
CURRENT RESEARCH ACTIVITIES

2018

Weizmann Institute of Science

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About the Weizmann Institute of Science

The Weizmann Institute of Science is one of the world's leading multidisciplinary basic research institutions in the natural and exact sciences. The Institute's five faculties Biology, Biochemistry, Chemistry, Physics, Mathematics and Computer Science are home to scientists and students who embark daily on fascinating journeys into the unknown, seeking to improve our understanding of nature and our place within it. The Institute has been the venue of pioneering research in neuroscience, nanotechnology and alternative energy, the search for new ways of fighting disease and hunger and creating novel materials and developing new strategies for protecting the environment. Mathematicians and computer scientists working together with biologists are uncovering unseen patterns in everything from our DNA to the ways our cells age to personal nutrition. From participating in the discovery of the Higgs boson at CERN to joining in scientific missions to the planets in our solar system, Weizmann Institute researchers are helping lead international science. The campus comprises of 1.1 sq km (280 acres) and includes over 240 buildings, research facilities, administration and housing; 2,500 faculty and staff; 1,400 students and postdocs Research volume annually is of more than \$100m total worth of grants for Weizmann Institute research projects.

Faculty of Biology

Department of Biological Regulation

Department Head: Prof. Yosef Yarden

The Department of Biological Regulation is comprised of approximately 170 people organized in 13 research groups. We are located in the Candiotty and Britannia buildings, which are equipped with all the cutting-edge facilities required for running excellent research endeavors. Our research is concentrated on the regulation of processes responsible for the concerted action of cells, tissues, and organs. A diversity of methodologies and experimental approaches are being used in order to tackle these pivotal issues in biology. These include biochemical, molecular and physiological methods, organ and tissue cultures, and whole animal studies utilizing mice, flies, and fish. In addition, some researchers of the Department are using methodologies and concepts of systems biology, host-pathogen interactions and a variety of imaging methods, including magnetic resonance imaging (MRI). Since de-regulation of biological control circuits often underlays human diseases (e.g., malignant transformation, heart failure, stroke, infertility, and defective tissue regeneration after injury), we make many efforts to implement the results of our studies in research projects leading to the development of new tools for early diagnosis, along with novel compounds suitable for pharmacological interventions.

Â The main projects that are currently performed in the department are:

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Host-pathogen interactions - Dr. Roi Avraham

Cell metabolism in health and disease - Dr. Ayelet Erez

Cell death and metabolism - Prof. Atan Gross

Protein degradation by the ubiquitin/proteasome system - Prof. Ami Navon

Vascularization during pregnancy and cancer development - Prof. Michal Neeman

ECM remodeling: from biophysical principles to drug design - Prof. Irit Sagi

Intracellular signaling cascades in health and disease - Prof. Rony Seger

Epigenetics in stem cells and cancer: developing and applying single-molecule imaging technologies to study the epigenetic code - Dr. Efrat Shema

Genome and epigenome regulation - Prof. Amos Tanay

Cellular functions of long noncoding RNAs - Dr. Igor Ulitsky

The development of the vascular system - Dr. Karina Yaniv

Growth factors and their receptors in cancer - Prof. Yossi Yarden

Investigating functional, metabolic and architectural features of normal and malignant tissues with magnetic resonance techniques - Prof. Hadassa Degani

The control of reproduction - Prof. Nava Dekel

Investigating ovarian follicle physiology, regulation and demise in mammals with

emphasis on the ovulatory response, including the control of oocyte maturation, transformation of the follicle into corpus luteum and culminating with the release of the fertilizable ovum - Prof. Alex Tsafiriri

Â In October 2018, we expect to welcome Dr. Philipp Selenko and his team â€“ Dr. Selenko is interested in cellular structural biology of human amyloid proteins.

Research activities

[Dr. Avraham Roi](#)

- The lab of host-pathogen genomics is interested in how individual encounters between host and pathogenic bacteria can ultimately define the outcome of infection. This is achieved by applying cross-disciplinary single-cell analysis platforms that collectively enable us to extensively profile and precisely monitor host-pathogen interactions within the context of in vivo infections.
 - The work in the lab centers on salmonella infection of mouse macrophages as a tractable in vitro host-pathogen system. We use this model to develop state of the art high throughput genomic tools and interdisciplinary approaches, and then apply them to various in vivo infection models to address critical biological aspects of host-pathogen biology.
 - Using comprehensive, quantitative, unbiased tools to analyse the molecular interactions that underlie distinct host-pathogen subpopulations and their impact on disease outcome.
 - Using a powerful combination of cutting-edge single cell genetic and genomic approaches, we wish to address what forms the basis for successful immune clearance, from the level of individual infected cells to that of the whole organism, and why, in some cases, sterilization is incomplete?

[Prof. Hadassa Degani](#)

- Perfusion and angiogenesis in lung cancer: The role of the bronchial and pulmonary vascular network using Fluorescence and magnetic resonance imaging methods
- Molecular magnetic resonance imaging of the estrogen receptor
Collaboration with: Professors David Milstein and Joel Sussman, Weizmann Institute
 - Synthesis of new, high affinity ligands of the estrogen receptor as probes for molecular imaging
 - Structural studies (x-ray crystallography and NMR) of the estrogen receptor - targeted ligands complex
 - Functional activities and molecular imaging of the new targeted ligands in estrogen receptor positive human breast cancer cells
- Mechanisms of lymphatic metastasis in breast cancer; In vivo fluorescence and magnetic resonance imaging
- Advanced non invasive MRI methods for breast cancer detection and diagnosis ;

clinical investigations

Collaboration with: Dr. Myra Shapiro, Meir medical Center

- 3D Tracking of the mammary tree using diffusion tensor magnetic resonance imaging
- Advanced methods for analysis of dynamic contrast enhanced MRI based on a combined model free and model based method.
- Hyperpolarized magnetic resonance spectroscopy and imaging of cancer metabolism; searching for novel metabolic markers of cancer

Collaboration with: Professor Lucio Frydman, Weizmann Institute

- Renal function through sodium gradients; Non-invasive, high resolution sodium MRI.

Collaboration with: Dr. Edna Haran, Weizmann Institute

- Estrogen regulation of angiogenesis and perfusion of breast cancer; from molecular mechanisms to functional MRI of the microvascular physiology

[Prof. Nava Dekel](#)

- Molecular characterization of the ovulatory cascade
- Mechanisms involved in successful implantation.
- Regulation of the meiotic cell cycle: use of rodent oocytes as a model system.
- Cell-to-cell communication: regulation of expression, posttranslational modification, degradation and function of the gap junction proteins, Cx43 and Cx37.

[Dr. Erez Ayelet](#)

- - Cancer Metabolic Rewiring
 - Metabolic regulation in the CNS
 - Metabolic adaptations during inflammation
 - Metabolism in senescence

[Prof. Atan Gross](#)

- How do mitochondria process stress signals and communicate them to the nucleus?
- The role of mitochondria in regulating the fate of embryonic and hematopoietic stem cells
- Establishing the role of mitochondrial carrier homolog 2 (MTCH2) in regulating the shape of mitochondria, metabolism and apoptosis
- Develop inhibitors for MTCH2 as potential therapies of diseases such as acute myeloid leukemia (AML) and obesity

[Prof. Rony Seger](#)

- The nuclear translocation of signaling protein as a drug target for cancer and inflammation
 - The nuclear translocation of ERK
 - The nuclear translocation of JNK and p38
 - Develop peptide inhibitors of the nuclear translocation of ERK/JNK/p38 for the cure of cancer and inflammation
 - Development of small molecular weight inhibitors of the nuclear translocation of ERK for the cure of cancer
 - The subcellular localisation of AKT
 - The mechanisms and roles of MEK nuclear translocation
- ERK1c in the regulation of Golgi fragmentation
 - The mechanisms of golgi translocation of ERK1c
 - Substrates of ERK1c in the Golgi
 - Mechanism of ERK1c-regulated Golgi architecture

[Prof. Alex Tsafri](#)

- Molecular regulation of ovulatory changes in mammals.
Collaboration with: Helena Ashkenazi, Shmulik Motola, Xiumei Cao, Malka Popliker, Seymour Pomerantz, Marco Conti, Stanford
 - The roles of gonadotropins and EGF-like factors in triggering ovulation.
 - The resumption of meiosis and its regulation.
 - Ovulation as a tissue remodeling process.
- The development and demise of ovarian follicles *in vivo* and *in vitro*: the role of apoptosis.
Collaboration with: Atan Gross, KerenYacobi

[Dr. Igor Ulitsky](#)

- Roles of long noncoding RNAs in gene regulation
 - Functions of long noncoding RNAs in establishing cell identity
 - Sequence determinants in long noncoding RNAs
 - Evolution of intergenic regions in vertebrates
 - Subcellular localization determinants in long RNAs

[Prof. Yosef Yarden](#)

- Epigenetics of growth factor action on target cells
Collaboration with: Prof. Moshe Szyf (Montreal)
- Roles for growth factors in tumor progression and in metastases
Collaboration with: Prof. Eytan Ruppin (Maryland)
- Development of proof-of-concept therapies to treat lung cancer
Collaboration with: Prof. Julian Downward (London)

Department of Immunology

Department Head: Prof. Steffen Jung

Research topics of our Department span the wide range from basic mechanisms in the development, recognition, inter-cellular communication, trafficking, and effector functions of the immune system to the role of these processes in autoimmune disorders, allergies and cancer. Special attention is given to the studies of immunomodulation and immunotherapy of these diseases leading to the development of specific vaccines to viruses, parasites, cancer and autoimmune diseases. Specific projects include production of specific antibodies for targeting of drugs and effector lymphocytes; raising of catalytic antibodies; studies of the repertoire and specificity of the T-cell receptor in autoimmune models for multiple sclerosis, diabetes, arthritis, and myasthenia gravis; definition of antigen recognition and mode of action of killer lymphocytes in allograft and tumor rejection; understanding the developmental process of leukemias and treating them; use of cytokines for immunotherapy of metastases and immunomodulation of lymphocyte migration; immune cell adhesion and migration; the control of inflammatory processes; development of hematopoietic stem cells and T-cells activity during aging as well as understanding antigen recognition mechanisms by their receptors and its coupling to cellular response in mast cells as a model.

Research activities

[Dr. Jakub Abramson](#)

- Understanding how breakdown of this process results in autoimmunity.
- Deciphering the molecular and cellular mechanisms that control the establishment of central immune tolerance.

[Prof. Ronen Alon](#)

- The role of talin1 and Kindlin-3 in integrin activation and lymphocyte adhesiveness to inflamed vessels under shear stress.
- Mice models for chronic obstructive pulmonary diseases (COPD) .
- Role of lymph node chemokines in lymphocyte scanning of dendritic cells.
- Effector lymphocyte trafficking to sites of inflammation.
- The functions of endothelial and myeloid ICAM-1 in adaptive and innate immunity.
- Endothelial stores of chemokines and their function in leukocyte extravasation.
- Chemokine activation of leukocyte integrins at endothelial contacts under shear stress.

