY	☐ EPIGENETICS
☐ Island Biogeography	☐ CONSERVATION & RESTORATION BIOLOGY	☐ EXTREMOPHILES
☐ Historical/ Evolutionary Biogeography	☐ CORAL REEFS	☐ GENOMICS (Genome sequence, organization, function)
☐ Phylogeography	☐ CURATION	☐ Viral
☐ Methods/Theory	☐ DATABASES	☐ Microbial
☐ BIOMATERIALS	☐ DEVELOPMENTAL BIOLOGY	☐ Fungal
☐ BIOTECHNOLOGY	☐ ECOSYSTEMS LEVEL	☐ Plant
☐ Animal Biotechnology	☐ Physical Structure	☐ Animal
☐ Plant Biotechnology	☐ Decomposition	☐ HUMAN NUTRITION
☐ Environmental Biotechnology	☐ Biogeochemistry	☐ INFORMATICS
☐ Marine Biotechnology	☐ Limnology/Hydrology	☐ MARINE MAMMALS
☐ Metabolic Engineering	☐ Climate/Microclimate	☐ MOLECULAR APPROACHES
☐ CHRONOBIOLOGY	☐ Whole-System Analysis	☐ Molecular Evolution
☐ COGNITIVE NEUROSCIENCE	☐ Productivity/Biomass	☐ NANOSCIENCE
☐ COMMUNITY ECOLOGY	☐ System Energetics	☐ ORGANISMAL SYSTEMS
☐ Community Analysis	☐ Landscape Dynamics	☐ Physiological Approaches
☐ Community Structure	☐ Chemical & Biochemical Control	☐ Metabolic Processes
☐ Community Stability	☐ Global Change	☐ Hormonal Regulation/ Integration
☐ Succession	☐ Climate Change	☐ Stress Responses
☐ Experimental Microcosms/ Mesocosms	☐ Regional Studies	☐ Sensory Biology
☐ Disturbance	☐ Global Studies	☐ Movement Studies
☐ Deforestation	☐ Forestry	☐ PALEONTOLOGY
☐ Patch Dynamics	☐ Resource Management (Wildlife, Fisheries, Range, Other)	☐ Floristic
☐ Food Webs/ Trophic Structure		

- ☐ Faunistic
- ☐ Paleoecology
- ☐ Biostratigraphy
- ☐ Palynology
- ☐ Micropaleontology
- ☐ Paleoclimatology
- ☐ Archeozoic
- ☐ Paleozoic
- ☐ Mesozoic
- ☐ Cenozoic
- ☐ PHOTOSYNTHESIS
- ☐ PLANT BIOLOGY
- ☐ Arabidopsis-Related Plant Research
- ☐ POPULATION DYNAMICS & LIFE HISTORY
- ☐ Demography/ Life History
- ☐ Population Cycles
- ☐ Distribution/Patchiness/ Marginal Populations
- ☐ Population Regulation
- ☐ Intraspecific Competition
- ☐ Reproductive Strategies
- ☐ Gender Allocation
- ☐ Metapopulations
- ☐ Extinction
- ☐ POPULATION GENETICS & BREEDING SYSTEMS
- ☐ Variation
- ☐ Microevolution
- ☐ Speciation
- ☐ Hybridization
- ☐ Inbreeding/Outbreeding
- ☐ Gene Flow Measurement
- ☐ Inheritance/Heritability
- ☐ Quantitative Genetics/ QTL Analysis
- ☐ Ecological Genetics
- ☐ Gender Ratios
- ☐ Apomixis/ Parthenogenesis
- ☐ Vegetative Reproduction
- ☐ REPRODUCTIVE ANIMAL BIOLOGY
- ☐ SPECIES INTERACTIONS
- ☐ Predation
- ☐ Herbivory
- ☐ Omnivory
- ☐ Interspecific Competition
- ☐ Niche Relationships/ Resource Partititioning
- ☐ Pollination/ Seed Dispersal
- ☐ Parasitism
- ☐ Mutualism/ Commensalism
- ☐ Plant/Fungal/ Microbial Interactions
- ☐ Mimicry
- ☐ Animal Pathology
- ☐ Plant Pathology
- ☐ Coevolution
- ☐ Biological Control
- ☐ SPINAL CORD/ NERVE REGENERATION
- ☐ STATISTICS & MODELING
- ☐ Methods/ Instrumentation/ Software
- ☐ Modeling (general)
  - ☐ Modeling of Biological or Molecular Systems
  - ☐ Computational Modeling
- ☐ Statistics (general)
  - ☐ Multivariate Methods
  - ☐ Spatial Statistics & Spatial Modeling
  - ☐ Sampling Design & Analysis
  - ☐ Experimental Design & Analysis
- ☐ STRUCTURAL BIOLOGY
- ☐ SYSTEMATICS
- ☐ Taxonomy/Classification
- ☐ Nomenclature
- ☐ Monograph/Revision
- ☐ Phylogenetics
- ☐ Phenetics/Cladistics/ Numerical Taxonomy
- ☐ Macroevolution
- ☑ NONE OF THE ABOVE

CATEGORY IV: INFRASTRUCTURE (Select 1 to 3)

COLLECTIONS/STOCK CULTURES
- ☐ Collection Enhancement
- ☐ Collection Refurbishment
- ☐ Living Organism Stock Cultures
- ☐ Natural History Collections
- ☐ DATABASES
- ☐ Database Initiation
- ☐ Database Enhancement
- ☐ Database Maintenance & Curation
- ☐ Database Methods

FACILITIES
- ☐ Controlled Environment Facilities
- ☐ Field Stations
  - ☐ Field Facility Structure
  - ☐ Field Facility Equipment
- ☐ LTER Site
- ☐ GENOME SEQUENCING
  - ☐ Arabidopsis Genome Sequencing
  - ☐ Other Plant Genome Sequencing
- ☐ INDUSTRY PARTICIPATION

INSTRUMENTATION
- ☐ Instrument Development
- ☐ Instrument Acquisition
- ☐ Computational Hardware Development/Acquisition

TOOLS DEVELOPMENT
- ☐ Analytical Algorithm Development
- ☐ Other Software Development
- ☐ Informatics Tool Development
- ☐ Technique Development

TRACKING SYSTEMS
- ☐ Geographic Information Systems
- ☐ Remote Sensing

TRAINING
- ☐ Multi-, Cross-, Interdisciplinary Training
- ☑ NONE OF THE ABOVE

CATEGORY V: HABITAT (Select 1 to 2)

TERRESTRIAL HABITATS
- ☐ GENERAL TERRESTRIAL
- ☐ TUNDRA
- ☐ BOREAL FOREST
- ☐ TEMPERATE
  - ☐ Deciduous Forest
  - ☐ Coniferous Forest
  - ☐ Rain Forest
  - ☐ Mixed Forest
  - ☐ Prairie/Grasslands
  - ☐ Desert
- ☐ SUBTROPICAL
  - ☐ Rain Forest
  - ☐ Seasonal Forest
  - ☐ Savanna

☐ Thornwoods ☐ Deciduous Forest ☐ Coniferous Forest ☐ Desert ☐ TROPICAL ☐ Rain Forest ☐ Seasonal Forest ☐ Savanna ☐ Thornwoods	☐ Deciduous Forest ☐ Coniferous Forest ☐ Desert ☐ CHAPPARAL/ SCLEROPHYLL/ SHRUBLANDS ☐ ALPINE ☐ MONTANE ☐ CLOUD FOREST ☐ RIPARIAN ZONES	☐ ISLANDS (except Barrier Islands) ☐ BEACHES/ DUNES/ SHORES/ BARRIER ISLANDS ☐ CAVES/ ROCK OUTCROPS/ CLIFFS ☐ CROPLANDS/ FALLOW FIELDS/ PASTURES ☐ URBAN/SUBURBAN ☐ SUBTERRANEAN/ SOIL/ SEDIMENTS ☐ EXTREME TERRESTRIAL ENVIRONMENT ☐ AERIAL
AQUATIC HABITATS		
☐ GENERAL AQUATIC ☐ FRESHWATER ☐ Wetlands/Bogs/Swamps ☐ Lakes/Ponds ☐ Rivers/Streams ☐ Reservoirs ☐ MARINE	☐ Open Ocean/Continental Shelf ☐ Bathyal ☐ Abyssal ☐ Estuarine ☐ Intertidal/Tidal/Coastal ☐ Coral Reef ☐ HYPERSALINE	☐ EXTREME AQUATIC ENVIRONMENT ☐ CAVES/ ROCK OUTCROPS/ CLIFFS ☐ MANGROVES ☐ SUBSURFACE WATERS/ SPRINGS ☐ EPHEMERAL POOLS & STREAMS ☐ MICROPOOLS (Pitcher Plants, Tree Holes, Other)
MAN-MADE ENVIRONMENTS		
☐ CELL/TISSUE CULTURE (In Vitro) ☐ In Silico	☐ THEORETICAL SYSTEMS	☐ OTHER ARTIFICIAL SYSTEMS
NOT APPLICABLE		
☑ NOT APPLICABLE		

