Institute for Behavioral Genetics

University of Colorado Boulder

The Institute

Mission

Founded in 1967, the Institute for Behavioral Genetics (IBG) conducts research which examines the genetic bases of individual differences in behavior and provides research training in this interdisciplinary area.

Research

IBG is one of the top facilities in the world for genetic research on behavior. Data collection and analysis are ongoing for several internationally renowned studies including the Colorado Adoption Project, the Colorado Twin Registry, the Colorado Learning Disabilities Research Center, and the Center on Antisocial Drug Dependence. IBG is home to a DNA repository of 40,000 samples for detailed longitudinal research on human behavior, as well as housing a wide array of behaviorally and genetically defined lines of selected, recombinant inbred, transgenic, and knockout-gene mice.

Throughout its history IBG has been characterized by the breadth of its interdisciplinary research and training programs. Although the methodology of behavioral genetics is generally applicable to the study of individual differences for any characteristic, research at IBG is focused on behaviors of societal relevance.

Current research includes studies of aging, neurodegenerative disease, psychopathology, reading and learning disabilities, cognition, substance abuse, behavioral development, brain development, structure, and function, and evolution.

Training

IBG trains graduate students in the study of genetic influences on behavior. This is accomplished by requiring students to obtain a strong training in a primary academic discipline, by instructing them in the interdisciplinary content of behavioral genetics, and by providing an atmosphere that fosters interactions among scholars from different disciplines.

We direct or co-direct three NIH pre- and postdoctoral training grants (from the National Institute of Mental Health, the National Institute on Drug Abuse, and the National Institute on Aging) supporting up to 11 graduate students and 6 postdoctoral fellows.

Societal Impact

Drug Abuse
- Center on Antisocial Drug Dependence
- Biology of Nicotinic Receptors
- Biology of Alcoholism

Aging & Neurodegenerative Diseases
- Molecular Genetics of Lifespan
- Autism, Down Syndrome, Alzheimer's
- Synaptic plasticity, memory

Reading and Learning Disabilities
- Colorado Learning Disabilities Research Center

Executive Functions Brain Imaging Mental Health
- Depression, Schizophrenia
- Development of brain structure/function
- Conduct Disorder, ADHD

Scientific Impact

50+ peer reviewed scientific papers annually

13 papers published in *Science* by IBG faculty

7 Faculty Fellows cited more than 1000 times each in 2016

Two major research centers: the Colorado Learning Disabilities Research Center and the Center on Antisocial Drug Dependence.

Major contributions to the molecular biology of nicotinic receptors, genetics of reading disability, genetic epidemiology of drug and alcohol abuse, identification of genes controlling lifespan and neurodegenerative disease, and genetic influences on behavioral development.

Fiscal Impact

8 Faculty

~$1,300,000 annual general fund investment (faculty salaries + operating budget)

~$2million overhead earned for CU annually

~30 externally funded research projects
~$9,600,000 total costs

~70 externally funded researchers, staff and students

~$24,000,000*
estimated annual local economic impact

*RIMS final output multiplier (9,600,000 X 2.4763)

Research Highlights

Reading Disability: showed genetic influence on reading difficulties (DeFries et al., 1987, *Nature*, 329: 537-539) and identified a locus on chromosome 6p which contributes to this genetic risk (Cardon et al, 1994, *Science*, 266: 267-269; Fisher & DeFries, 2002, *Nature Reviews Neuroscience*, 3, 767-780).

Aging: discovered mutation, *age-1,* that results in a two-fold increase in the life span of the nematode, *C. elegans*, a model organism for aging research (Johnson TE, *Science*, 1990, 249: 908-912). Developed the only existing method for predicting subsequent life span (Rea et al., 2005, *Nature Genetics*, 37:894-898). Showed link between RCAN1 overexpression and age-related neurodegeneration in Down syndrome and Alzheimer's disease. (Wong et al, 2015, *Acta Neuropathol.* 130: 829-43 .

Nicotine and nicotinic receptors: Generated a mouse containing a human variant associated with smoking and schizophrenia (Sciaccaluga et al., 2015; Koukouli et al., 2017). Discovered role for melatonin in modulating the effects of nicotine (Mexal et al., 2012; Horton et al., 2015). Found evidence for association between rare variants in nicotinic receptor genes CHRNA6/CHRNB3 and antisocial drug dependence (Kamens et al., Behavior Genetics, 2016).

Risky behavior: described a heritable trait, behavioral disinhibition, that predisposes individuals to a range of risky behaviors such as substance use and abuse, conduct problems, and impulsive behavior (Young et al, 2009, *Journal of Abnormal Psychology*, 102:78-87). Ongoing twin, adoption, and family studies include brain imaging and genome wide association studies to locate specific brain regions and genes associated with behavioral disinhibition.

Personality: identified chromosomal loci influencing anxiety in a mouse model of neuroticism (Flint et al, 1995, *Science*, 269: 1432-1435).

Cognition: demonstrated that executive cognitive control, associated with frontal cortical function, is genetically influenced independently of general intelligence (Friedman et al, 2008, *Journal of Experimental Psychology: General*, 137: 201-225). Identified a causal role for the cytokine IL-17 in the manifestation of autism-related phenotypes in offspring exposed prenatally to maternal inflammation. (Wong et al, 2016, *Science*, 351: 933-9).

Faculty, Researchers & Students

There are 8 tenured or tenure-track faculty rostered in the Graduate School and based at IBG. In total there are 33 Faculty Fellows, most of whom hold joint appointments in academic units on the Boulder and Denver campuses.

Our faculty comes from a broader range of backgrounds. On the **Boulder campus**: Dept of Psychology & Neuroscience (10 +3 emeriti), Dept of Ecology & Evolutionary Biology (1 + 1 emerita), MCDB (1), Dept of Integrative Physiology (6), Dept of Sociology (1), Graduate School (2)

At the **University of Colorado Denver**: Departments of Pharmaceutical Sciences (1), Pharmacology (2 + 1 emeritus), and Psychiatry (1 + 1 emeritus), and the Center for Bioethics and Humanities (1). At the **University of Denver**: Department of Psychology (1).

In addition to our research mission, faculty on the Boulder campus teach both undergraduate and graduate courses.

Currently, 21 graduate students mentored by IBG faculty fellows in the IBG training program; since we are not a degree-granting institute, all current graduate students are affiliated with academic units on the Boulder campus.

Approximately 22 postdoctoral fellows, research associates, and senior research associates are employed at IBG.

Approximately 26 PRAs, 5 administrative staff members, as well as undergraduate student employees, work on our research projects.