[Prof. Ido Amit](#)

- Genomics and Systems Biology of the Immune System.
- Decoding the mammalian transcriptional Regulatory Code in health and disease.

Prof. Ruth Arnon

- Pathological mechanism in the CNS of various multiple sclerosis animal models.
- Neuroprotection, neurogenesis and remyelination – consequences of Glatiramer Acetate treatment in EAE.
- Mechanism of action of Copolymer 1 (Copaxone®), a therapeutic vaccine against multiple sclerosis.

Collaboration with: M. Sela

Prof. Avi Ben-Nun

- Neuroimmunology, pathogenic autoimmunity, myelin/neuronal repair, and treatment of autoimmune diseases in central nervous system (CNS):
 - T-cell pathogenesis and regulation in autoimmune diseases of the CNS.
 - Effects of functional epistasis between HLA class-II alleles on genetic predisposition to multiple sclerosis (MS) in “humanized” HLA-Tg mice and MS patients.
 - Defining major pathogenic MS-related myelin/neuronal epitopes in HLA-transgenic (Tg) mice.
 - Antigen-based immune-specific approaches to therapy (and mechanisms) of MS and other T-cell mediated autoimmune diseases.
 - Myelin/neuronal repair by adult neural stem cells in mice with chronic MS-like disease.

Prof. Gideon Berke

- Cancer Immunity: a) Tetrameric MHC-peptide complexes in cancer detection and as cancer vaccines, b) Fas/Fas-L in tumor immunity c) Tumor escape mechanisms.
- Immunological memory in cancer.
- Apoptosis of the heart muscle.

[Prof. Irun R. Cohen](#)

- Development and clinical applications of an antigen microarray device and informatics analyses aimed at diagnosis, prognosis, monitoring and management of autoimmune and other inflammatory diseases – the ImmunArray Ltd iCHIP (Israel and USA); now in clinical use.
- Treatment of inflammatory bowel disease, arthritis and other autoimmune conditions using DNA plasmids encoding human HSP90 or HSP70 – Alma Bio Therapeutics (France).
- Treatment of ALS using a synthetic peptide that inhibits apoptosis and fosters cell growth – Immunity Pharma Ltd. (Israel); entering clinical trials.
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[Prof. Lea Eisenbach](#)

- Autoimmunity and immunotherapy
Collaboration with: Dr Ilan Volovitz, Prof. Irun Cohen
- Cancer Stem Cells and immunotherapy
- the role of small interferon induced genes in tumorigenicity and apoptosis
- cryoimmunotherapy
- tumor escape and tolerance
- T cell receptor evolution for immunotherapy
- Antigen presentation by engineered MHC molecules
Collaboration with: Dr Gideon Gross

Prof. Zelig Eshhar

- Development of universal vaccine for the control of allergic responses.
- Study of colorectal induced tumors in colitis.
- Redirecting regulatory T cells for adoptive cell therapy of autoimmune inflammation.
- Redirecting effector T cells for adoptive cell treatment of cancer.

[Prof. Nir Friedman](#)

- Applications of TCR-seq: Autoimmunity, Neuroimmunology, Vaccination.
Collaboration with: R. Arnon, M. Schwartz, B. Chain - UCL
- Mapping T cell receptor repertoire using high-throughput sequencing (TCR-seq): developing methodologies and bioinformatic tools.
- Live cell imaging of T cell activation and differentiation using microfluidics devices.
- Studies of intercellular cytokine communication networks in T-cell development and differentiation.
- Studies of CD4 T cell differentiation combining experimental single cell approaches and mathematical modeling.

Prof. Sara Fuchs

- The basis of D2 dopamine receptor diversity: Cloning, signal transduction, development, and correlation with disease.
- The nicotinic acetylcholine receptor: Structure, function, and regulation of gene expression.
- Myasthenia gravis: Regulatory mechanisms, epitopes, and immunodulation.

[Prof. Steffen Jung](#)

- Microglia Functions in Functional Brain Maintenance and Neurological Disorders.
- The role CX3C chemokine axis in intercellular communication.

- Dendritic cell, Macrophage and Monocyte Contributions to the Maintenance of Intestinal Homeostasis and the Development of Inflammatory Bowel Disease (IBD).
- Studying Molecular Cues guiding Mononuclear Phagocyte Differentiation
- Studying Interactions of Macrophages with Sympathetic Nerve System

[Prof. Tsvee Lapidot](#)

- Metabolic regulation of Blood and Bone forming Stem Cells by Daily Light and Dark Cues (NE, TNF, Melatonin and PGE2).
- Regulation of Human and Murine Hematopoietic Stem Cell Migration and Development by Coagulation Cascades (both aPC/EPCR/Par1 anti inflammatory signals and Thrombin/PAR1 pro-inflammatory signals).
- Studying Molecular Cues guiding Human and murine Hematopoietic Stem Cells Homing and Bone Marrow (BM) recognition, retention and mobilization to the circulation.
- Metabolic regulation of BM Neutrophils activation and recruitment by Lactatae and GPR81 Signaling.
- Metabolic regulation of BM Neutrophils by Daily Light and Dark Cues.
- Energy sharing, Chemotherapy Resistance and Stress induced Mitochondria Transfer between Blood and Bone forming Stem Cells.
- AML AF9 Leukemic Stem Cells Metabolic interactions with BM Stromal Cells and Chemotherapy Resistance.
- Dynamic regulation of the Blood Bone Marrow Endothelial Barrier and Hematopoietic Stem Cell Niches.

Prof. Edna Mozes

- Systemic lupus erythematosus (SLE): Induction and development in various animal models.
- The role of various cell types (APC, T, B) and cytokines in the pathogenesis of autoimmune diseases.
 - The status and role of T regulatory cells in autoimmune diseases.
- Specific immunomodulation of the autoimmune diseases, Systemic lupus erythematosus and Sjogren Syndrome by a synthetic, tolerogenic peptide.

Collaboration with: Prof. Zev Stoeber, Kaplan Medical Center.

- Elucidation of the mechanisms (effects on main pathways, cell types, cytokines and other pathogenic molecules) by which the tolerogenic peptide ameliorates autoimmune disease manifestations in animal models and in patients with SLE and Sjogren Syndrome.
- Development of the tolerogenic peptide as a novel specific drug for the treatment of SLE and Sjogren Syndrome.

Prof. Roald Nezlin

- Immunoglobulin properties and functions

Collaboration with: No

[Prof. Israel Pecht](#)

- Electron transfer mechanisms in proteins.
- Antigen recognition and trans-membrane signaling by immuno-receptors.

[Prof. Yair Reisner](#)

- Immature dendritic cells: investigating a novel granule mediated killing mechanism and the therapeutic potential for the prevention of Graft versus Host Disease.
- Crossing allogeneic and xenogeneic barriers by growing organs in-vivo from embryonic tissues : potential curative approaches for diabetes, hemophilia and lung diseases.
- Hematopoietic size control: A novel role for coagulation cascade factors in regulating the interplay between dynamic bone structure and long term survival and mobilization of hematopoietic stem cells.
- Developing a protocol for the production of human central memory CD8 T cells, to induce tolerance in allogeneic stem cell transplantation.
- Investigating the use of activated CD8 T cells as novel cell therapy for the treatment of autoimmune diseases.
- Role and mechanism of tolerance induction by activated CD8 T cells: A novel cell therapy for chimerism induction, stem cell transplant engraftment and enhanced Graft versus Lymphoma / Leukemia effect.

Prof. Michael Sela

- An aptamer strategy to target oncogenic signaling in ErbB2 carrying human tumors.
Collaboration with: G. Mahlknecht , Y. Yarden
G. Mahlknecht
- Synergy of antibodies towards decreasing pancreatic cancer.
Collaboration with: R. Maron, B. Schechter, Y. Yarden
- Towards vaccination: Generation of peptide mimotopes specific for anti ErbB-2 monoclonal antibodies.
Collaboration with: E. Witsch, Y. Yarden
- Mechanism of action of Copolymer 1 (Copaxone), a therapeutic vaccine against multiple sclerosis.
Collaboration with: R. Arnon
- Effective synergism by anti ErbB-2 mAb combinations comprising one mAb against the dimerization site of ErbB-2.
Collaboration with: Y. Yarden
- Monoclonal antibodies (mAbs) to ErbB-1 and ErbB-2 receptors and their role in

potential anti-tumor strategy.

Collaboration with: B. Schechter, Y. Yarden

- Synergistic effects of combinations of mAb against distinct epitopes on EGFR/ErbB-1 and ErbB-2 receptors: accelerated receptor aggregation, down regulation and inhibition of tumor growth.

Collaboration with: B. Schechter, Y. Yarden

[Prof. Idit Shachar](#)

- Analyze the pathway regulateing the survival cascades in Chronic lymphocytic leukemia

Collaboration with: Dr Michal Haran, Kaplan Medical center

- Follow the mechanisms controlling homing of immune cells in health and disease.
- Determine the mechanisms regulating peripheral B cell maturation and survival in health and disease.

[Prof. Guy Shakh](#)

- Dendritic cell behavior:
 - The dynamics of antigen sampling, chemokinesis, lymphatic migration
 - Antigen presentation by dendritic cells as revealed by intravital imaging

[Dr. Liran Shlush](#)

- EPIC project

Collaboration with: John Dick Phillip Awadella

Department of Molecular Cell Biology

Department Head: Prof. Eldad Tzahor

The molecular mechanisms underlying cell structures, dynamics and fate, and their involvement in embryonic development and cancer are among the primary topics of interest of the Department. These include studies on the mode of action of growth factors and the nature of signals triggered by them in target cells following binding to specific surface receptors. Growth regulation is also approached through the study of suppressor genes encoding such proteins as p53, which inhibit proliferation and drive cells towards differentiation or apoptosis. These studies, focusing on the mechanisms stimulate cell proliferation, differentiation, or death, can elucidate the basis for cancerous transformation in a large variety of systems. Overproduction or hyperactivation of growth-promoting systems was shown to have an oncogenic (cancer-causing) effect, and a similar process may be induced when growth-suppressor or apoptosis-inducing genes fail to function. The levels at which cell structure, activity and fate are studied in this department and the focus of these studies are many and diverse, including the

characterization of soluble growth factors and their receptors, the nature of complex signal transduction pathways, the action of specific regulators of cytokine action, rearrangement of genes associated with oncogenic processes, and the properties of tumor suppressor and apoptosis promoting genes. Since such processes involve networks of interacting factors, we are also interested in mathematical modeling and computerized analysis of biological gene circuits.

In addition, there is broad interest in the molecular mechanisms of cell adhesion and their involvement in the regulation of cell fate. These studies include characterization of the basic rules underlying adhesive interactions, the binding of surface-associated adhesion molecules with the cytoskeleton, and the nature of growth- and differentiation-promoting signals triggered by adhesive interactions. Of special interest are proteins such as β -catenin, which play a crucial role in reinforcing cell-cell adhesions as well as triggering gene expression.