CATEGORY VI: GEOGRAPHIC AREA OF THE RESEARCH (Select 1 to 2)

☐ WORLDWIDE ☐ NORTH AMERICA ☑ United States ☐ Northeast US (CT, MA, ME, NH, NJ, NY, PA, RI, VT) ☐ Northcentral US (IA, IL, IN, MI, MN, ND, NE, OH, SD, WI) ☐ Northwest US (ID, MT, OR, WA, WY) ☐ Southeast US (DC, DE, FL, GA, MD, NC, SC, WV, VA) ☐ Southcentral US (AL, AR, KS, KY, LA, MO, MS, OK, TN, TX) ☐ Southwest US (AZ, CA, CO, NM, NV, UT) ☐ Alaska ☐ Hawaii ☐ Puerto Rico ☐ Canada ☐ Mexico ☐ CENTRAL AMERICA (Mainland) ☐ Caribbean Islands ☐ Bermuda/Bahamas ☐ SOUTH AMERICA	☐ Eastern South America (Guyana, Fr. Guiana, Suriname, Brazil) ☐ Northern South America (Colombia, Venezuela) ☐ Southern South America (Chile, Argentina, Uruguay, Paraguay) ☐ Western South America (Ecuador, Peru, Bolivia) ☐ EUROPE ☐ Eastern Europe ☐ Russia ☐ Scandinavia ☐ Western Europe ☐ ASIA ☐ Central Asia ☐ Far East ☐ Middle East ☐ Siberia ☐ South Asia ☐ Southeast Asia ☐ AFRICA	☐ North Africa ☐ African South of the Sahara ☐ East Africa ☐ Madagascar ☐ South Africa ☐ West Africa ☐ AUSTRALASIA ☐ Australia ☐ New Zealand ☐ Pacific Islands ☐ ANTARCTICA ☐ ARCTIC ☐ ATLANTIC OCEAN ☐ PACIFIC OCEAN ☐ INDIAN OCEAN ☐ OTHER REGIONS (Not defined) ☐ NOT APPLICABLE

CATEGORY VII: CLASSIFICATION OF ORGANISMS (Select 1 to 4)

☐ VIRUSES ☐ Bacterial	☐ Plant ☐ Animal	☐ PROKARYOTES ☐ Archaebacteria

- ☐ Cyanobacteria
- ☐ Eubacteria

☐ PROTISTA (PROTOZOA)

- ☐ Amoebae
- ☐ Apicomplexa
- ☐ Ciliophora
- ☐ Flagellates
- ☐ Foraminifera
- ☐ Microspora
- ☐ Radiolaria

☐ FUNGI

- ☐ Ascomycota
- ☐ Basidiomycota
- ☐ Chytridiomycota
- ☐ Mitosporic Fungi
- ☐ Oomycota
- ☐ Yeasts
- ☐ Zygomycota

☐ LICHENS

☐ SLIME MOLDS

☐ ALGAE

- ☐ Bacillariophyta (Diatoms)
- ☐ Charophyta
- ☐ Chlorophyta
- ☐ Chrysophyta
- ☐ Dinoflagellata
- ☐ Euglenoids
- ☐ Phaeophyta
- ☐ Rhodophyta

☐ PLANTS

- ☐ N0N-VASCULAR PLANTS
  - ☐ BRYOPHYTA
    - ☐ Anthocerotae (Hornworts)
    - ☐ Hepaticae (Liverworts)
    - ☐ Musci (Mosses)
- ☐ VASCULAR PLANTS
  - ☐ FERNS & FERN ALLIES
  - ☐ GYMNOSPERMS
    - ☐ Coniferales (Conifers)
    - ☐ Cycadales (Cycads)
    - ☐ Ginkgoales (Ginkgo)
    - ☐ Gnetales (Gnetophytes)
  - ☐ ANGIOSPERMS
    - ☐ Monocots
      - ☐ Arecaceae (Palmae)
      - ☐ Cyperaceae
      - ☐ Liliaceae
      - ☐ Orchidaceae
      - ☐ Poaceae (Graminae)
    - ☐ Dicots
      - ☐ Apiaceae (Umbelliferae)
      - ☐ Asteraceae (Compositae)
      - ☐ Brassicaceae (Cruciferae)
      - ☐ Fabaceae (Leguminosae)
      - ☐ Lamiaceae (Labiatae)
      - ☐ Rosaceae
      - ☐ Solanaceae

☐ ANIMALS

- ☐ INVERTEBRATES
  - ☐ MESOZOA/PLACOZOA
  - ☐ PORIFERA (Sponges)
  - ☐ CNIDARIA
    - ☐ Hydrozoa (Hydra, etc.)
    - ☐ Scyphozoa (Jellyfish)
    - ☐ Anthozoa (Corals, Sea Anemones)
  - ☐ CTENOPHORA (Comb Jellies)
  - ☐ PLATYHELMINTHES (Flatworms)
    - ☐ Turbellaria (Planarians)
    - ☐ Trematoda (Flukes)
    - ☐ Cestoda (Tapeworms)
    - ☐ Monogenea (Flukes)
  - ☐ GNATHOSTOMULIDA
  - ☐ NEMERTINEA (Rynchocoela) (Ribbon Worms)
  - ☐ ENTOPROCTA (Bryozoa) (Plant-like Animals)
  - ☐ ASCHELMINTHES
    - ☐ Gastrotricha
    - ☐ Kinorhyncha
    - ☐ Loricifera
    - ☐ Nematoda (Roundworms)
    - ☐ Nematomorpha (Horsehair Worms)
    - ☐ Rotifera (Rotatoria)
  - ☐ ACANTHOCEPHALA (Spiny-headed Worms)
  - ☐ PRIAPULOIDEA
  - ☐ BRYOZOA (Ectoprocta) (Plant-like Animals)
  - ☐ PHORONIDEA (Lophophorates)
  - ☐ BRACHIOPODA (Lamp Shells)
  - ☐ MOLLUSCA
    - ☐ Monoplacophora
    - ☐ Aplacophora (Solenogasters)
    - ☐ Polyplacophora (Chitons)
    - ☐ Scaphopoda (Tooth Shells)
    - ☐ Gastropoda (Snails, Slugs, Limpets)
    - ☐ Pelecypoda (Bivalvia) (Clams, Mussels, Oysters, Scallops)
    - ☐ Cephalopoda (Squid, Octopus, Nautilus)
  - ☐ ANNELIDA (Segmented Worms)
    - ☐ Polychaeta (Parapodial Worms)
    - ☐ Oligochaeta (Earthworms)
    - ☐ Hirudinida (Leeches)
  - ☐ POGONOPHORA (Beard Worms)
  - ☐ SIPUNCULOIDEA (Peanut Worms)
  - ☐ ECHIUROIDEA (Spoon Worms)
  - ☐ ARTHROPODA
    - ☐ Cheliceriformes
      - ☐ Merostomata (Horseshoe Crabs)
      - ☐ Pycnogonida (Sea Spiders)
      - ☐ Scorpionida (Scorpions)
      - ☐ Araneae (True Spiders)
      - ☐ Pseudoscorpionida (Pseudoscorpions)
      - ☐ Acarina (Free-living Mites)
      - ☐ Parasitiformes (Parasitic Ticks & Mites)
    - ☐ Crustacea
      - ☐ Branchiopoda (Fairy Shrimp, Water Flea)
      - ☐ Ostracoda (Sea Lice)
      - ☐ Copepoda
      - ☐ Cirripedia (Barnacles)
      - ☐ Amphipoda (Skeleton Shrimp, Whale Lice, Freshwater Shrimp)
      - ☐ Isopoda (Wood Lice, Pillbugs)
      - ☐ Decapoda (Lobster, Crayfish, Crabs, Shrimp)
    - ☐ Hexapoda (Insecta) (Insects)
      - ☐ Apterygota (Springtails, Silverfish, etc.)
      - ☐ Odonata (Dragonflies, Damselflies)
      - ☐ Ephemeroptera (Mayflies)
      - ☐ Orthoptera (Grasshoppers, Crickets)
      - ☐ Dictyoptera (Cockroaches, Mantids, Phasmids)
      - ☐ Isoptera (Termites)
      - ☐ Plecoptera (Stoneflies)
      - ☐ Phthiraptera (Mallophaga & Anoplura) (Lice)
      - ☐ Hemiptera (including Heteroptera) (True Bugs)
      - ☐ Homoptera (Cicadas, Scale Insects, Leafhoppers)
      - ☐ Thysanoptera (Thrips)
      - ☐ Neuroptera (Lacewings, Dobsonflies, Snakeflies)
      - ☐ Trichoptera (Caddisflies)
      - ☐ Lepidoptera (Moths, Butterflies)
      - ☐ Diptera (Flies, Mosquitoes)
      - ☐ Siphonaptera (Fleas)
      - ☐ Coleoptera (Beetles)
      - ☐ Hymenoptera (Ants, Bees, Wasps, Sawflies)
    - ☐ Chilopoda (Centipedes)
    - ☐ Diplopoda (Millipedes)
    - ☐ Pauropoda
    - ☐ Symphyta (Symphyla)
  - ☐ PENTASTOMIDA (Linguatulida) (Tongue Worms)
  - ☐ TARDIGRADA (Tardigrades, Water Bears)
  - ☐ ONYCHOPHORA (Peripatus)
  - ☐ CHAETOGNATHA (Arrow Worms)
  - ☐ ECHINODERMATA
    - ☐ Crinoidea (Sea Lilies, Feather Stars)
    - ☐ Asteroidea (Starfish, Sea Stars)

