

## **PUSHCHINO SCIENCE CENTER RESEARCH TOPICS & SAMPLE PROJECTS**

More than 3,000 scientists conduct research at the Pushchino Science Center in a wide variety of scientific disciplines and concentrations. The following research directions are available at the Center:

- biomedicine
- pathology
- oncology
- bioengineering
- computer modeling
- virology
- parasitology
- biochemistry
- inorganic chemistry
- organic chemistry
- pharmacology
- molecular biology
- recombinant DNA technology
- genetic engineering
- signal transduction
- neurology
- agricultural science
- soil science
- behavioral biology
- zoology
- botany
- ecology
- geology
- meteorology
- environmental science
- biophysics
- astrophysics
- radio-astronomy
- applied mathematics
- ... and many more fields of science

### **Student Projects**

Research topics range from physiology of plants and animals to recombinant DNA technology to mathematical analysis of biological systems to quantum physics and radio-astronomy. In the past students characterized new species of Siberian Permafrost bacteria, developed artificial skin grafts, regulated gene expression in eukaryotic cells of plants and animals, and mathematically modeled calcium oscillations. Others analyzed the effects of free radicals on tumors in mice, examined olfactory transduction in insects, produced computer simulations of calcium ion channels, and studied the effect of heat shock proteins on skin cell recovery.

All research projects are unique -- not repetition of other people's work. Students work with a Russian scientist (in English) in a laboratory that is of interest to them. The precise path of scientific inquiry is determined through a joint effort between the student and the scientist mentor. Students become part of the research team by contributing data obtained

from their experiments to the overall study conducted in the laboratory.

Research projects vary each year depending on student interest and the current research direction of participating laboratories. Below is a short list of projects from previous years. The list is a good indicator of the level of research that is available each year.

- Effect of CAMP on Na<sup>+</sup>-K<sup>+</sup> ATPase activity in rat erythrocytes
- Participation of endogenous protein phosphatases in regulation of Ca<sup>2+</sup>ATPase or Na<sup>+</sup>-K<sup>+</sup>ATPase
- Mechanisms of Na<sup>+</sup> / H<sup>+</sup> exchange regulation in rat thymocytes activated with mitogenic lectins
- Participation of arachidonic acid in receptor-activated ion transport through the plasma membrane.
- The role of protein kinase C in gamma-radiation-induced death of rat thymocytes
- The effect of protein kinase C inhibitors on vacuolar solute transport in yeast cells
- Investigation of phosphoinositol Ca<sup>2+</sup> -dependent systems
- Mechanisms of Ca<sup>2+</sup> influx in activated lymphocytes
- Participation of mitochondria in Ca<sup>2+</sup> -dependent signal transduction
- The regulation of the potassium channel of Ehrlich Ascites tumor cells
- Development dependent changes in elemental content of *C. elegans* egg
- Study of changes in alpha-amylase activity of rat small intestine after chronic irradiation
- Influences of polyamines on glutamate transport into isolated nerve endings (synaptosomes)
- Effect of amiloride derivative on cyclic nucleotide-activated channels
- Investigation of role of light on photosensitive plasma membrane proteins
- Analysis of plant heat shock proteins
- Structural investigation of archaeobacterial flagella
- Phosphorylation of MRNP proteins
- Analysis of protein products of mobile genetic elements
- Radiation induced shift of elements (K and Na) in epithelium of small intestine
- Apurinic sites - induction and repair in mouse lymphocytes
- Dynamic of alkaline phosphatase secretion in *E. coli*
- Yeast killer toxins: mechanism of action, purification, and properties
- Influence of UV-irradiation of seeds on plant development
- Investigation of peroxidases in plant leaves during senescence
- Analysis of recombinant reverse transcriptases of retroviruses
- Construction of phase T5 amber suppressers TRNA genes
- Structural and functional analysis of *Rhizobium leguminosarum* genes involved in symbiosis
- Restriction analysis of brain DNA after pharmacological influence
- Role of 3'-terminal untranslated regions on the level of their expression in a cell-free translation system
- Effects of chronic irradiation on the expression of hsp70 genes in mouse tissues
- Induction of the TRPM-2 gene in cells undergoing programmed death
- Effects of bcl-2 on apoptotic cell death
- Pesticide degradation through soil microorganisms activity
- Persistence of soil microbial communities