Research activities

[Prof. Uri Alon](#)

- Combining theoretical and experimental methods to discover design principles of biological circuits
 - Systems level analysis of gene regulation networks, with *E. coli* as a model system.
 - Systems Immunology
- Collaboration with:** Nir Friedman
- Evolution

Prof. Abraham Amsterdam

- Plasticity of gene expression during differentiation in the gonads.
- Crosstalk among signals that control apoptosis.
- Carcinogenesis in endocrine glands.

[Prof. Avri Ben-Ze'ev](#)

- Epithelial-mesenchymal transition (EMT), cancer stem cells (CSCs) and Wnt target genes in colon cancer metastasis
- The interplay between the role of beta-catenin in cell adhesion and signaling during colon cancer development.
- The molecular basis and signaling roles of nerve cell adhesion receptors in colon cancer metastasis
- The role of novel beta-catenin target genes in tumor development and metastasis

Prof. Alexander D. Bershadsky

- Integrin-mediated cell-matrix adhesions as mechanosensors: molecular requirements for the force-induced focal adhesion growth.
- Cell-cell contact-dependent regulation of the actin cytoskeleton and microtubule system: Role of p120 catenin and other components of cadherin adhesion complex.
- Role of myosin-driven contractility in the retrograde surface flow and cell motility.
- Cooperation between neuregulin, ErbB-family receptors, and cell surface heparan sulfate proteoglycans in the regulation of cell motility and morphogenesis.

Prof. Eli Canaani

- Comparison of the properties of the leukemogenic ALL-1 fusion proteins with those of normal ALL-1.
- Transcription profiles of primary tumors with ALL-1 rearrangements.
- Functions of the human ASH1 protein.
- Studies of the ALR gene.

[Prof. Benjamin Geiger](#)

- Molecular diversity of adhesion complexes
- The roles of mechanical force in adhesion development
- Role of phosphorylation in regulating cell adhesion and migration
- Signaling from the ECM
- Cell adhesion and migration in cancer
- Quantitative automated microscopy and high throughput screens

[Dr. Shalev Itzkovitz](#)

- Design Principles of mammalian tissues
- Spatially resolved single cell genomics
- mRNA localization in tissues

[Prof. Zvi Kam](#)

- Cellular Biophysics
 - **Collaboration with:** Benjamin Geiger, John Sedat, David Agard (UCSF)
 - Quantitative analysis of structural features and dynamic changes in cells using microscope imaging
 - High throughput high-definition microscopy application in systems cell biology
 - Adaptive optics methods applied to thick sample imaging
 - Cell level informatics

[Dr. Valery Krizhanovsky](#)

- The role of cellular senescence in human disease
- Mechanisms of interaction of senescent cells with their microenvironment
- Cellular senescence in cancer development and treatment

[Prof. Sima Lev](#)

- Breast cancer progression and metastasis.
 - Signal transduction therapy for triple negative breast cancer (TNBC).
 - PYK2 and FAK as potential therapeutic targets for breast cancer metastasis.
 - Chemotherapy resistance and recurrence of breast cancer.

[Prof. Gil Levkowitz](#)

- hypothalamus
- Developmental neurobiology
- Molecular neurophysiology
- Genetics
- Neuroendocrinology

[Prof. Moshe Oren](#)

- Role of p53 in tumor-host interactions.
- Gain of function of mutant p53 in cancer.
 - **Collaboration with:** Prof. Varda Rotter, Weizmann Institute; Prof. Vassilis Gorgoulis, Athens University Medical School
- Molecular biology of p53.
- Regulation of the Hippo pathway and its deregulation in cancer
- Crosstalk between the p53 and Hippo pathways
- Involvement of microRNAs in cancer

[Prof. Varda Rotter](#)

- Molecular mechanisms controlling the expression of p53 in normal cells and its deregulation in cancer cells
 - Involvement of p53 in cell differentiation and apoptosis: in vivo and in vitro models.
 - Cellular proteins that specifically complex with the p53 protein.
 - Cellular proteins that are induced upstream or downstream to the p53 protein following genotoxic stress.

[Prof. Yardena Samuels](#)

- Synthetic lethal interaction network of melanoma
- Identification of melanoma hub interactomes

- CRISPR screens to reveal driver gene interactions and drug resistance genes
- Decipher the immuno-genetic interactions between melanoma and T cells
- HLA peptidome analysis of metastatic melanoma lesions

[Prof. Oren Schuldiner](#)

- A genetic dissection of developmental axon regeneration
- Molecular mechanisms of neuronal remodeling during development: Developmental axon pruning in *Drosophila*
 - The role of cell-cell interaction in regulating developmental axon pruning
 - The role of intracellular signaling in regulating developmental axon pruning
 - The role of trafficking in regulating developmental axon pruning
 - Glia and their effect on neuronal growth and remodeling

[Dr. Yonatan Stelzer](#)

- DNA methylation dynamics during cell fate decisions
- Epigenetic reprogramming during gametogenesis
- Mammalian parental imprinting as an epigenetic paradigm
- Environmental effects on the epigenome
- Epigenetic perturbations in disease and cancer

[Dr. Ravid Straussman](#)

- Tumor microenvironment-mediated chemoresistance
- Tumor microbiome

[Dr. Itay Tirosh](#)

- Intra-tumor heterogeneity: combining computational and experimental approaches to understand the diversity of cells within tumors, their functions, interactions and clinical significance.

Collaboration with: Mario Suva, Massachusetts General Hospital

- Single cell analysis of clinical tumor samples, with a focus on glioma
- Computational modeling of the tumor ecosystem
- Testing the function of tumor subpopulations in cell and animal models

[Prof. Eldad Tzahor](#)

- Head muscle patterning and differentiation
 - Characterization of head muscle derived satellite cells
 - Dissecting the myogenic programs in head muscle progenitors
 - Involvement of p53 in cranial myogenesis
- Cardiac and skeletal muscle progenitors during vertebrate embryogenesis

- Studying the crosstalk between BMP and FGF signaling pathways in cardiac progenitors
- Regulation of Islet1 gene expression using novel imaging techniques in live embryos
- The origin of the heart endocardium: Focus on the role of endothelial cells in cardiogenesis

[Prof. Yehiel Zick](#)

- Mode of action of galectin-8, a mammalian lectin
- The molecular basis of Insulin Resistance: a Phosphorylation based Uncoupling of Insulin Signalling
- The insulin receptor as a model system for transmembrane signaling: Mode of interaction of the insulin receptor with its downstream effector molecules.
- Mammalian lectins as regulators of cell adhesion, cell growth, and apoptosis.
- Receptor trafficking: Regulation of endocytosis and recycling of the insulin receptor.
- Role of Galectin-8 in bone remodeling

Department of Neurobiology

Department Head: Prof. Alon Chen

Research in Neuroscience in the Department of Neurobiology encompasses a wide variety of subjects, in areas including cellular and molecular biology, neuroanatomy, functional magnetic resonance imaging (fMRI), physiology, pharmacology, psychophysics, and computational sciences.

Basically, the research of the various groups of the Department covers, among others, the following topics: Analysis of the molecular and cellular basis of neuronal and synaptic function. Imaging of neuronal activity underlying higher brain functions. Tracing and characterization of neuronal communication profiles. Characterization of the CNS response to trauma and lesion; developing molecular and cellular therapeutic agents. Determination of the underlying processes and mechanisms of vision, perception, learning, and memory in behaving rodents and primates. Computer modeling of brain function.

At the Neurobiology Department, the structure, function, development, and plasticity of the nervous system are studied at various levels of analysis, using different types of cell and experimental animal models. The groups studying neuronal function at the molecular and cellular levels use *in vitro* systems ranging from non-neuronal and neuronal cell lines to primary neuronal and glial cells of cerebellar, hippocampal and cortical origin. In many cases, the cells studied are transfected with genes of interest. These cell systems allow the study of the roles of various components of the nervous system, including cell surface

membrane components, specific enzymes, neurotransmitters, neuromodulators, growth factors, neuroreceptors, lipid components, ionic channels and cytoskeletal constituents. Algorithms for the synaptic plasticity between neurons, and the role of dendritic ion channels in synaptic input and information processing, are also being studied. Injury models of nerve lesion and oxidative stress paradigms are applied to examine the principles of CNS regeneration, rescue from ischemia and stroke, and apoptotic cell death and senescence.

The groups studying the CNS at the system level are striving to understand the complex neuronal mechanisms underlying learning, memory, and sensory processing (vision, taste, smell), and to determine the relationship between brain and mind. Using track tracing methods, the rules governing the interconnections in the visual cortex are being unraveled. Behavioral studies focus on principles of learning and consolidation, cortical information processing, learning disabilities, and addiction. Functional brain imaging of the human visual cortex is being studied by various techniques, including fMRI. Psychophysical approaches are being used to define processes involved in image segmentation, learning and memory skill acquisition, motor control, and language. Nearly 20 groups of researchers carry out both independent studies and collaborative research with colleagues from within the Department and outside it.

Research activities

[Prof. Ehud Ahissar](#)

- Active sensing: Mechanisms of closed loop perception.
- Biomimetic technology for active vibrissal touch
- Object localization
- Sensory substitution - from vision to touch

[Prof. Shabtai Barash](#)

- Neuroscience of looking and seeing

[Prof. Yadin Dudai](#)

- The role of saliency-and novelty-detectors in the acquisition and retention of memory in brain.
- Mechanisms of memory consolidation, reconsolidation and extinction in the mammalian brain.
- Theories of learning and memory.

[Prof. Amiram Grinvald](#)

- The Interactions between evoked and on-going activity and their potential functional role in cortical processing.

Collaboration with: D. Omer, M. Tsodyks

- The space-time dynamics of cortical activity as revealed by population activity (EEG, LFP and real-time optical imaging) coupled with single-unit and intracellular recordings.

Collaboration with: D. Omer, L. Rom M. Tsodyks

- Cortical correlates of attention in behaving monkeys.

Collaboration with: D. Omer, L. Rom

- The functional architecture underlying visual perception.

Collaboration with: D. Omer, L. Rom,

- The dynamics of cortical representations in the visual cortex.

Collaboration with: S. Naaman

[Prof. Tali Kimchi](#)

- Neuronal Basis of Sexually Dimorphic Behaviors
 - Sexually dimorphic pheromone signals – perception, processing and biology function
 - Characterizing novel pheromone-mediated responses in wild-caught mouse colonies
 - Identifying the genetic basis of sex-typical social and reproductive behaviors
 - Mapping brain circuits controlling innate social and reproductive behaviors

Prof. Yitzhak Koch

- Regulation of GnRH expression in the mammary gland.
- Development of cytotoxic analogs of gonadotropin-releasing hormone (GnRH).
- Expression and functions of GnRH-II in the brain and in T lymphocytes.