- ☐ Ophiuroidea (Brittle Stars, Serpent Stars)
- ☐ Echinoidea (Sea Urchins, Sand Dollars)
- ☐ Holothuroidea (Sea Cucumbers)
- ☐ HEMICHORDATA (Acorn Worms, Pterobranchs)
- ☐ UROCHORDATA (Tunicata) (Tunicates, Sea Squirts, Salps, Ascideans)
- ☐ CEPHALOCHORDATA (Amphioxus/Lancelet)
- ☐ VERTEBRATES
- ☐ AGNATHA (Hagfish, Lamprey)
- ☐ FISHES
- ☐ Chondrichthyes (Cartilaginous Fishes) (Sharks, Rays, Ratfish)
- ☐ Osteichthyes (Bony Fishes)
- ☐ Sarcopterygia (Lobe-finned Fishes) (Coelacanth, Lungfish)
- ☐ Actinopterygia (Ray-finned Fishes)
- ☐ AMPHIBIA
- ☐ Anura (Frogs, Toads)
- ☐ Urodela (Salamanders, Newts)
- ☐ Gymnophiona (Apoda) (Caecilians)
- ☐ REPTILIA
- ☐ Chelonia (Turtles, Tortoises)
- ☐ Serpentes (Snakes)
- ☐ Sauria (Lizards)
- ☐ Crocodylia (Crocodilians)
- ☐ Rhyncocephalia (Tuatara)
- ☐ AVES (Birds)
- ☐ Paleognathae (Ratites)
- ☐ Sphenisciformes (Penguins)
- ☐ Procellariiformes (Albatrosses, Petrels, Fulmars)
- ☐ Pelecaniformes (Pelicans, Gannets, Boobies, Tropicbirds)
- ☐ Ciconiiformes (Herons, Bitterns, Egrets, Storks, Ibis, Flamingo)
- ☐ Anseriformes (Ducks, Geese, Screamers)
- ☐ Falconiformes (Vultures, Hawks, Eagles, Condors, Kites, Falcons)
- ☐ Galliformes (Megapodes, Turkeys, Quail, Pheasants, Peafowl, etc.)
- ☐ Gruiformes (Cranes, Rails, Gallinules, Coots, Bustards, Crakes)
- ☐ Charadriiformes (Terns, Gulls, Stilts, Avocets, Plovers, Puffins, etc.)
- ☐ Columbiformes (Pigeons, Doves)
- ☐ Psittaciformes (Parrots, Lories, Cockatoos, Kakapo, Conures, etc.)
- ☐ Cuculiformes (Cuckoos, Turacos, Anis, Coucal, Roadrunner, etc.)
- ☐ Strigiformes (Owls)
- ☐ Apodiformes (Hummingbirds, Swifts, Thornbills)
- ☐ Coraciformes (Kingfishers, Todies, Bee-Eaters, Rollers, Hornbills, etc.)
- ☐ Piciformes (Woodpeckers, Toucans, Jacamars, Barbets, Honeyguides)
- ☐ Passeriformes (Passerines)
- ☐ MAMMALIA
- ☐ Monotremata (Platypus, Echidna)
- ☐ Marsupalia (Marsupials)
- ☐ Eutheria (Placentals)
- ☐ Insectivora (Hedgehogs, Moles, Shrews, Tenrec, etc.)
- ☐ Chiroptera (Bats)
- ☐ Edentata (Anteaters, Sloths, Armadillos)
- ☐ Primates
- ☐ Monkeys
- ☐ Apes (Gibbons, Orang-utan, Gorilla, Chimpanzee)
- ☐ Humans
- ☐ Rodentia
- ☐ Laboratory Rodents (Rat, Mouse, Guinea Pig, Hamster)
- ☐ Non-Laboratory Rodents
- ☐ Lagomorphs (Rabbits, Hares, Pikas)
- ☐ Tubulidenata (Aardvarks)
- ☐ Carnivora (Bears, Canids, Felids, Mustelids, Viverrids, Hyena, Procyonids)
- ☐ Ungulates
- ☐ Perissodactyla (Odd-toed Ungulates) (Horses, Rhinos, Tapirs, etc.)
- ☐ Artiodactyla (Even-toed Ungulates) (Cattle, Sheep, Deer, Pigs, etc.)
- ☐ Sirenia (Manatees, Dugongs)
- ☐ Proboscidea (Elephants)
- ☐ Marine Mammals (Seals, Walrus, Whales, Otters, Dolphins, Porpoises)
- ☐ TRANSGENIC ORGANISMS
- ☐ FOSSIL OR EXTINCT ORGANISMS
- ☑ NO ORGANISMS

CATEGORY VIII: MODEL ORGANISM (Select ONE)

- ☑ NO MODEL ORGANISM

MODEL ORGANISM (Choose from the list or input up to 9 characters)

VIRUS/BACTERIA

- ☐ Lambda Phage
- ☐ Rhizobacterium
- ☐ Escherichia coli
- ☐ Bacillus subtilis
- ☐ Cyanobacteria (Selenococcus/Selenobacter)

PROTISTA

- ☐ Acetabularia acetabulum
- ☐ Chlamydomonas reinhardtii
- ☐ Paramecium
- ☐ Tetrahymena

FUNGI

- ☐ Dictyostelium
- ☐ Neurospora
- ☐ Saccharomyces cereviseae
- ☐ Schizosaccharomyces pombe

PLANT

- ☐ Mouse-Ear Cress (Arabidopsis thaliana)
- ☐ Ice Plant (Mesembryanthemum spp.)
- ☐ Barley (Hordeum vulgare)
- ☐ Corn (Zea mays)
- ☐ Pea (Pisum sativum)
- ☐ Tobacco (Nicotiana spp.)
- ☐ Spinach (Spinacia oleracea)
- ☐ Alfalfa (Medicago spp.)
- ☐ Tomato (Lycopersicon spp.)

ANIMAL

- ☐ Nematode (Caenorhabditis elegans)
- ☐ Sea Slug (Aplysia californica)
- ☐ Sea Slug (Hermissenda spp.)
- ☐ Pond Snail (Lymnaea spp.)
- ☐ Terrestrial Snail (Helix spp.)
- ☐ Squid/Cuttlefish (Loligo, Sepia, etc.)
- ☐ Octopus (Octopus spp.)
- ☐ Leech (Hirudo medicinalis)
- ☐ Horseshoe Crab (Limulus spp.)
- ☐ Brine Shrimp (Artemia spp.)
- ☐ Lobster (Homarus, Panilurus, etc.)
- ☐ Crayfish (Procambarus, Astacus, etc.)
- ☐ Dragonfly (Aeschna, etc.)
- ☐ Grasshopper/Locust (Schistocerca, etc.)
- ☐ Cockroach (Periplaneta, Blatta, Blatella, etc.)
- ☐ Mantis (Mantis, Parasphendale, etc.)
- ☐ Six-Lined Hawk Moth (Manduca sexta)
- ☐ Fruitfly (Drosophila melanogaster)
- ☐ Syrphid Fly (Syrphidae)
- ☐ Apple Maggot (Rhagoletis spp.)
- ☐ Mosquito (Culex, Aedes, Anopheles, etc.)
- ☐ Flour Beetle (Tenebrio spp./Tribolium spp.)
- ☐ Honeybee (Apis mellifera)
- ☐ Parasitic Wasp (Braconids, Pteromalids, etc.)
- ☐ Sea Urchin (Diadema, Mellita, etc.)
- ☐ Ascidian (Boltenia, Molgula, etc.)
- ☐ Lancelet (Amphioxus spp.)
- ☐ Lamprey (Petromyzon spp.)
- ☐ Skate (Raja, Myliobatis, etc.)
- ☐ Croaker (Sciaenid Fishes)
- ☐ Electric Fish (Eigenmannia, Sternopygus, etc.)