- Determination of soil microbial biomass for ecological goals
- Climatic and anthropogenic stress of soil microbial communities
- Model of ion-osmotic homeostasis for a single cell under cold ionic shock conditions
- Unitary theory of chemiosmotic coupling for cell plasma membranes
- Electric cable space constant determines the functional module length of fungal hyphae
- Ion-osmotic homeostasis in the mixed cell cultures: the role of gap-junctions
- The regulation of voltage-dependent L-type  $\text{Ca}^{2+}$  current
- Chemosensor properties of multilayer films containing polycytidylic acid
- Determination of the single ion channel diameter by use of hydrophilic nonelectrolytes
- Molecular mechanisms of dodecylamine and dodecyltrimethylammonium effects upon artificial bilayer lipid membrane
- Comparative study of ancient and modern soils as indicators of change of a climate and environment and soil monitoring of the Nature-Archaeological Preserve "Arcaim" Construction of insect resistant transgenic plants
- Biochemical adaptation of plants to UV radiation
- The regulation and function of the receptor-dependent mitochondrial  $\text{Ca}^{2+}$  signal of intact cells
- Comparative of the Calcium system of immune memory cells and naive T-cells
- N immobilization by soil microorganisms in two ecosystems of gray forest soil Prokaryotic and eukaryotic microorganisms from Arctic and Antarctic permafrost
- The effect of antioxidants on  $\text{Ca}^{2+}$  transport in mitochondria cloning and sequencing of part of S6 operon from *T. Thermophilus*, containing genes of proteins S18 and SSB Identification of proteins interacting with the universal major mRNP protein, p50
- $^{13}\text{CO}_2$  breath test estimation of the human carbohydrate metabolism
- The effect of morphine on the rat EEG is modified by weak combined magnetic fields
- EEG effects of agonist and antagonist of the cholinergic system
- Formation of the transmembrane antenna complexes in the cells of *Chromatium minutissimum* with inhibited synthesis of carotenoids Use of activated carbon for bioremediation of soil highly contaminated by 3,4-dichloroaniline
- Enumeration, isolation and estimation of prey ranges Bdellovibrio in the rhizosphere of plants
- The joint effect of UV-B radiation and  $\text{CO}_2$  concentration on wheat plants: Regulatory effect of light and temperature The role of glutamate NMDA receptor in ammonia toxicity
- Antioxidant enzymes in alloxan-diabetic rat liver and brain, and the effect of blockade of the NMDA receptor
- Palaeoclimate reconstruction based on magnetic properties of buried Quaternary palaeosols
- The isolation and study of ribosomes of the extreme thermophilic bacterium *Thermus thermophilus*
- Quantitative evidence of rubisco's enzyme complexes in sugar beet leaves
- Electrical activity of the brain and glutamate mechanism of classical nootropic drug Piracetam and new nootropic drug GVS Investigation of the Abamectin

- influence upon electrical properties on bilayer lipid membrane DNA complexes with cationic lipids as gene delivery systems into eukariotic cells:  
 Physicochemical characterization of DNA complexes with dodecyltrimethylammonium bromide and dodecylamine Multilayer chemosensitive films DNA-CTAB
- Fabrication, structure and daunomycin binding UVC-induced thymocyte apoptosis: studying the role of intracellular  $\text{Ca}^{+2}$  and macromolecular synthesis by flow cytometry
  - The study of  $\text{Ca}^{2+}$  signaling system in freshly isolated brown preadipocytes of the mice
  - A comparative study of photosynthetic characteristics of fresh-isolated “lichenized”-symbiotic green alga *Trebouxia* and a free-living green alga *Chlorella*
  - A study of the  $\text{Ca}^{2+}$  signaling system and calcium paradox regulation in naive and memory T-lymphocytes
  - Investigations of ribosomal protein S6 from *Thermus thermophilus*
  - Determination of phylogenetic status of polysporal anaerobic bacterium *Anaerobacter polyendosporus*
  - Participation of membrane-bound carbonic anhydrase of thylakoids in consumption of the transmembrane proton gradient
  - Molecular selection for HlyIIRed target sites.
  - Purification and biochemical characterization of homogenous preparations of restriction endonuclease Eco29kl-R, its 6His derivative and methyltransferase Eco29kl-M.
  - Mathematical modeling of DNA and genetic diseases.
  - Charge transfer in multilayer polymer structures containing nucleic acids.
  - Sequential layer-by-layer deposition of oppositely charged polyelectrolytes onto colloidal micro- and nanoparticles as a new approach in encapsulation of biologically active substances.
  - A modal investigation of mechanisms of olfactory signal transduction in receptor cells.
  - New DNA-containing materials designed and fabricated with the use of nanotechnology
  - Biophysical study of beta-barrel ion channels formed by *Bacillus cereus*
  - Hemolysin II: transmembrane pore sizing by using of hydrophilic nonelectrolytes
  - Use of an adsorbent for accelerated bioremediation of soil contaminated with polychlorinated biphenyls
  - The  $\text{Ca}^{2+}$  - dependent permeability transition in mitochondria: examining with fluorescent membrane probes
  - Investigation of extragalactic radio sources by Interplanetary Scintillations Method.
  - Rearrangement of insulin signaling in peripheral neutrophils during tumor growth *in vivo*
  - Computer modeling of hydrate shell of DNA oligonucleotides