[Prof. Ilan Lampl](#)

- Synaptic plasticity induced by sensory stimulation in the cortex
- Construction of receptive field properties in the somatosensory cortex
 - studying functional connectivity in the barrel cortex
 - Mechanisms of adaptation in the cortex
- Noise and synchrony in the mammalian cortex
 - Dynamic properties and mechanisms of ongoing activity in the cortex
 - Patterns in neuronal activity in the cortex

[Prof. Rony Paz](#)

- Psychiatric disorders from pathologies in the amygdala-prefrontal pathway (e.g. autism, anxiety-disorders, post-traumatic-stress-disorder (PTSD), epilepsy)
- Computational approaches to coding mechanisms in the brain
- Motivational and emotional modulation of memory

- Extinction of memory
- Generalization and specificity of learning
- Neurobiology of learning and memory
- Neuronal circuits and interactions between the amygdala and the prefrontal cortex

[Dr. Michal Rivlin](#)

- Mechanisms underlying the computation of motion direction in the retina.
- Dynamic computations in retinal circuits.
- How do retinal targets integrate and interpret the visual signal?
- Role of dopamine in retinal processing.

[Prof. Dov Sagi](#)

- Human vision, with an emphasis on processes involved in image segmentation, learning, and memory.

[Prof. Elad Schneidman](#)

- Biological networks
- Decision making and learning
- Animal swarming and collective behavior
- Computational Neuroscience
 - Neural Coding
 - Information and noise in neural populations
 - Decoding neural activity
 - Network organization and design
 - Natural Scenes

[Prof. Michal Schwartz](#)

- The cross-talk between the immune and nervous systems – autoimmunity as a mechanism of tissue repair: Molecular, cellular, physiological and behavioral aspects.
- Immunological aspects of neuronal loss in neurodegenerative and mental disorders (Alzheimer's, ALS, Huntington, Glaucoma).
- Spinal cord injury and repair
- Development of vaccination for neurodegenerative disorders.
- Neurogenesis (stem cells) and inflammation in the CNS.

[Prof. Menahem Segal](#)

- Electrical activity in small hippocampal networks
Collaboration with: Dominik Freche

- Intracellular calcium and structural/functional plasticity in cultured neurons.
Collaboration with: Dr. Eduard Korkotian, Professor Michael Frotscher
- Activity maintains survival of neurons in culture
Collaboration with: Eldi Schonfeld-Dado
- Hippocampal structure and function during stress
Collaboration with: Dr. Gayane Grigoryan, Prof. Gal Richter-Levin

Prof. Israel Silman

- Localization and anchorage to the plasma membrane of acetylcholinesterase.
- Regulation of folding and assembly of acetylcholinesterase.
- Three-dimensional structure of acetylcholinesterase and acetylcholinesterase-anticholinesterase complexes.

[Prof. Michail Tsodyks](#)

- Information transmission through dynamic synapses.
Collaboration with: H. Markram
- Modeling of cortical neuronal populations: From microcircuits to large scale networks.
- Population activity in visual cortex.
Collaboration with: A. Grinvald, D. Sagi

[Prof. Nachum Ulanovsky](#)

- * Neurophysiological recordings of individual neurons in freely flying bats, using radio-telemetry -- in hippocampus and entorhinal cortex
- * The neural basis of behavior
- * From the bat's biological sonar system to spatial cognition
- * Mammalian hippocampus (hippocampal place cells) and entorhinal cortex (grid cells)
- * Neuronal circuits: hippocampal and entorhinal neural activity in freely-behaving echolocating bats
- * Neural codes for 2-D and 3-D space in the mammalian brain
- * Neurobiology of learning and memory: a systems neuroscience approach

[Prof. Zvi Vogel](#)

- Molecular mechanisms of opiate addiction, tolerance and withdrawal.
- The cannabinoid ligands, their endogenous ligands and signal transduction.
Collaboration with: Raphael Mechoulam
- Regulation of microglial activation by cannabinoids: Possible role in neurodegenerative and neuroinflammatory diseases

Prof. Ephraim Yavin

- Signal transduction and protein kinase C isozymes in brain of normal and growth-retarded fetuses.
- Free radicals and lipid modulators in the developing and aging brain.
- Novel genes during oxidative stress in utero and role of docosahexaenoic acid.

[Dr. Ofer Yizhar](#)

- * Functional analysis of neural circuit changes associated with psychiatric disease
- * Development of novel optogenetic methods for light-based control of neural activity in vitro and in vivo
- * Synaptic organization and function in cortical networks

Faculty of Biochemistry

Department of Biomolecular Sciences

Department Head: Prof. Eitan Reuveny

The scientific activities in the department of biological chemistry span several areas in the Life Sciences. The common thread is the study of the biochemistry of life and disease. Emphasis is given to the examination of proteins, whether soluble or membrane-bound, and their key biological functions and we seek a molecular understanding of their evolution, cellular interactions, structures and functions. A variety of biochemical, biophysical, structural, molecular-biological, and state of the art imaging methodologies are employed in our department. Overlapping interests and inter-group cooperations signify the spirit of our research. The department has more than 20 research groups whose activities are centered around the following foci of interest:

Protein science and macromolecular machines. Several groups investigate the basic principles governing protein-protein interactions; composition, assembly, and architecture of multi-enzyme and other large complexes; catalytic mechanisms and the evolution of proteins and enzymes. A major aim is to understand how the findings relate to intricate biological processes.

Â DNA and regulation of gene expression. Various aspects of nucleic acids research are addressed in our department including: DNA repair and mutagenesis in mammals; basal and activated transcription; specific gene expression in the pancreas; phylogenetic analysis of accumulated somatic mutations.

Â Structure, function, and biogenesis of membrane proteins. We investigate important integral membrane proteins on the biochemical, biophysical, structural, and physiological levels. This includes Na⁺ and K⁺ channels, Na⁺/K⁺ ATPase and its FXYD protein regulators, multidrug transporters, intra-membrane proteases, and peptides that integrate into membranes in various systems.

Â Membranes, lipids, and organelle structure, function, and biogenesis. Studies in our department include the biosynthetic pathway of membrane proteins; intracellular protein traffic, especially during the process of autophagy; lysosome biogenesis and lipid homeostasis; Calcium homeostasis; and, assembly and function of membrane proteins involved in the immune response, infectious diseases, and viral envelopes.

Â Signaling within and between cells. Several researchers in the department are interested in problems related to signal transduction. Cell guidance and navigation; axon guidance; cell death and tissue damage; long distance intracellular signaling; regulation of expression of virulence factors; regulation of the circadian rhythm; epigenetic gene silencing; epigenetics and developmental regulation.

Â Molecular basis of disease. Many research programs in our department involve human disorders, diseases, and syndromes. This includes inflammation, infections and antibiotic resistance, organophosphate detoxification, obesity and diabetes, cancer, and lysosomal storage diseases. Many of these disorders are investigated at the molecular level.

A variety of methodologies are being utilized, with an emphasis on biochemistry, biophysics, molecular genetics, advanced light microscopy, computation methods, and structural tools (such as crystallography, atomic force microscope, mass spectrometry). Additional information can be obtained in the department's Home Page.

Research activities

[Dr. Ori Avinoam](#)

- The mechanisms of protein mediated membrane sculpting in health and disease
 - Spatial and temporal organization of the molecular machines driving vesicle formation.
 - Endocytosis and membrane trafficking in eukaryotes.
 - Caveolae in muscle biogenesis, homeostasis and atrophy.
 - Cell-to-cell fusion
- Imaging Across Scales
 - Correlative light and 3D electron microscopy at room temperature and in cryo.
 - Advanced light microscopy techniques.

[Prof. Ed Bayer](#)

- Structural and functional aspects of the multi-enzyme cellulosome complex from cellulose-degrading bacteria.
 - The cohesin-dockerin couple - Protein-protein interactions that mediate recognition and specificity in cellulosome assembly.
 - Cellulose-binding domains as models for protein-sugar interactions.
 - Bioinformatics of cellulases and cellulosome components
 - Comparative genomics of cellulosome components.
 - Structure determination of cellulosome components.
 - Enzymology of cellulosomes for conversion of biomass to biofuels
 - Designer cellulosomes - Selective engineering of chimaeric cellulosome constructs for nanotechnology.
 - Avidin-biotin system - Mutated avidins and streptavidins

[Prof. Eitan Bibi](#)

- Structure/function studies of the *E. coli* multidrug transporter, MdfA.
Collaboration with: Klaas Martinus Pos, Goethe University, Frankfurt, Germany
Hassane Mchaourab, Vanderbilt University, Nashville, TN, USA
Melissa Brown, Flinders University, Adelaide SA, Australia
 - The multidrug recognition pocket of MdfA (genetic and biochemical studies)
 - 3D crystallization of MdfA
 - Mechanism of MdfA-mediated multidrug transport (proton/drug antiport)
 - Conformational behavior of MdfA
- Membrane protein biogenesis in *E. coli*

Collaboration with: Gert Bange, Philipps University Marburg, Germany

- FtsY, the essential prokaryotic SRP-receptor: biogenesis and function
- Membrane targeting and association of ribosomes in E. coli.
- Membrane targeting and association of mRNAs encoding membrane proteins

[Prof. Rivka Dikstein](#)

- Transcription and translation control in health and disease

Collaboration with: Chen-Ming Chiang, Hiroshi Handa, Yuki Yamaguchi, Idit Shachar, Nahum Sonenberg, Yuri Svitkin, Franck Martin, Katsura Asano, Igor Ulitsky, Michael Walker

- Mechanism of rapid transcriptional induction of inflammatory genes
- Links between mammalian transcription and mRNA translation
- Developing pharmacological tools to address fundamental equations in transcription and translation and for therapeutic purposes
- Mechanism of start site selection in transcription and translation and its role in cancer and neurodegenerative diseases

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[Prof. Michael Eisenbach](#)

- Chemotaxis of bacteria
 - Molecular mechanisms and function of acetylation of the response regulator
 - Molecular mechanism of function of the switch of the bacterial flagellar motor
- Sperm guidance in mammals
 - Molecular mechanism of sperm thermotaxis

[Prof. Zvulun Elazar](#)

- Molecular mechanisms of autophagy
 - Mechanism of autophagosomes biogenesis
 - Autophagy and neurodegeneration
 - Regulation of autophagy in yeast and mammals
- Mechanism of intracellular protein trafficking
 - Regulation of intra-Golgi protein transport

[Prof. Michael Fainzilber](#)

- Molecular mechanisms underlying spatial signaling within neurons and other large cells
 - Retrograde signaling mechanisms in healthy, diseased or injured neurons.
 - Molecular mechanisms of axonal communication and neuronal regeneration.
 - Size sensing mechanisms in neurons and other large cells.

[Dr. Sarel-Jacob Fleishman](#)

- Computational design of protein function
 - Computational design and experimental characterization via in vitro evolution of high affinity interactions
 - The role of multispecificity in small signaling networks
 - Specificity and multispecificity in membrane-protein interactions
 - Design of membrane-protein interactions

[Prof. Anthony H. Futerman](#)

- The regulation of ceramide synthesis
- The molecular mechanisms of sphingolipid storage diseases (Gaucher disease).