☐ Goldfish (Carassius auratus, etc.)	☐ House Sparrow (Passer domesticus)	☐ Guinea Pig (Cavia porcellus)
☐ Perch (Perca spp.)	☐ White-Crowned Sparrow (Zonotrichia leucophrys)	☐ Hamster (Mesocricetus, Phodopus, etc.)
☐ Zebrafish (Danio (Brachydanio) rerio)	☐ Zebra Finch (Poephila guttata)	☐ Kangaroo Rat (Dipodomys, etc.)
☐ Axolotl (Ambystoma mexicanum)	☐ Opossum (Monodelphis, Didelphis, etc.)	☐ Mouse, Laboratory
☐ Mudpuppy (Necturus spp.)	☐ Bat (Antrozous, Eptesicus, etc.)	☐ Rat, Laboratory
☐ African Clawed Frog (Xenopus laevis)	☐ Owl Monkey (Aotus spp.)	☐ Vole (Microtus spp.)
☐ Bullfrog (Rana catesbeiana)	☐ Rhesus Monkey (Macaca mulatta)	☐ Domestic Dog (Canis domestica/familiaris)
☐ Grass Frog (Rana pipiens)	☐ Tamarin (Sanguinus, Leontopithecus spp.)	☐ Domestic Cat (Felis domestica/cattus)
☐ Marine Toad (Bufo marinus)	☐ Chimpanzee (Pan troglodytes)	☐ Ferret (Mustelus spp.)
☐ Turtle (Chrysemys, Pseudemys, etc.)	☐ Human (Homo sapiens)	☐ Farm Animals (Horse, Sheep, Pigs, Cattle, Goats)
☐ Quail (Coturnix spp.)	☐ Chinchilla (Chinchilla laniger)	[Enter your own model organism - up to 9 characters]
☐ Chicken Embryo (Gallus domesticus)	☐ Deer Mouse (Peromyscus spp.)	☐

The 21st Century Biology subcommittee of the Advisory Committee for the Biological Sciences Directorate (BIO AC) will hold a two day workshop to address the current status, anticipate the potential, and provide guidance to the Directorate on how NSF Bio can best empower the biological sciences community to utilize the extraordinary impact of modern information technology, which will lead to a more effective, productive environment for research and education. This is made possibly by a new, underlying, NSF-driven, infrastructure empowering people, their ideas and their use of tools for discovery. The numerous advances in the basic and applied fields, within all performance domains, for the computer and information science and engineering (notably, funded by CISE) have been extraordinary. After several decades of exponential advances in hardware and software, information technology has become an intrinsic component of our economy, our sciences, our industry, and our society. The pervasive, ubiquitous, embedded, seamlessly available technology not only has become the singular most important cog in the Nation's industry, but also the central cog in world wide research and development, commerce and communication. Correspondingly, by consolidating and accelerating the components, NSF, as has been described routinely by the NSF Director, can exploit the convergence of these exponential trends, which are said collectively to have passed a threshold in applicability and importance, to create a comprehensive foundation, a cyberinfrastructure (CI), on which to build the Science, Technology and Education of the 21st Century. The previous AD for CISE commissioned a blue ribbon panel, chaired by Prof. Dan Atkins, whose report underscores these opportunities, and which now is the basis for CISE and for NSF as a whole in its central objectives for the next few years. CI is perceived as being as transformational for science, technology and commerce as Gutenberg's invention of the printing press was for society, setting the stage for growing literacy, public dialogue for growing populations, and ultimately, democracy. CI promises the same open access to literacy, public dialogue and democratic rewards. The Atkins report, "Revolutionizing Science and Engineering Through Cyberinfrastructure," with its compelling arguments for the potential for NSF action, now forms the basis of central planning for all NSF domains for FY05.

CI is indeed ideally suited for the cottage industry that is biology, due to the revolution in grid services, data integration, and modern information technology, coupled with the advent of a biological research approach, focused at a systems level, that is integrative, synthetic and predictive, or what NSF calls: 21st Century Biology. 21st Century Biology absolutely requires a strong cyberinfrastructure, and more than any other domain, biology, due to its inherent complexity and requirements for IT, will drive the future cyberinfrastructure for all science.

Most NSF Directorates have held workshops to determine the potential of CI for specific research domains, where their community stands with respect to implementation of CI today, what the next steps are, what the longer term implications will be, and what needs to be done by NSF and by the community to ensure an optimum impact for CI across all sciences and educational programs and across the Nation. The Biological Sciences Directorate needs to undertake the same levels of analyses, first to plan internally and prepare itself for the transformation, and then to reach out to the community and help them prepare to take advantage of this profound underpinning for 21st Century Biology. The NSF, as a whole, will build a comprehensive CI for new types of scientific and engineering knowledge environments and organizations, to allow research to go forward in novel ways with increased efficiency. The BIO AC Workshop of the 21st Century Biology subcommittee will address the key questions for BIO's involvement and role within the NSF fabric, and at the conclusion of the workshop will provide BIO with a short white paper, along with presentation material, containing relevant policy advice. Further steps to involve and empower the full biological sciences community will be outlined at the workshop.

The two criteria for consideration by NSF are deeply intertwined in this proposal. That is, the intrinsic scientific merit of the activity and the potential contribution arising from the proposed activity to the Nation's infrastructure, and other related goals of NSF beyond supporting the best research per se, are fully coupled for the outcome of the workshop. Not only is CI international in scope, but also, the implementation of CI will require breaking down the digital divide. Already, the universities and states without tier 1 research Institutions are prepared proposals and working on implementing CI to enable their science. CI for BIO is ideal in democratizing access to information and resources, and meeting the needs of the entire community. Community Colleges, Minority Serving Institutions such as Tribal Colleges, Hispanic Institutions, Colleges for Research and Education, Historically Black Colleges and Universities will all have increased opportunities to participate. The web has already provided novel access to all. CI infrastructure will empower many new ways in which all scientists, and students, will be able to contribute to the Nation's research endeavors, and enhanced modes of training will be established. It would be hard to find an activity that will contribute more in terms of outreach and also of societal impact.

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*Proposers may select any numbering mechanism for the proposal. The entire proposal however, must be paginated. Complete both columns only if the proposal is numbered consecutively.

Building a Cyberinfrastructure for the Biological Sciences
A Workshop of the BIO Directorate Advisory Committee, Subcommittee on 21st Century Biology
July 14-15, 2003
Old Town Alexandria

The National Science Foundation aims to consolidate its computer and information science and engineering advances for research and education, which have the capacity to transform all aspects and all corners of work supported by the NSF, both be exploiting its accomplishments across all Directorates, the science and education pulls for this profound science and technology revolution, and within the core disciplinary push arising from CISE and its IT and CS programs. This promises to be the most coordinated and probably the most important step ever taken by NSF. Dr. Colwell has described the power of modern IT in bringing wisdom and a deeper value toward society of all of the work conducted under NSF support. Each Directorate needs to examine what it has done, what it is doing, and what it should do, in terms of providing the right types of support and encouragement to the community. In the case of the biological sciences, the inherent, extraordinary even for science, complexity of living systems, of biology, makes IT an ideal partner. IT is the language for biology the way calculus is the language of the physical sciences. At the same time, the hierarchical nature of the biological sciences, the myriad data types, the need for multiscale, multimodal, data integration over vast scales of time and space and over degrees of organizational complexity as well, make the biological sciences and the intrinsic nature of biology a particular challenge for computer science and engineering. The two fields, CSE and BIO, have participated over the past five decades in the most profound revolutions ever in science and technology and now are ideally suited for each other. The challenge is for NSF to bring the two fields together, consolidating and integrating the connections that now exist along the frontier, exploiting innovative opportunities at the interface, and providing the training and outreach necessary to engage the entire country, all types and categories of Institutions and educational levels, and in the end, for scholars all along this frontier, to serve society.

The Directorate for Biological Sciences (BIO) of the National Science Foundation (NSF) has taken a proactive role in building Biology 21, the Biological Sciences of the 21st Century. Genome-enabled science, systems biology, high throughput biology, and biocomplexity in the environment are among the many visible signs of the future. The entire research community has enthusiastically watched NSF's BIO staff, in interacting with the community at professional society meetings, through peer review processes, through public presentations, and through communication to the Biological Sciences Directorate's Advisory Committee (BIO AC) to begin to implement a vision to sustain these opportunities. To facilitate tomorrow's advances in biology built upon the revolution in the life sciences, the biological sciences community, using technology from computing, will increasingly depend on access to and use of information. Biology 21, most notably, will be entirely built upon a foundation of information technology.