[Prof. Steven J.d Karlish](#)

- Development of isoform-selective drugs
- Molecular mechanisms involved in generation of essential hypertension.
- Regulation of Na/K-ATPase by FXYD proteins.
- Crystalization and function of Na/K-ATPase.

[Prof. David Mirelman](#)

- Molecular pathogenesis of the human intestinal parasite *Entamoeba histolytica*.
Collaboration with: Rivka Bracha
 - Molecular biology and genome organization in the lower eukaryot *Entamoeba histolytica*.
 - Selective inhibition of expression of virulence genes by Antisense RNA.
 - Transcriptional epigenetic gene silencing mechanisms
 - Pathogenesis of Amoebiasis
 - Development of vaccine against *Entamoeba histolytica*.
- Mode of action and therapeutical potential of Allicin from Garlic
Collaboration with: Aharon Rabinkov, Elena Appel
 - Uses of derivatives of Allicin against hypertension and obesity
 - Antifungal delivery system which produces in situ toxic allicin molecules
 - A delivery system for the in-vivo killing of cancer cells by Allicin

[Dr. Ruth Scherz-Shouval](#)

- Tumor microenvironment
 - Transcriptional profiling of stromal cells within tumors, Characterization of stromal stress responses

[Prof. Yechiel Shai](#)

- Membrane-protein interaction and molecular recognition within the membrane milieu. Implication to the function and structure of membrane proteins.
 - Assembly and organization of pore forming toxins and ion channels in membranes: Studies with isolated fragments and intact proteins.
 - Molecular mechanism of membrane fusion and its inhibition: Studies with HIV and Sendai Virus.
 - Molecular basis for cell selectivity by cytolytic antimicrobial peptides.

[Prof. Michal Sharon](#)

- Studying large protein complexes involved in the protein degradation pathway using a novel mass spectrometry approach.
 - Developing novel methodological approaches for structural mass spectrometry
 - Structure-function relationship of the signalosome complex
 - Investigation of the 20S ubiquitin-independent degradation pathway

[Prof. Yoram Shechter](#)

- Mechanism of insulin action: Post-binding events in insulin action
 - Post-receptor agents mimicking insulin.
 - Effect of vanadium in vivo and in vitro.
 - Role of protein tyrosine kinases and protein phosphotyrosine phosphatases in insulin effects.
 - Inhibitors of tyrosine kinases.
 - Chemical modifications of peptides and protein drugs.
 - Novel technologies to prolong life time of peptide and protein drugs.

[Prof. Dan Tawfik](#)

- Evolution and mechanism of enzymes
 - Molecular evolution in man-made cell-like compartments.
 - Directed evolution of tailor-made hydrolases (esterases, phosphoesterases, organophosphate hydrolases, and amidases) and DNA-modifying enzymes.
 - Structure, mechanism and evolution of serum paraoxonases (PONs)
 - The role of promiscuity and conformational plasticity in protein evolution.
 - Directed evolution of DNA-methyltransferases and DNase inhibitors
 - The stability effects of mutations
 - Protein evolvability
 - Chaperones and protein evolution

[Prof. Michael Walker](#)

- Selective gene expression in pancreatic beta cells:
 - Role of specific transcription factors in expression of the insulin gene in pancreatic beta cells and in control of pancreatic development.

- Novel beta cell specific genes: isolation, characterization and use as potential tools in diagnosis and therapy of diabetes.

[Prof. David Wallach](#)

- Regulation of cell death and tissue damage:
 - Proteins involved in the signaling for the cell-killing (apoptotic and necrotic), immunoregulatory, and inflammatory functions of cytokines of the tumor necrosis factor (TNF) family, and in the regulation of these functions.
 - In vivo models for the functions of the signaling mechanisms activated by ligands of the TNF family and for their pathological aberrations.
 - Natural antagonists to ligands of the TNF family, for protection against the deleterious effects of these cytokines in autoimmune and infectious diseases.
 - Regulation of the activity of the NF kappa B transcription factors.
 - The caspases, their functions and mechanisms of activation.
 - Molecular mechanisms for chronic inflammatory skin diseases.
 - Contributions of aberrations in the function of signaling proteins activated by ligands of the TNF family to cancer
 - cancer-cells' survival factors

[Prof. Meir Wilchek](#)

- Study and application of molecular biorecognition
 - Avidin-biotin system: Studies of the strong binding using chemical, physical and biological methods; new applications of the system.
 - Affinity chromatography: Studies to improve purification of protein by developing new carriers, new activation methods and new principles.
 - Affinity therapy: Development of methods to couple drugs and toxins to biological carriers, such as antibodies, and their delivery to target cells.

[Prof. Avraham Yaron](#)

- Signaling mechanisms of axonal guidance cues
- Mechanisms of axonal degeneration

Department of Molecular Genetics

Department Head: Prof. Naama Barkai

The molecular basis of genetics and related biological processes are under investigation in our Department. The investigators approach these processes from the most reduced and reconstructed systems up to more systemic and computational analysis. Different organisms are employed including virus, yeast, Drosophila, mouse and human. These animal models and cell culture systems are used to study the mechanisms of;

- a. Basic processes in gene expression, such as transcription, translation and protein

degradation.

- b. Cellular responses to various stimuli, such as cytokines, growth factors and exposure to DNA-damage.
- c. Regulation of cell growth, senescence, differentiation and death.
- d. Development; Mechanistic view of zygote to embryo transition and development of various organs, such as brain, muscles, bones and pancreas.
- e. Genetic and acquired diseases such as cancer and virus infection. Embryonic stem cell biology, early development and advance human disease modeling.
- f. Study of pluripotent stem cell biology and epigenetic reprogramming.
- g. Computational and system biology. The function/evolution of genes and their diversification.

Research activities

[Prof. Eli Arama](#)

- Genetic regulation of apoptosis and its molecular mechanisms.
- Roles of caspases in “conventional” apoptosis and during cellular remodeling.

[Prof. Ari Elson](#)

- Protein Tyrosine Phosphatases and Cell Signaling
 - Role of tyrosine phosphatases in regulating production and function of bone-resorbing osteoclasts
 - Osteoclast-related diseases: osteoporosis, osteopetrosis, cancer-related bone loss
 - Roles of tyrosine phosphatases in regulating body mass.
 - Roles of tyrosine phosphatases in diabetes and blood glucose homeostasis

[Prof. Jeffrey Gerst](#)

- Intracellular and Intercellular mRNA trafficking
 - Intracellular mRNA trafficking in yeast and its role in organelle biogenesis and cell physiology
 - Intercellular trafficking of mRNAs in mammalian cells and its role in cell physiology
 - Genome-wide mapping of mRNA localization in yeast
 - Specialized ribosomes in the control of protein translation
 - Identification of genes involved in chemotropism and chemotaxis

[Prof. Yoram Groner](#)

- Runx transcription factor 1 and 3 in development and disease
Collaboration with: The Proprioceptive System Masterminds Spinal Alignment: Insight into the Mechanism of Scoliosis. Blecher R, Krief S, Galili T, Biton IE, Stern T, Assaraf E, Levanon D, Appel E, Anekstein Y, Agar G, Groner Y, Zelzer E. Dev Cell. 2017 Aug 21;42(4):388-399.e3. doi: 10.1016/j.devcel.2017.07.022. PMID: 28829946

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Runx3-mediated transcriptional program in cytotoxic lymphocytes. Lotem J, Levanon D, Negreanu V, Leshkowitz D, Friedlander G, Groner Y. *PLoS One*. 2013 Nov 13;8(11):e80467. doi: 10.1371/journal.pone.0080467. eCollection 2013. PMID: 24236182 Free PMC Article Similar articles Select item 24204843 14. Transcriptional reprogramming of CD11b+Esam(hi) dendritic cell identity and function by loss of Runx3. Dicken J, Mildner A, Leshkowitz D, Touw IP, Hantisteanu S, Jung S, Groner Y. *PLoS One*. 2013 Oct 15;8(10):e77490. doi: 10.1371/journal.pone.0077490. eCollection 2013. PMID: 24204843 Free PMC Article Similar articles Select item 24055056 15. Addiction of t(8;21) and inv(16) acute myeloid leukemia to native RUNX1. Ben-Ami O, Friedman D, Leshkowitz D, Goldenberg D, Orlovsky K, Pencovich N, Lotem J, Tanay A, Groner Y. *Cell Rep*. 2013 Sep 26;4(6):1131-43. doi: 10.1016/j.celrep.2013.08.020. Epub 2013 Sep 19. PMID: 24055056 Free Article Similar articles Select item 23717578 16. Cell-autonomous function of Runx1 transcriptionally regulates mouse megakaryocytic maturation. Pencovich N, Jaschek R, Dicken J, Amit A, Lotem J, Tanay A, Groner Y. *PLoS One*. 2013 May 23;8(5):e64248. doi: 10.1371/journal.pone.0064248. Print 2013. PMID: 23717578 Free PMC Article Similar articles Select item 22903063 17. Positional differences of axon growth rates between sensory neurons encoded by Runx3. Lallemand F, Sterzenbach U, Hadjab-Lallemand S, Aquino JB, Castelo-Branco G, Sinha I, Villaescusa JC, Levanon D, Wang Y, Franck MC, Kharchenko O, Adameyko I, Linnarsson S, Groner Y, Turner E, Ernfors P. *EMBO J*. 2012 Sep 12;31(18):3718-29. doi: 10.1038/emboj.2012.228. Epub 2012 Aug 17. PMID: 22903063 Free PMC Article Similar articles Select item 22693452 18. The App-Runx1 region is critical for birth defects and electrocardiographic dysfunctions observed in a Down syndrome mouse model. Raveau M, Lignon JM, Nalesso V, Duchon A, Groner Y, Sharp AJ, Dembele D, Brault V, HÃ©rault Y. *PLoS Genet*. 2012 May;8(5):e1002724. doi: 10.1371/journal.pgen.1002724. Epub 2012 May 31. PMID: 22693452 Free PMC Article Similar articles Select item 22370763 19. Roles of VWRPY motif-mediated gene repression by Runx proteins during T-cell development. Seo W, Tanaka H, Miyamoto C, Levanon D, Groner Y, Taniuchi I. *Immunol Cell Biol*. 2012 Sep;90(8):827-30. doi: 10.1038/icb.2012.6. Epub 2012 Feb 28. PMID: 22370763 Similar articles Select item 21786422 20. Absence of Runx3 expression in normal gastrointestinal epithelium calls into question its tumour suppressor function. Levanon D, Bernstein Y, Negreanu V, Bone KR, Pozner A, Eilam R, Lotem J, Brenner O, Groner Y. *EMBO Mol Med*. 2011 Oct;3(10):593-604. doi: 10.1002/emmm.201100168. Epub 2011 Aug 8. PMID: 21786422 Free PMC Article Similar articles A Runx1-Smad6 rheostat controls Runx1 activity during embryonic hematopoiesis. Knezevic K, Bee T, Wilson NK, Janes ME, Kinston S, Polderdijk S, Kolb-Kokocinski A, Ottersbach K, Pencovich N, Groner Y, de Bruijn M, GÃ¶ttgens B, Pimanda JE. *Mol Cell Biol*. 2011 Jul;31(14):2817-26. doi: 10.1128/MCB.01305-10. Epub 2011 May 16. PMID: 21576367 Free PMC Article Similar articles Select item 21536859 22. ERG promotes T-acute lymphoblastic leukemia and is transcriptionally regulated in leukemic cells by a stem cell enhancer. Thoms JA, Birger Y, Foster S, Knezevic K, Kirschenbaum Y, Chandrakanthan V, Jonquieres G, Spensberger D,

Wong JW, Oram SH, Kinston SJ, Groner Y, Lock R, MacKenzie KL, GÄttgens B, Izraeli S, Pimanda JE. Blood. 2011 Jun 30;117(26):7079-89. doi: 10.1182/blood-2010-12-317990. Epub 2011 May 2. PMID: 21536859 Free Article Similar articles Select item 20959602 23. Dynamic combinatorial interactions of RUNX1 and cooperating partners regulates megakaryocytic differentiation in cell line models. Pencovich N, Jaschek R, Tanay A, Groner Y. Blood. 2011 Jan 6;117(1):e1-14. doi: 10.1182/blood-2010-07-295113. Epub 2010 Oct 19. PMID: 20959602 Free Article Similar articles Select item 20615577 24. The novel RUNX3/p33 isoform is induced upon monocyte-derived dendritic cell maturation and downregulates IL-8 expression. Puig-KrÄgger A, Aguilera-Montilla N, MartÄnez-NuÄez R, DomÄnguez-Soto A, SÄnchez-Cabo F, MartÄn-Gayo E, Zaballos A, Toribio ML, Groner Y, Ito Y, Dopazo A, Corcuera MT, Alonso MartÄn MJ, Vega MA, CorbÄ AL. Immunobiology. 2010 Sep-Oct;215(9-10):812-20. doi: 10.1016/j.imbio.2010.05.018. Epub 2010 Jun 20. PMID: 20615577 Similar articles Select item 20596738 25. In vivo effects of APP are not exacerbated by BACE2 co-overexpression: behavioural characterization of a double transgenic mouse model. Azkona G, Levannon D, Groner Y, Dierssen M. Amino Acids. 2010 Nov;39(5):1571-80. doi: 10.1007/s00726-010-0662-8. Epub 2010 Jul 2. PMID: 20596738 Similar articles Select item 20554226 26. Translation regulation of Runx3. Bone KR, Gruper Y, Goldenberg D, Levanon D, Groner Y. Blood Cells Mol Dis. 2010 Aug 15;45(2):112-6. doi: 10.1016/j.bcmd.2010.04.001. Epub 2010 Jun 2. PMID: 20554226 Similar articles Select item 19233693

- Dynamic combinatorial interactions of RUNX1 and cooperating partners during megakaryocytic differentiation
Collaboration with: Amos Tanay Department of Computer Science & Applied Mathematics
- Biological function of the RUNX transcription factors
- Positive and negative transcriptional regulation by Runx3
- The Human Leukemia Associated Transcription Factor RUNX1/AML1 and Down syndrome leukemia

[Dr. Jacob \(Yaqub\) Hanna](#)

- Deciphering Cellular Reprogramming
 - Following a breakthrough that was made in 2006 (by Takahashi & Yamanaka), today we can reverse cellular differentiation, and generate induced pluripotent stem cells from somatic cells by epigenetic "reprogramming". We investigate what are the dramatic molecular changes happening in the cell during reprogramming and how they are connected to similar in-vivo processes. We pointed out two chromatin regulators that play a role in this process, one is essential for reprogramming (Utx, Mansour et al 2012), and the other (Mbd3/NuRD, Rais et al 2013) is an obstacle, which upon its near-removal the reprogramming becomes dramatically faster and synchronized.

- Understanding Na⁺-ve and Primed Pluripotent States
 - Being able to generate all cell types, mouse embryonic stem cells are a most valuable tool for research. They can be found in the developing mouse embryo in two distinct states: na⁺-ve “ in the blastocyst, and primed “ in the post-implantation epiblast. These two states are distinct in various aspects, most notable, only na⁺-ve cells can contribute efficiently to chimera. Na⁺-ve and primed cells can be sustained in-vitro, and are dependent on distinct signaling. In human, na⁺-ve stem cells were out of reach for a long time. We investigate the regulation of na⁺-ve and primed pluripotent stem cell in mouse and human. Specifically, we were able to maintain human stem cells in a “naive” state, with distinct molecular and functional properties, including enhanced ability to contribute to cross-species mouse chimeric embryos (Gafni et al, 2013). In addition, we found that mRNA methylation has a critical role in facilitating degradation of pluripotent genes, an essential step during the switch from na⁺-ve to primed states, both in-vitro and in-vivo (Geula et al, 2014). Our current studies involve elucidating molecular regulation of these states across different species, and define how their molecular architecture dictates their functional competence.
- Human-Mouse Cross-Species Chimerism
 - Human stem cells that are sustained in na⁺-ve culture conditions, can be injected to mouse blastocyst and contribute to cross-species chimera (Gafni et al, 2013). We investigate these chimeric mice, which are valuable tool for human disease modeling in a whole-organism context.

[Prof. Eran Hornstein](#)

- miRNA role in human disease
 - miRNA role in motor neurons and amyotrophic lateral sclerosis
 - miRNA role in pancreas and diabetes
 - miRNA stem cells

[Prof. Adi Kimchi](#)

- Programmed Cell Death: from single genes and molecular pathways towards systems level studies
 - Deciphering the roles of the DAP genes in programmed cell death
 - Systems biology analysis of the programmed cell death network
 - Functional annotations of a family of death-associated kinases: DAPk, DRP-1 and ZIPk
 - Protein translation control during cell death: structure/function analysis of the DAP5 gene

[Prof. Doron Lancet](#)

- Bioinformatic tools for disease gene discovery, Origin and early evolution of life on earth

Collaboration with: Prof. Rafi Zidovetzki, University of California Riverside Dr. Omer Markovitch, University of Groningen Prof. Daniel Segre, Boston University

- Identification of disease-related mutations by next generation DNA sequencing (NGS), development of software tool for the analysis of NGS results
- Computer simulations of emergence, selection and evolution at the origin of life. Chemical kinetic models for mutually catalytic sets, Systems Protobiology.

[Prof. Shmuel Pietrokovski](#)

- Developing computational methods for using and identifying protein motifs and applying them for the analysis of particular protein families.
 - Developing advanced methods for comparing protein motifs.
 - Applying protein motif comparisons for functional and structural predictions and to database annotation.
 - Analysis of inteins ("protein splicing" elements) and homing endonucleases.
- Genetic variations in humans and different gene usage in women and men
 - Gene variations causing human disease, in particular infertility in men and various cancers.
 - Different gene usage in women and men leading to differential selection between the sexes and allowing the accumulation of deleterious mutations.

[Prof. Yitzhak Pilpel](#)

- Systems biology of genetics regulatory networks

[Prof. Orly Reiner](#)

- Formation of the brain structure in human is a complex process. One of the most striking features of the human brain is characteristic convolutions. These convolutions are lacking in a severe human brain malformation known as lissencephaly (smooth brain).
 - Identification of genes that are downstream to Lis1 mutation using microarray technology.
 - Study of LIS1 and DCX functions through characterization of protein interactions
 - Analysis of the developmental function of LIS1, DCX and Doublecortin-like-kinase using gene targeting in the mouse.
- Functional Analysis of Genes Involved in Lissencephaly.

Prof. Michel Revel

- Applications of IL-6 Chimera and Interferon-beta in neurology, hematopoiesis, and oncology.

Collaboration with: J. Chebath

- Interleukin-6 Chimera, a superactivator of the gp130 receptor system: role in nerve myelination, neuroprotection and in the development of neuro-glial cells from

embryonic tissues and stem cells.

Collaboration with: J. Chebath

- Transdifferentiation of neural crest cell derived melanoma into myelinating Schwann cell. Genes controlling cell growth, differentiation, melanogenesis and synthesis of myelin proteins.

Collaboration with: J. Chebath

[Prof. Menachem Rubinstein](#)

- Role of oxidative stress in type 2 diabetes

Collaboration with: Mike Walker

- Metabolic diseases

- CAR-T optimization

Collaboration with: Zelig Eshhar

- Gene therapy in cancer

- Role of C/EBPbeta in multidrug resistance

Collaboration with: Chiara Riganti (Univ. Torino, Italy)

- Cancer Research

- Attenuation of chemotherapy side effects

Collaboration with: Gillian Dank (Koret School of Veterinary Medicine of the Hebrew University of Jerusalem)

- Cancer Research

[Prof. Maya Schuldiner](#)

- Uncovering tethers, functions and regulators of membrane contact sites in yeast

- Mitochondria-Peroxisome contact sites

- Peroxisome-Plasma membrane contact sites

- Lipid Droplet-Mitochondria contact sites

- The proteome of contact sites

- Targeting and translocation to Organelles

- Uncovering a role for the Ssh1, alternative, translocon in yeast

Targeting of membrane proteins to peroxisomes

- Deciphering targeting of proteins to mitochondria

- Targeting of membrane proteins to peroxisomes

- Uncovering new peroxisomal proteins and their functions

Collaboration with: Dr. Einat Zalckvar

- Metabolite transport across the peroxisome membrane

- Peroxisome contact sites
- Peroxisome quality control
- Peroxisome targeting
- Novel methodologies for systematic exploration of yeast organelle protein functions
 - Creation of versatile yeast libraries
- High throughput electron microscopy techniques
- Translocation sensors

[Prof. Yosef Shaul](#)

- Transcription regulation of the hepatitis B virus. To understand how overlapping promoters are autonomously functional.
- The molecular basis of virus-host cell interaction. How HBV modifies cell behavior.
- The activation and the role of c-Abl-p73 signaling axis in response to DNA damage and cancer.
- modulation of Hippo signaling by c-Abl; the role of Yap1 and TAZ transcription coactivators in cell proliferation and in apoptosis
- proteasomes as a target in cancer therapy
- proteasome composition, dynamics, function and regulation and various conditions.
- proteasomal degradation of intrinsically disordered proteins (IUP or IDP). the concept of degradation by default

[Prof. Rotem Sorek](#)

- Microbial genomics and systems biology
- CRISPR-Cas, an antiviral microbial defense system
- Interactions between bacteria and phages
- Communication between viruses
- RNA-mediated regulation in bacteria
- Computational discovery of novel natural antimicrobials

[Dr. Noam Stern-Ginossar](#)

Prof. Ernest Winocour

- virology, viral vectors for gene therapy, viruses associated with cancer

[Prof. Elazar Zelzer](#)

- the roles of the VEGF pathway in different steps during skeletal development.
- Studying the role of mechanical load on embryonic bone development

Department of Plant and Environmental Sciences

Department Head: Prof. Yuval Eshed

Plants offer the world its only renewable resource of foods, alternative energy and biotherapeutic compounds. Plants have highly sophisticated short and long-term adaptive mechanisms to the environment as a result of the simple fact that they cannot alter their location during environmental change. Basic understanding of how plants react to the environment and why they grow the way they do are central to devising a rational approach to address three important global challenges, namely to secure more and healthier food, to develop novel plant-based products associated with biotherapeutics and to produce alternative energy resources in the form of biofuels. Research activities in the Department of Plant Sciences are associated with all of the above-mentioned global challenges and range from studies on the function and regulation of isolated genes to their interactive behavior in the context of the whole plant. We have developed extensive in-house genomic, bioinformatics and transgenic infrastructure that enables us to isolate novel genes by gene trapping, knockout or map-based cloning. Cloned genes are manipulated and studied by transgenic analysis to establish their potential in the whole plant. Our research as listed below integrates methodologies of molecular biology, protein modeling, genomics, metabolomics, bioinformatics, system biology, genetics, biochemistry and physiology.