The world of information technology, from computing to storage to communication, is moving toward the establishment of a cyberinfrastructure for all science domains; the NSF Director, Rita Colwell, has announced this goal to be essential to define science and engineering research and education for our society in this Century, and thus, to be a central responsibility for the National Science Foundation. As the BIO Advisory Committee works with the staff of our Directorate and with other members of the scientific community to sharpen the vision for 21st Century biology, we must explore the needs of the biological science community for cyberinfrastructure, what specifics are required, and what NSF BIO should do.

As one reflects on the partnership between NSF and the community over the past decades, it is apparent that the core of that partnership concerns a shared commitment to the value of well-organized, integrated, synthesized information, or knowledge. Knowledge is enabling for our society, not just our science, in the deepest sense. Our ability to use science for public benefit depends on the set of transactions and translations that take data to information and to knowledge, or in the broadest scheme, to the kinds of empowering understanding we call wisdom. The opportunities in the biological sciences today to advance our fundamental understanding of life and to apply that understanding to societal needs, ranging from the environment to personal well being, is simply extraordinary. We have entered an era characterized by data-intensive research observations. Collecting, managing, and in particular, connecting data from various modalities and on multiple scales of biological systems, from molecules to ecosystems, is essential to turn that data into information. Each biological science discipline also now requires the tools of information technology to probe that information, to interconnect experimental observations and modeling, and contribute to an enriched understanding or knowledge. The central aspect of the challenge is why this century is widely recognized as the "Century of the Biological Sciences"; that is, the very complexity of biology means that the information technology challenges for achieving wisdom, or acumen, for basic and applied life science research are at a level and scale at least as significant, and often more so, than other research areas.

The BIO Directorate is well positioned, given its history, to play a major role in this transformation of science. In 1984, as the High Performance Computing program began, BIO held a workshop at Airlie House to evaluate if and if, how, biologists could use supercomputers. The answer to the first question was a responding yes, and the answer to the second, with full support from BIO management, led the Instrumentation Program to undertake entirely new directions. For example, as a direct result of the commitment by BIO to sustain access, biological science applications using high performance computing moved from a fractional percent of the compute-time available in 1985 to nearly 30% of the time as the major application at NSF supercomputer centers in 1998. The singularly most important information resource for the next decade is the repository for the architectures of macromolecules, the Protein DataBank or PDB. NSF funded the creation of that database decades ago, when few could see its ultimate impact. The revision, updating and expansion of the PDB to serve the entire community of biologists superbly, as NSF has driven and enabled over the past decade, will turn out to be essential for understanding the mechanisms by which the cell's supramolecular machines work. Similarly, the BIO development of an infrastructure of computer and information technology for the extraordinarily successful LTER program has been singularly important for ecosystems research. Analysis of plant and microbial genomes relies on computational tools. The neurosciences, also, have central requirements for simulation and computational modeling. With PDB, LTER, and numerous, increased core research needs from molecules to the mind providing the pull, and pushed by the High Performance Computing and Information Technology initiative, BIO, at a particularly prescient point in time (over a decade ago), began the first programs in government to fund computational biology and bioinformatics (then, database activities). In the following decade, BIO has strengthened this interface across all its own programs and partnered with CISE on each of its subsequent initiatives, including HPCCIT, KDI and ITR. In sum, BIO already has a foundation upon which to build a cyberinfrastructure for the biological sciences. It is natural and even imperative that the Directorate for the Biological Sciences take a leadership role in its full implementation.

The revolution in the computer science and information technology world, driven by the academic research community and the commercial sector, has happened at the same time as the revolution in the biological sciences. The two have now become ideal partners for each other. Life along the frontier between the biology and computing is truly exciting and already contributions from this frontier are essential for progress in life science research. The development of the computational grid services model, from data and information grids to compute grids to communication grids, will be especially enabling to the biological science community and its widely distributed laboratory environment of individual investigators, as well as to research teams. Grid and cluster computing brings what had been rare and difficult to access technology to the entire biological sciences community. Today, linking knowledge resources together with readily exploited portals is equally essential. Of particular importance in achieving the vision of NSF BIO, the growing world of cyberinfrastructure promises democracy in action for biology, with participation by the entire spectrum of basic scientists supported by NSF BIO, ranging from minority serving institutions to research intensive universities. Even K-12 education will be facilitated by a cyberinfrastructure for biology. Our entire community, the community of biologists in the broadest sense, will participate more fully in the power and joy of discovery and the impact of its consequences. The world wide web has promoted a new kind of dialogue in the life sciences, in which everyone can access the same information and participate in discovery; a high school student can send out a question concerning an some biological detail and mere hours later, a Nobel Laureate from another continent will send back the answer. The expansion of today's information technologies to create a cyberinfrastructure for biology will accelerate that access, that openness and inclusiveness, while accelerating progress across all biological science research domains.

NSF BIO must integrate today's ad hoc first steps, architect and organize, and then build out a comprehensive cyberinfrastructure for biology to ensure this vision of democratic access. As early as a decade ago, a molecular biology Nobel Laureate proposed that access to global data would be critical for driving biological science research as well as for individuals sustaining competitiveness (W. Gilbert, Nature, 1991; "Toward a New Paradigm for Molecular Biology."). The Laureate predicted that experimentalists, in deciding what to pursue each day, would come to depend on the world's production of new findings over the past 24 hours, and that a comprehensive biological information infrastructure and associated computing tools would become deeply embedded in experimental biology. At that time, coupling biology and computing seemed oxymoronic to many; today, that partnership is inherently obvious and must be a central feature of NSF BIO activities from this point forward, if BIO is to lead and accelerate the movement of the life sciences research community into 21st Century Biology.

To establish a cyberinfrastructure for biology, the science drivers that will on the commercial technology to address our needs should first be defined. There will continue to be a major technology push arising from the academic and industrial sectors within the computer and information sciences and engineering, and that technology push will interconnect with science pulls from across the entire domain of scientific investigation. From geochemistry to astronomy, from engineering to oceanography, the scientific communities supported by NSF recognize the opportunities from cyberinfrastructure and are rapidly addressing their own needs, through workshops and white papers. While biology writ large, and BIO specifically, will be able to utilize these visions and advances, BIO must establish the path for the life sciences, to ensure our needs are met and because our community absolutely requires this infrastructure and will drive it further than we can now possibly imagine.

Within NSF, all Directorates have some inherent interest in partnering with BIO. CISE, MPS, ENG, OCE are obvious, and even the K-12 educational programs will have numerous intersections with BIO. While, both nationally and globally, NSF is the only agency and BIO the only potential leader for the overall effort, there will be many potential external partners. For example, the USGS is already directly involved in biodiversity informatics and will be an important partner. NIH and DOE have recognized the importance of computational biology and bioinformatics, and will build specialized programs for their specific missions and objectives. The Department of Agriculture, State Government science programs, and numerous environmental entities outside government will also be natural partners. Many of these programs will naturally extend the cyberinfrastructure of basic biology to the applied life sciences, ranging from health care to agricultural improvements and environmental remediation and restoration.

The nature of the maturation of the biological sciences as we implement 21st Century Biology underpins the expectations for cyberinfrastructure. Beyond the great success of reductionist approaches of the past five decades, biology is moving into an environment to consolidate these gains through information integration. The entry of biology into discovery and synthetic analysis, that is, genome-enabled biology and systems biology as well as the hardening of many biological research tools into high throughput pipelines, serves also to drive the need for cyberinfrastructure. Biodiversity and biocomplexity in the environment are two areas in BIO's domain for which active scientists and policy makers have already begun to think about the cyberinfrastructure needs, needs that have even been recognized at the White House level though PCAST. The most prominent example of an early application of cyberinfrastructure in biology is BIRN, which serves to link remote neuroscience data, utilizing a multiscale, multimodal database to accelerate new discovery. BIRN can be generalized for most NSF communities, besides cognitive neuroscience and basic neurobiology, and is particular obvious as a model for LTER, NEON, and for numerous activities within environmental biology. Similarly, there are already hundreds of molecular biology databases. Connecting them to research conducted on higher levels of biological organization is important for 21st Century Biology.

NSF BIO needs to carry out two levels of response to these incredible opportunities. For 21st Century Biology, it is essential that the BIO Advisory Committee's 21st Century Biology Working Group hold a planning session to provide key first steps, milestones, and near and longer term objectives. Then, as the other NSF communities have done, NSF BIO, through its AC and other members of the community, should establish a small, public workshop, leading to specialized white papers, a web presence, and a more complete NSF BIO AC report. The planning session should be held July 14-15, so we can meet BIO Directorate's immediate needs, and the workshop in 2004.