Harnessing light energy and energy transduction in the plant cell: Research is carried out on the basic biophysical phenomenon of photon absorption by chlorophyll through transduction of this energy to ATP and the regulation of energy flux by the plant redox state.

Adaptive response in the plant to the biotic and abiotic environment: Molecular mechanisms that drive the cellular response are investigated under environmental perturbation. Research is directed in understanding the elements that play a role in the recognition of pathogens and the subsequent mounting of plant defense responses as well as in the response of plants to abiotic stresses, such as salt stress.

Plant metabolism and growth: Research is centered around elucidating regulatory metabolic networks for production of essential primary and secondary metabolites as well as understanding gene expression and hormonal networks that control plant metabolism, growth, reproduction and productivity.

Plant genome organization: Molecular tools have been developed to examine the fluidity of the plant genome, as described by transposon element, and the evolution of polyploid plants.

Research activities

[Prof. Asaph Aharoni](#)

- Genetic Regulation of Metabolic Pathways and its Co-ordination with Developmental and Stress Response Programs in Plant Biology
 - The Primary-Secondary Metabolism Interface
 - Regulation of Plant Surface Formation

- Regulation of Secondary Metabolism Associated Metabolic Pathways
- Plant and Yeast Metabolomics
- Riboswitches in Plants: Post Transcriptional Regulators of Metabolic Pathways

[Prof. Avihai Danon](#)

- RNA-binding proteins controlling light-regulated translation.
- Redox-signaling controlling light-regulated translation. Mechanisms of disulfide bond formation and isomerization in the chloroplast.
- Mode of action of redox-signal transduction factors.

Prof. Marvin Edelman

- Duckweed biotechnology
Collaboration with: Barak Cohen, Ron Vunsh
 - Volumetric growth of Wolffia
 - Polyploidization of duckweeds for biomass increase and metabolic vigor
 - Mutagenesis from photoautotrophy to photoheterotrophy
 - Transgenic duckweed for veterinary products
 - Genomic analysis of calcium dependent protein kinases in duckweeds

[Prof. Robert Fluhr](#)

- Plant Response to Environmental Stress
 - Reactive oxygen species in plant stress response
 - Cellular REDOX state
 - Gene expression networks in abiotic and biotic stress
 - Proteases and their inhibitors in the regulation of programmed cell death

[Dr. Assaf Gal](#)

- Mineral formation pathways in phytoplankton
 - Silica formation in diatoms, from intracellular condensation of silica to morphogenesis of the cell-wall structure.
 - Mechanisms of calcite precipitation by coccolithophores. The role of intermediate mineral pools inside the cell and the interactions between biomacromolecules with the inorganic phase.

[Prof. Gad Galili](#)

- Association of metabolism and cell biology with plant development and response to stress
Collaboration with: Zevulun Elazar, Aviah Zilberstein, Rachel Amir, Yoram Kapulnik, Alisaider Fernie
 - Gene expression programs and metabolic networks associated with seed

maturation and germination

- Metabolic engineering of high-lysine plants
- Genetic, genomic and bioinformatics approaches to elucidate metabolic networks in plants
- Regulatory interactions between primary and secondary metabolism of plants
- Cell biology and physiology of autophagy-associated processes in plants

[Prof. Jonathan Gressel](#)

- Developing slow release herbicide formulations
Collaboration with: Michael Burnet
- Designing tandem constructs to mitigate gene flow from transgenic crops to weeds

[Dr. Tamir Klein](#)

- Tree carbon metabolism
 - Tree-Tree root carbon transfer
 - Whole-tree carbon balance
- Tree water transport
 - Tree drought resistance
 - Xylem recovery from embolism

[Prof. Ron Milo](#)

- Environmental Sustainability Indicators
Collaboration with: Gidon Eshel - Bard College
- Synthetic carbon fixation pathways
- Cell Biology by the Numbers
Collaboration with: Rob Phillips - Caltech
- Design principles in energy and carbon fixation

[Prof. Avigdor Scherz](#)

- Quantification of atoms, groups and molecules electronegativity using metal substituted bacteriochlorophylls and application to chemical reactivity.
- Resolving the forces which drive membrane protein assembly.
- The mechanism behind generation of reactive oxygen species (ROS) by illuminating novel bacteriochlorophyll derivatives and their application in photodynamic therapy (PDT) of tumors.

[Prof. Assaf Vardi](#)

- The ecological and evolutionary role of programmed cell death in single-celled marine photosynthetic microorganisms

- The role of infochemicals and their regulation of cell fate and cell-cell interactions in marine photosynthetic microorganisms
- Sensing Environmental Stress and Acclimation Strategies in Marine Algae
- Cell Signaling Pathways and their role in the Chemical “Arms Race” during Algal Host-Virus and Predator-Prey interactions

Faculty of Chemistry

Department of Chemical and Biological Physics

Department Head: Prof. Lucio Frydman

The Chemical and Biological Physics Department provides an interdisciplinary home to a broad range of topics spanning Physics, Chemistry and Biology. The Department is composed by over 20 tenured and tenure-track physicists and chemists, evenly split between theorists and experimentalists, and working on the following broad areas

Fundamental quantum frontiers are explored with advanced theoretical tools, including topics in the quantum control of atomic and molecular dynamics (*Ilya Averbukh, Eli Pollak, David Tannor*); light-matter interactions (*Ilya Averbukh, Gershon Kurizki, David Tannor*); fundamental issues in quantum information, control and thermodynamics (*Gershon Kurizki, David Tannor*); ab-initio quantum chemistry and surface scattering (*Eli Pollak*); and real time quantum dynamics methods (*Eli Pollak, David Tannor*).

The department has a strong program at the interface between classical physics, chemistry and biology. *Eran Bouchbinder* studies the plasticity of disordered systems, glassy phenomena, dynamic fracture, frictional interfaces and biophysics. *Itamar Procaccia* studies turbulence, as well as the physics of fractals, glass formation and mechanical properties of amorphous systems. Theoretical biological physics is the main thrust of research of *Nir Gov*, who models with predictive power emerging phenomena ranging from cellular shapes to the collective behavior of insects. *Samuel Safran* employs statistical thermodynamics to study the structure, phase behavior and dynamics of soft matter in biology.

The chemistry/biology interface is also studied and evaluated experimentally by *Roy Bar-Ziv*, who develops and explores living-like systems in cell-free environments, and by *Michael Elbaum*, who employs advanced microscopic tools to elucidate the complex behavior of cells and biomolecules.

Experimental atomic and molecular spectroscopies are also mainstays of the Department. Quantum optics is the focus of *Barak Dayan*'s experiments on atom mediated photon-photon interactions. Light matter interaction, nonlinear laser spectroscopy and plasmonics are the focus of the experimental research of *Yehiam Prior*. *Edvardas Narevicius* is a leader in using magnetic field control and the slowing down of molecular beams to study quantum effects in sympathetically cooled systems. *Oren Tal* has developed unique methods for the study of single molecule conductors, including electronic, spintronic and thermal conductivity effects. Molecular electronics and spin-chemistry are also main themes of research for *Ron Naaman*, who investigates these using organic-inorganic interfaces via self-assembled monolayers. Single molecule

spectroscopy and its application to a broad range of topics, from protein dynamics to nanoplasmonics, are at the center of the experimental program of *Gilad Haran*. *Baran Eren* exploits new forms of microscopy and spectroscopy, to understand the chemistry and electronic behavior of solid surfaces under relevant conditions with unprecedented accuracy.

A centerpiece of the combined experimental/theoretical program in the Department rests on Magnetic Resonance research. *Amit Finkler* bridges this topic with optics, in a program relying on optically-detected magnetic resonance as an emerging form of quantum sensing. *Lucio Frydman* and his group focus on developing and utilizing new concepts and techniques in NMR and MRI, with applications ranging from Physics to Biology and Medicine. *Assaf Tal's* group focuses on developing new spectroscopy and imaging tools for understanding the brain's physiology in-vivo. *Shimon Vega* and *Daniella Goldfarb* are developing and utilizing dynamic nuclear polarization methods for NMR and EPR research, with the Vega group also deeply involved in solid state NMR, and the Goldfarb research also focused on multiple-resonance high-field EPR techniques applied to biophysics and materials science. *Although emeritus*, *Zeev Luzstill* partakes of these efforts with his research on liquid crystal NMR.

The diverse interests as represented above have created an atmosphere of outstanding scientific creativity. Members of the Department have overlapping interests and collaborations among themselves, with other scientists throughout the Weizmann Institute, and with scientists throughout the world. **New training opportunities for students and postdocs are always emerging, at whose conclusion participating scientists will have been exposed to a broad spectrum of challenges and acquired state-of-the-art knowledge. If you are interested in joining this elite group of researchers as a M.Sc., Ph.D or postdoctoral trainee, do not hesitate to contact the expert(s) of your choice.**

Research activities

[Prof. Ilya Averbukh](#)

- Manipulation of atoms and molecules by laser fields
- Laser control of molecular alignment and orientation. Control of chiral molecules
- Echo phenomenon
- Atomic and molecular wave packets, ultra-fast optical phenomena.

[Prof. Eran Bouchbinder](#)

- Dynamic fracture
- Physics of sliding friction
- Glass physics
- Plasticity theory and non-equilibrium thermodynamics

- Biophysics and cell mechanics

[Prof. Barak Dayan](#)

- Experimental Quantum Optics
 - Cavity QED with single atoms coupled to chip-based micro-resonators
 - Nonclassical photon-photon interactions

Dr. Baran Eren

- Following surface reactions with ambient pressure XPS and polarisation modulated IRRAS
- Atomic structure of surfaces in the presence of reactant gases
- Developing new techniques to bridge the 'material gap' and the 'pressure gap' between surface science and industrial processes

[Dr. Amit Finkler](#)

- \hbar^0 Quantum-assisted sensing, from the single-spin limit to coherent, macroscopic objects
- \hbar^0 Nanoscale magnetic resonance imaging of molecules
- \hbar^0 Observation of quantum coherence in chemical reactions

[Prof. Lucio Frydman](#)

- Development of new methods in nuclear magnetic resonance and magnetic resonance imaging analysis.
- In vitro and in vivo hyperpolarized NMR and MRI
- Application of novel magnetic resonance methods to the study of cancer, fetal development, protein folding and unfolding.