Along with providing BIO with initial suggestions and answers to the questions above at the session, we can more fully plan a detailed workshop for next year, if the Working Group concurs that further discussion is needed. By holding the meeting on 14 and 15 July 2003, our draft report can immediately inform CISE's ongoing analyses and the Foundation-wide discussion on cyberinfrastructure, enable coordination with all of the Divisions and other Directorates that have held similar workshops and are proceeding with establishing milestones, and in particular, facilitate your efforts to lay out the best strategy for addressing the cyberinfrastructure for biology.

The biological sciences today, as the NSF BIO AD has often pointed out, are indeed living in exciting times. Research and education infrastructure of all types is becoming more and more essential for scientific research, and cyberinfrastructure is particularly important for the future of all aspects of biology. The entire BIO community and its representatives pro temp, the BIO AC, share an appreciation for our role and involvement during this period of radical innovation, novel advances in culture and vision, and the transformation of opportunities for science and engineering, as information technology becomes part of the fabric of all science.

In helping the biological sciences prepare for the cyberinfrastructure opportunities, and most immediately, for the planning session on 14 and 15 July, a list has been prepared, with web locations, for the contributions from other communities, and all participants have an electronic (CD) version of the relevant white papers under consideration in other disciplines and the vision from the Computer and Information Science and Engineering Directorate that is fundamental to the planning effort for the other disciplinary programs. There are now slightly more than thirty participants from the University and Not-For-Profit sector, plus the workshop will include however many NSF staff from BIO and CISE are able to attend. Selections have been based on the recommendations of disciplinary staff with BIO, on achieving a balance with respect to all considerations the community would expect, and to utilize the contributions of some of those whose research focus have already forced an early adoption of the paths leading toward a cyberinfrastructure for biology. In addition, the group provides a reasonable distribution of expertise and research specialities, around the entire BIO science domains; furthermore, consideration of NSF's responsibility to a broad biological sciences community and its parallel commitment to the future scientific personnel needs to implement 21st Century Biology. The response from the community has been extraordinary. While the sense of importance for this activity was so obvious everyone tried to rearrange their schedule to participate, those who couldn't asked to be kept informed and also asked that they be invited to any follow on meetings. The several dozen of biologists whom have been consulted in establishing this initial workshop all recognize that the NSF is taking a profound and exceptional commitment to enabling its scientists to live and contribute in the future, providing an environment for science that is unprecedented. Every program in BIO will benefit and the all of their cognizant scientific domains will be enabled, enhancing forever the opportunities for participation in the pathway from data to information, knowledge and ultimately understanding.

By the end of July, the investigators, with my taking a lead in editing as chair, will assemble about a consensus, overview white paper, on the order of ten pages in length for the use of BIO leadership. We assume that the recommendation from the workshop will be that further, more specialized, workshops should be held, some in conjunction with professional society meetings, and that ultimately a larger workshop involving representatives from every BIO community will be required. Toward those ends, we plan on creating a web site for academic, research, and noncommercial purposes that would reflect the vision and goals of building a cyberinfrastructure for the biological sciences. We will interact with those who lead the specialized workshops, be sure that the information is properly hyperlinked, and intellectually connected, as well as suitable for NSF BIO's implementation stage planning. That is, besides having workshops that set the right intellectual framework and the right scientific and technical goals, we hope that some of the output of various workshops would ultimately fit into programmatic details for NSF's ambitions in CI and CI for BIO, and that some of the material would thus wind up on NSF BIO web pages. To allow full engagement by the community as soon as possible and to present a comparable presence to the other NSF science communities, we think it is important to develop a community web site immediately, to populate that first with the relevant references and background material, and then to update that as a roadmap for the biological sciences is developed. Such a roadmap would include either the original documents or hyperlinks to documents produced by the cognizant professional societies for the biological sciences as well as documents or links to the relevant equivalent documents arising from the computer and information science and engineering domain.

<u>Questions to consider at CI BIO July 14-15, 2003</u>

General questions and considerations to be reviewed are Why CI? Why should the biological sciences be players? Why NSF? Why BIO? These questions are, of course, already answered in the original Atkins report, but will be reviewed in content, to provide background. We will look at the BIO CI history, how we got to where we are, and will examine the technology and an example of a full-blown application of CI to BIO's science domains. We will consider the administrative scope, outreach, and what are next steps for BIO. To prepare the white paper given this background information, we will use smaller group discussions to stimulate discussion, although each group will consider all of the questions. These specific questions fall into four categories and will be considered accordingly. Those questions, grouped in consideration of breakout group discussions, A-D, follow.

A.

Why is cyberinfrastructure for biology so important? What difference will it make?

What is its scientific scope?

- *Where are we now? What are successful examples?*
- *Where do we have to go? Opportunities? Challenges?*

B.

What is its technology scope?

- *What are requirements for Data Intensive Bioscience and BioKnowledge Management?*

What are the explicit educational opportunities and requirements (besides those naturally arising in the above context / that is, besides those in the context of specific research)?

C.

What is its administrative scope?

- *What do we need to get there? Funds? Management?*

Who will be natural collaborators?

- *Internal Agency Partners, External Agency Partners*
- *Not for Profits; NGOs; International Implications*

D.

What further meetings or actions are needed in the near term?

What will BIO need to do to establish the relevance of BIO objectives for the global CI?

What are the other first policy and planning steps for BIO?

What review and other management processes will be needed for implementation?

(DRAFT) Workshop Agenda:

Building a Cyberinfrastructure for the Biological Sciences

Day 1, 14 July 2003

-Morning Session: 9:30 start.
Introduction, Welcome, Charge by AD, BIO; Workshop Chair, BIO AC (9:30-9:40)
Presentation by DAD, CISE on CI as viewed by CISE (9:40-10; Qs&As, 10 - 10:10)
Review of Initial Requirements and Overview of CI-BIO ("seabio"), CH (10:10-10:20) <10 m break>
Examples and Models for CI / examples from biological science (10:40-11:40)
Overview of Grid, CI Technologies, Issues, CA (11:40 – 12:10)
Working Lunch (12:10-1:10)
Lunch discussion include overviews, general group discussion and assignments for breakout groups
-Afternoon Session
Breakout Groups formed, begin (Discuss A. 1:10-2:40; < break; then reassemble>; discuss B. 3-4:30)

A. Science Assignments; Science Drive, Pull; "Why SciBIO CI,"
B. Application Assignments; Generic Infrastructure; Technology Push

Presentations from Breakout Group Chairs - Review Initial Contributions (4:30-5:10)(<10 m break>)
Round Table Discussion (5:30-6:30)
- Break for dinner by 6:30; expect continued discussion
- about 8:30 - 10 PM, hotel
Brief Meeting of Writing Group/Steering Committee, Review Outcomes, Plans for Day 2

Day 2, July 15 Tuesday

- Morning Session: 9 AM Start
Reform Breakout Groups (A. 9-10; <break>; B. 10:15-11:15)
[Review Monday "A" and "B" discussions, add "C" to first group; add "D" to second group]
[During Breakouts, Complete First Draft Major Writing Contributions, esp. both re BIOSCI and General Enablers – connections to CISE & Technology]
Review Output for consensus (11:15-12:15)
- Working Lunch – continued discussion
[Outcomes, Implications, OPTIONS FOR FUTURE MEETINGS, OTHER STRATEGIES]
- Afternoon Session
Final Draft of Each Section Prepared 1:15 – 2:25; outline key points/prepare overview
Overview presented to AD, BIO. possibly also to CISE, other NSF. (2:30-3:15) <15 min break>
Integrated Draft Prepared (3:30 – 6:30 PM)
- Writing Team will stay through working dinner Tuesday.
[Others can probably leave sooner or later during the final group writing and discussion session, that is, after the overview presentation, to catch very late afternoon, early evening flights.]

Day 3, July 16 Wednesday

- updated, more complete review provided to to AD, BIO AM
{Draft on Web Site as soon as possible; one week for comments by BIO AC and others invited/ interested/ involved but couldn't attend. Updated drafts on web site routinely available to all; final draft version, Microsoft Office Word text and Microsoft Office PowerPoint slides, submitted by end of 1 August. After BIO review and considerations, final version presented to BIO AC at Nov 2003 Meeting. Community Web Presence created by 1 October 2003, and sustained indefinitely, updated and fully interconnected/hyperlinked to other communities and notably to developments within the biological sciences.}

CI Bibilography
Background Relevant to July 14 – 15 BIO AC Workshop

The five most relevant background considerations (presentations or reports) are noted with three large astericks, i.e.,

***

The five most relevant white papers from community discussions (in NSF CI context) are noted with three large exclamation marks, i.e.,

!!!

American Association for the Advancement of Science **Research and Development Budget and Policy Program Homepage** (http://www.aaas.org/spp/rd/)

AAAS REPORT XXVIII RESEARCH AND DEVELOPMENT FY 2004 (http://www.aaas.org/spp/rd/rd04main.htm**)**

Page from AAAS XXVII Report Research and Development FY 2003 Computing Research in the FY 2003 Budget Request (http://www.aaas.org/spp/rd/03pch23.htm**)**

Background for the Discussion on Long-Range Planning at the MPSAC meeting of April 3-4 2003 Directorate for Mathematical and Physical Sciences
See page 5 for cyberinfrastructure discussion
http://www.nsf.gov/mps/mpsac/documents/MPS_FY_2005_PlanningDocument.pdf

The Biomedical Information Science and Technology Initiative: BISTI
http://www.nih.gov/about/director/060399.htm

*** **Charting our Cyberinfrastructure Future** Dr. Deborah Crawford June 6, 2003 Workshop on Cyberinfrastructure
www.eng.nsf.gov/general/Workshop/cyberinfrastructure/crawford.ppt

*** **CISE Advisory Committee on Cyberinfrastructure**
http://www.cise.nsf.gov/evnt/blu_rbbn/index.html

CISE Cyber-research: **Meeting the Challenges of a Terascale Computing Infrastructure** Fran Berman 05/15/2001
http://www.cise.nsf.gov/evnt/lec/cise_dist_lec/2001_15_05.htm

CISE Lecture List
http://www.cise.nsf.gov/evnt/lec/cise_lec_main.htm

Recent talks by the Assistant Director
http://www.cise.nsf.gov/div/oad/freeman_talk_page/

Collaborative Large-scale Engineering Assessment Network for Environmental Research (CLEANER/ENG)
http://cleaner.ce.berkeley.edu/

Computational Cell Biology – Challenges and Opportunities for an Emerging Field
http://www.ncrr.nih.gov/biotech/compcellbiorpt03-2001.pdf

*** **Computing: Getting us on the Path to Wisdom** Dr. Rita R. Colwell SC2002: From Terabytes to Insights November 19, 2002
http://www.nsf.gov/od/lpa/forum/colwell/rc021119sc2002.htm

Cyberinfrastructure for Engineering Research and Education: A Workshop Sponsored by the National Science Foundation. June 5 - June 6, 2003
http://www.eng.nsf.gov/general/Workshop/cyberinfrastructure/

!!! **Cyberinfrastructure for Environmental Research and Education Workshop sponsored by the National Science Foundation October 30 - November 1, 2002 (**http://www.ncar.ucar.edu/cyber/agenda.htm**)**

Cyberinfrastructure – Issues and Challenges Fran Berman
http://director.sdsc.edu/ppt/WP_Cyberinfrastructure.doc

Cyberinfrastructure Needs of the Engineering Community by Esin Gulani Acting Assistant Division Director for Engineering at NSF
https://lapp1.cise-nsf.gov/rhilderb/Presentations/Esin%20Gulari.ppt

Cyberinfrastructure: Opportunities for Connections and Collaboration
Joan Lippincott Coalition for Networked Information 2002
http://www.vala.org.au/vala2002/2002pdf/31Lipnct.pdf

Cyberinfrastructure or the Grid – Is there a Difference? CISE Grid Today February 10, 2003: Vol. 2 No. 6
http://www.gridtoday.com/03/0210/101045.html

*** **Cyberinfrastructure: Revolutionizing Science & Engineering**
Peter A. Freeman, NSF Assistant Director for Computer and Information Science and Engineering (CISE) CENIC 2003 May 9, 2003
http://www.cise.nsf.gov/div/oad/freeman_talk_page/cenic_files/frame.htm

Cyberinfrastructure Will Fuel Scientific Discovery, NSF Chief Says
Paul Shread Gridcomputing November 19, 2002
http://www.gridcomputingplanet.com/news/article.php/3281_1503721

Cybersecurity, Cyberinfrastructure Top Priorities at Information Technology Forum
National Association of State Universities and Land Grant Colleges (NASUCGC) Newsline. APRIL 2003 VOLUME 12 NUMBER 4
http://www.nasulgc.org/Whatsnew/Newsline/2003/NewslineApr03.pdf

Digital Libraries Fact Sheet (http://www.nsf.gov/od/lpa/news/02/fsdigitallibry_02.htm**)**

Digital Libraries Initiative phase 2(CISE) (http://www.dli2.nsf.gov/**)**

!!! **Environmental CyberInfrastructure** (ECI) Tools for the Study of Complex Environmental Systems. **An Occasional Paper of the NSF Advisory Committee for Environmental Research and Education AC-ERE. May 1, 2003**
http://www.nsf.gov/geo/ere/ereweb/ac-ere/ac-ere1_ECI.pdf

Environmental Cyberinfrastructure: Turning Data into Knowledge. Margaret Cavanaugh NSF SINE Workshop- SDSC October 29, 2001
http://www.sdsc.edu/pbi/sine_workshop_slides/mcavanaugh_SINEPresentation.ppt

Environmental Research and Education (ERE)
http://www.nsf.gov/geo/ere/ereweb/index.cfm

Experimental Program to Stimulate Competitive Research (EPSCoR)
http://www.ehr.nsf.gov/epscor/start.cfm

Extensible Terascale Facility (ETF) http://cise.nsf.gov/news/cybr/cybr.htm

!!! **GEON Cyberinfrastructure for the Geosciences** http://www.geongrid.org/

Global Terabit Research Network: Building Global Cyber Infrastructure. Steven Wallace. Global Research Networking Summit. May 2002
http://www.dante.net/conference/globalsummit2002/html/3-3wallace/sld001.htm

The Human Side of the Cyberinfrastructure. Berman, F. 2001 Envision. 17: (http://www.npaci.edu/envision/v17.2/director.html**)**

Implication of Information Technologies: IT Overview (SBE) (http://srsweb.nsf.gov/it_site/it/infotech.htm**)**

Information Technology & Research (ITR) Program http://www.itr.nsf.gov/

Key Issues Cyberinfrastructure for Engineering Research and Education: A Workshop Sponsored by the National Science Foundation. June 5 evening and June 6, 2003
http://www.eng.nsf.gov/general/sanderson.doc

The Langer Report Department of Energy/National Science Foundation
NATIONAL WORKSHOP ON ADVANCED SCIENTIFIC COMPUTATION
July 30-31, 1998
http://www.cise.nsf.gov/evnt/wksp/LangerRep.html

Long Term Ecological Research (LTER/DEB) http://lternet.edu/

Moving Forward with Cyberinfrastructure: Some Straight Talk Dr. Peter A. Freeman
http://www.cise.nsf.gov/div/oad/freeman_talk_page/alliance/

National Center for Atmospheric Research (NCAR/GEO)
http://www.geo.nsf.gov/cgi-bin/geo/showprog.pl?id=59&div=atm

National Coordination Office for Information Technology Research and Development (http://www.ccic.gov/pubs/pitac/index.html**)**

National Computational Science Alliance (the "Alliance) http://www.ncsa.edu/

National Partnership for Advanced Computational Infrastructure (NPACI)
http://www.npaci.edu/
Bio Applications: http://www.npaci.edu/Alpha/index.html

National Ecological Observatory Network (NEON/DEB)
http://www.nsf.gov/bio/neon/start.htm

National Science Digital Library (NSDL) (Program Solicitation: http://www.nsf.gov/pubs/2003/nsf03530/nsf03530.pdf**)**

National Science Foundation FY 2004 Budget Request Overview
http://www.nsf.gov/bio/bio_bdg04/overview.htm

Summary of NSF Accounts http://www.nsf.gov/bio/bio_bdg04/sum.htm

National Science Foundation Releases New Report from Advisory Committee for Cyberinfrastructure
http://www.nsf.gov/od/lpa/news/03/pr0318.htm

Network for Earthquake Engineering Simulation (NEES/GEO)
http://www.eng.nsf.gov/nees/

Next Generation Biology: The Role of Next Generation Computing July 1998
http://cbcg.lbl.gov/ssi-csb/nextGenBioWS.html

Next Generation Software Program (NGS)
http://www.cise.nsf.gov/fndg/pubs/display2.cfm?pgm_pims_id=5160&pgm_supp_id=10070&loc=acir&pub_id=5372&div=acir

NSF's Blue Ribbon Panel on Cyber-Infrastructure Material for Meeting 1
May 14, 2001
http://www.cise.nsf.gov/evnt/blu_rbbn/mint/pwrpnt/frame.htm

NSF Blue Ribbon Panel on High-Performance Computing (Branscomb Report)
http://www.cise.nsf.gov/div/acir/hilderbrandt/branscomb/challenges.htm

NSF Middleware Initiative (CISE)
http://www.nsf.gov/pubsys/ods/getpub.cfm?nsf03513

Partnerships for Advanced Computational Infrastructure (PACI)
http://www.cise.nsf.gov/news/cybr/paci.htm

Planning Our Cyberinfrastructure Future Dr. Peter Freeman
http://www.cise.nsf.gov/div/oad/freeman_talk_page/npaci/

Report on the Computational Infrastructure Workshop for the Genomes to Life Program
http://www.doegenomestolife.org/compbio/mtg_1_22_02/infrastructure.html

*** **Report on the Cyberinfrastructure Workshop**
Information about the Town Hall Meeting on June 23rd
May 14-15, 2003 Workshop http://www.si.umich.edu/cyber/

Report of the Task Force on the Future of the NSF Supercomputer Centers Program (Hayes Report) September 1995
http://www.nsf.gov/pubsys/ods/getpub.cfm?nsf9646

Revolutionizing Science and Engineering Through Cyberinfrastructure: Report of the National Science Foundation Blue-Ribbon Advisory Panel on Cyberinfrastructure. (Atkins Report) January 2003
http://www.cise.nsf.gov/evnt/reports/toc.htm

Science and Technology Centers (Office of Integrative Activities)
http://www.nsf.gov/od/oia/programs/stc/

The Science Board Science and Engineering Infrastructure for the 21st Century February 2001 http://www.nsf.gov/nsb/documents/2003/chapter3.htm

Securing Cyberinfrastructure NSF Workshop on Cyberinfrastructure Research for Homeland Security. Michael McRobbie. February 26, 2003
http://web.calit2.net/RiskReduction/powerpoints/MCROBBIE.ppt

Space Physics and Aeronomy Research (Collaboratory SPARC/GEO)
http://intel.si.umich.edu/sparc/

State of Computational Ecology
http://www.sdsc.edu/NEON/mar2000/sdsc-tr-1999-5.pdf

Steering Committee for Cyberinfrastructure Research and Development in the Atmospheric Sciences (CyRDAS) (GEO)
http://netstats.ucar.edu/cyrdas/

TeraGrid http://www.teragrid.org/

!!! **A Workshop for Identifying the Cyberinfrastructure Needs and Opportunities for Petrology, Geochemistry and Tectonics**
http://www.geo.ku.edu/TectonicsWorkshop/main.html

Workshop on Cyberinfrastructure Research for Homeland Security. February 25-27, 2003. La Jolla, CA
http://web.calit2.net/RiskReduction/index.html

!!! **Workshop on EPSCoR Cyber Infrastructure for Large-Scale Science and Engineering** April 27-29, 2003
http://www.epscorfoundation.org/cdi/ci-workshop/

BIOGRAPHICAL SKETCH

JOHN C. WOOLEY

Education

B.S., Michigan State University, The Honor's College,Physics, Chemistry and Biochemistry, 1967
Ph.D., The University of Chicago, Physics, Biophysics, 1975

Professional Experience

1999-present	Associate Vice Chancellor, Research, UC San Diego
1999- present	Adjunct Professor, Chemistry and Biochemistry and Pharmacology
1996-1998	Chief of Staff, OER, ER-4, DoE (concurrent position)
1995-1998	Associate Director, OER, ER-1, DoE, (rotating position)
1993-1996	Division Director, Medical Applications and Biophysical Research, OER, DoE
1992-1999	Deputy Associate Director, Office of Health and Environmental Research, U.S. Department of Energy
1992-present	Research Associate Professor of Biophysics, Johns Hopkins Medical School
1988-1992	Division Director, Instrumentation and Resources Division (DIR), Biological, Behavioral and Social Sciences (BBS) Directorate, National Science Foundation
1988	Program Director, Special Projects, DIR, NSF
1986-1988	Program Director, Biological Centers Program, BBS, NSF, (concurrent position)
1984-1988	Program Director, Biological Instrumentation Program, Division of Molecular Biosciences (DMB), BBS, NSF
1979-Present	Visiting Scientist, Biology Department, Brookhaven National Labs
1979-1983	Assistant Professor, Affiliated Appointment, Biology Department, Princeton University
1978-1983	Assistant Professor, Department of Biochemical Sciences, Princeton University

Honors and Awards

Research in Computational Molecular Biology Outstanding Contribution Award and Keynote Speaker, 1999 International Symposium
Medical Informatics Lecturer, National University of Singapore, 1998, 1999, 2000
Vice President Al Gore National Performance Review Hammar Award, 1998
U.S. Federal Government Quality Team Award, 1997
Senior Executive Service Presidential Rank Award, Meritorious Executive, 1997
National Science Foundation Superior Accomplishment Award, 1987
Searle Visiting Scientist, 1975-1976
Danforth Teaching Scholar, 1969-1970

Five Significant Publications Relevant to this Proposal

Head-Gordon, Teresa and John C. Wooley (2000), "Computational Challenges in Structural and Functional Genomics", IBM Research Journal on Deep Computing in the Life Sciences, 40, 265-296.

Wooley, J. (1999), Trends in Computational Biology, J. Comput. Biol. 1999 Fall-Winter; 6 (3-4), 459-74

Teresa Head-Gordon and, John C. Wooley, (1998) "Advanced Computational Structural Biology" url:cbcg.lbl.gov/ssi-csl/Index.html or the Lawrence Berkeley Labs or the Department of Energy, Washington, DC

John C. Wooley (1998) "Next Generation Biology - the Requirements for Next Generation Computing. a workshop report" Report to National Science Foundation, National Institutes of Health and Department of Energy, url: cbcg.lbl.gov/ssi-csl and available from

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Su-Yun Chung and John C. Wooley (1997), "The Likely Impact of Developments in Computer-based Information, Networking and Research: A Perspective from the Biological Sciences," in Equipping Science for the 21st Century, ed. John Irvine, Ben Martin, Dorothy Griffiths and Roel Gathier, Edward Elgar Press, Cheltenham, United Kingdom.

Five Other Significant Manuscripts

Wooley, J.C., Cone, R., Tartof, D. and Chung, S.Y., "Small Nuclear Ribonucleoproteins of Drosophila melanogaster; Proc. Nat. Acad. Sci. USA 79, 6762-6766.

Chung, S., Folsom, V. and Wooley, J. (1983) "Chromatin Structure of Immunoglobin kappa light chain genes probed by DNase I", Proc. Natl. Acad Sci. USA, 80, 2427-2431.

Wooley, J., Zukerberg, L. and Chung, S., (1983) "Polypeptide Components of Human Small Nuclear Ribonucleoproteins", Pro. Natl. Acad. Sci. USA, 80, 5208-5212.

Wooley, J. Chung, S.Y., Wall, J. and LeStourgeon, w. (1986), The Architecture of Pre-messenger Ribonucleoproteins Biophysics J., 49: 17-19.

Chung, S.Y. and Wooley, J. (1986) A Set of Novel, Conserved Proteins Fold Pre-messenger RNA into Ribonucleosomes. PROTEINS: Structure, Function, Genetics 1: 195-210.

Collaborators Within The Last 48 Months

Professor Shankar Subramaniam, Bioengineering Department, UCSD
Professor Susan Taylor, Chemistry and Biochemistry Department, UCSD
Professor Phil Bourne, Pharmacology Department, UCSD
Dr. Michael Gribskov, San Diego Supercomputer Center, UCSD
Dr. Lynn TenEyck, San Diego Supercomputer Center, UCSD
Professor Ian Wilson, The Scripps Research Institute and Beckman Institute for Chemical Biology
Professor Ray Stevens, The Scripps Research Institute and Beckman Institute for Chemical Biology
Professor Keith Hodgson, Chemistry Department, Stanford University (SU), Palo Alto
Professor Peter Kuhn, Stanford Synchrotron Radiation Laboratory, SU, Palo Alto
Dr. Su Chung, Kris Informatics, Palo Alto
Professor Mark Ellisman, Director, Center for Research in Biological Structure, UCSD
Professor Larry Smarr, Director, California Institute for Telecommunications and Information Technology
Professor, Francine Berman, Director, San Diego Supercomputer Center, UCSD
Dr. Peter Arzberger, Director, Life Sciences Initiatives, UCSD

List Of Advisees

Professor Roger Cone, Oregon University of the Health Sciences, Portland
Dr. Larry Zukerberg, Harvard University School of Medicine, Boston
Dr. Virginia Folsom, Genomics Research Corporation, Bethesda
Dr. Kathleen Dwyer, Cornell University, Ithaca

Graduate And Postgraduate Advisors

Professor Albert Crewe, Physics Department, The University of Chicago
Professor Robert Uretz, Biophysics Department, The University of Chicago