[Prof. Nir Gov](#)

- Research of collective quantum effects in Super-fluid, solid and super-solid Helium. Including magnetic phase transitions in solid and liquid helium.
- The physics of large scale pattern formation of cells in cellular cultures, in morphogenesis and wound-healing.
- Theoretical problems in biological physics; active processes in cells involving molecular motors.
- Theoretical studies and modelling of the physics that determines the shapes and dynamics of cells.

[Prof. Gilad Haran](#)

- Protein folding studied on the level of the individual molecule
- Functional Dynamics of Proteins
Collaboration with: Amnon Horovitz, Weizmann, Rina Rosenzweig, Weizmann, Douglas Kojetin, Scripps Florida
- Membrane Organization and Dynamics
Collaboration with: Ronen Alon, Weizmann, Frank Brown, UCSB, Andres Alcover, Pasteur Institute
 - Correlated motion in the membrane plan
 - Super-resolution microscopy of the organization of receptors on the membrane of the T cell
- Interaction of surface plasmons with quantum emitters
Collaboration with: Ora Bitton, Weizmann, Lothar Houben, Weizmann, Lev Chuntonov, Technion
 - Strong coupling of plasmons and quantum dots

Prof. Gershon Kurizki

- Quantum optics of cold atoms .
- Superluminal effects in optics.
- Quantum and nonlinear optics in photonic band gap structures.
- Control of quantum states and decoherence.

[Prof. Ron Naaman](#)

- Spin selectivity in electrons transmission through chiral molecules
Collaboration with: Yossi Paltiel, Hebrew University David H. Waldeck, University of Pittsburgh USA Claudio Fontanessi, Modena University, Italy E. W. Meijer, Eindhoven, Netherland C. Achim, Carnegie Melon, USA
 - electron transfer in bio-molecules
 - spin selective electron transfer
 - spin dependent electrochemistry
 - spintronics with chiral molecules
 - enantio-selective interaction
 - Spin effect in water splitting

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[Prof. Yehiam Prior](#)

- Strong field nonlinear optics.
- Alignment and orientation of atoms and molecules in strong laser fields.
Collaboration with: Ilya Averbukh

- Molecular Dynamics with ultrashort shaped femtosecond pulses.
- femtosecond laser material processing

[Prof. Itamar Procaccia](#)

- The glass transition and slow relaxation phenomena
Collaboration with: Jacques Zylberg, Yossi Cohen
- Mechanical properties of amorphous solids with theory of plasticity
Collaboration with: Valery Ilyin, Ratul Dasgupta, Limei Xu, Smarajit Karmakar
- Failure in Amorphous Media: fracture, shear bands and necking.
Collaboration with: Ratul Dasgupta, Ashvin Joy, Eran Bouchbinder
- Fractals and scaling in nonequilibrium physics.
- Turbulence in classical and in quantum fluids
Collaboration with: Victor L'vov, Anna Pomyalov, Laurent Boue'

[Prof. David Tannor](#)

- Control of chemical reactions with tailored femtosecond pulses.
- Laser cooling of molecules.
- Quantum theory of dissipation and chemical reactions in solution.
- Semiclassical theory of reactive scattering.

Prof. Shimon Vega

- Proton NMR Spectroscopy of Solids
- Dynamic Nuclear Polarization
Collaboration with: Akiva Feintuch
- Surface mobility of molecules in mesoporous materials

Department of Earth and Planetary Sciences

Department Head: Prof. Yinon Rudich

The research in this Department is dedicated to understanding the complex inter-relationships among the major Earth Systems, the human impact on the Earth's environment and on planetary atmospheres and geomorphologies.

The Department's research activities have several general areas of activities. One focuses on water and includes hydrology, geochemistry, land-plant-atmosphere interactions and oceanography. A second activity is in the use of stable isotopes for reconstructions of paleoclimatic and of biosphere-atmosphere dynamics, and a third is in the area of atmospheric chemistry and dynamics, and cloud physics. A fourth area of

research is in planetary sciences. Our research requires knowledge of the interdependent components that together constitute the "environment", as well as a commitment to protect this environment by improving the manner in which air, water, land and energy are utilized by humans. The Department is distinguished by the interactions among scientists from different backgrounds and expertise, which is critical to achieve a comprehensive understanding of the global environment and planetary sciences.

Our

department promotes international collaborations based on short- and long-term visits for research and training by scientists who complement existing expertise in the Department. The interdisciplinary nature of the Department is well reflected in the academic training of the research students. Their backgrounds vary from physics and mathematics through geology to biology. We encourage the participation of students who are interested in not only investigating in depth a specific subject, but who are also interested in a broader, more integrative approach to science.

Research activities

[Prof. Oded Aharonson](#)

- Planetary Science

[Prof. Brian Berkowitz](#)

- Development of chemical methods for remediation of water polluted by organic compounds and heavy metals.
- Fluid flow and chemical transport in groundwater systems.
- Percolation, scaling and statistical physics models of structural and dynamic processes in geological formations.
- Experimental and theoretical analysis of reactive transport and precipitation/dissolution patterns in porous media.

[Dr. Itay Halevy](#)

- The long-timescale co-evolution of biogeochemical cycles, the chemical and isotopic composition of the oceans and atmosphere, and climate on Earth and other planets.
 - The geological, geochemical, and geobiological history of Earth, planets and satellites.
 - Global biogeochemical cycles and their interaction with the climate system.
 - Episodes of global climatic, biological or geochemical change, their causes and consequences, and their expression in the sedimentary rock record.
 - Fractionation of stable isotopes during metabolic activity, its governing factors, and its expression in modern environments and in the sedimentary rock record.

[Dr. Yohai Kaspi](#)

- Geophysical fluid dynamics
- Atmospheric dynamics on Earth and other planets
 - Storm track dynamics
 - Geostrophic turbulence
 - Superrotation
 - Climate dynamics
- Planetary interiors
 - Gravitational signature of internal dynamics on giant planets
 - Jets on giant planets
 - Internal tides
 - The Juno mission to Jupiter

[Prof. Ilan Koren](#)

- The twilight zone - convective clouds and their interaction with the free atmosphere
Collaboration with: NOAA-ESRL Boulder CO.
- Anthropogenic Effects on Clouds and Precipitation and the Derived Climate Forcing
Collaboration with: NASA-GSFC, UMBC
- Cloud microphysics and dynamics
- Cloud classification and cloud textures and morphology

[Prof. Yinon Rudich](#)

- Health effects of atmospheric particulate matter
- Ice nucleation by atmospheric particles
- The transport of microorganisms in the atmosphere and their possible biogeochemical effects. Atmospheric microbiome.
- Optical properties of atmospheric organic aerosols

[Prof. Dan Yakir](#)

- Developing the use of stable isotopes (in particular, ^{13}C , ^{18}O , ^{15}N , ^2H) as tracers of biogeochemical cycles on land.
- Environmental and climatic influence on the exchange of trace gases and energy between plants, soil and the atmosphere.
- Climatic influence on the natural abundance of carbon, oxygen and hydrogen isotopes in CO_2 , O_2 , H_2O and organic matter.

Department of Materials and Interfaces

Department Head: Prof. Leeor Kronik

Activities in the Department span a wide range of topics from soft, composite and hard materials to energy research, nanoscience, and biological materials. A unifying theme is the study of material functionality and its relation to fundamental properties at multiple scales. These properties may be mechanical, structural, chemical, electronic, magnetic, optical, and more. Some examples are:

How do shapes and sizes of nm-sized particles affect their properties?

How can we tune the properties of solar cells by manipulating their material interfaces?

How does friction in knee and hip joints depend on polyelectrolytes that lubricate them?

How can we design self-assembling (bio)chemical systems?

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THE RESEARCH IS BASED ON AN INTERDISCIPLINARY APPROACH, and indeed the scientists bring complementary experience in chemistry and physics, including theory and experiment.

Research activities

[Prof. Roy Bar-Ziv](#)

- Artificial biochemical circuits
 - Cell-free gene expression on a chip
 - Cell-free expression of protein nano-structures
 - Autonomous interrogation of the state of a living cell
- The physics of microfluidic crystals

[Prof. David Cahen](#)

- Solar Energy: New materials and concepts, and understanding of Photovoltaics
Collaboration with: G. Hodes, D. Oron, S. Cohen, L. Kronik, I. Lubomirski + D. Ehre, A. Kahn (Princeton); Helmholtz Centre Berlin perovskite group; H. Bolink (Valencia); P. Nayak + H. Snaith (Oxford U), D. Egger (Regensburg), S. Sarkar (IIT-B)
 - new Optoelectronic materials: Halide Perovskites; What is special?

Photovoltaic effect at Inorganic/Organic Hybrid Interfaces

Assessing possibilities and limitations of solar to electrical and chemical energy conversion

- Bioelectronics, fundamentals
Collaboration with: M. Sheves, I. Pecht, M. Tornow (TU-Munich)
 - Proteins as solid-state electronic materials

[Prof. Michael Elbaum](#)

- Cellular Biophysics and Molecular Transport Machines
 - Single-molecule manipulations using optical tweezers.
 - Dynamics of DNA uptake into the cell nucleus.
 - Structure and function of the nuclear pore complex (with Z. Reich): application of atomic force microscopy and advanced optical spectroscopies.
 - Anomalous diffusion in polymer networks and living cells (with R. Granek).
 - Organization of forces driving cell movements (with A. Bershadsky): optical force measurements and particle tracking studies; influence of cell biochemistry on biophysical forces.
 - Novel surface-patterning lithographies.

[Prof. Gary Hodes](#)

- Semiconductor-sensitized nanoporous solar cells and semiconductor film deposition
Collaboration with: D. Cahen (WIS)
 - Electrochemical and chemical bath deposition of semiconductor films.
 - Nanocrystalline solar cells; semiconductor-sensitized nanoporous cells
 - Charge transfer in nanocrystalline films

[Prof. Ernesto Joselevich](#)

- Nanotubes and Nanowires: From Self-Organization to Functional Nanosystems
 - Nanometer-scale materials can have unique properties due to their reduced dimensions, and serve as building blocks for the assembly of miniature functional systems. In macroscopic functional systems, wires, tubes and rods play critical roles of transporting energy, forces, matter and information. Which materials could play analogous roles at the smallest possible scale? How does the reduced dimensionality determine the properties of molecular wires? How can they be organized and integrated into functional systems?
 - Our research focuses on the organization of one-dimensional nanostructures, such as carbon nanotubes, inorganic nanotubes and nanowires, their integration into functional nanosystems (mechanical, electronic, electromechanical, optoelectronic, electromagnetic, thermal, etc.) and their characterization by mechanical, electrical and optical measurements at the nanometer scale.
- Projects
 - Guided growth of horizontal nanowires
 - Epitaxial approaches to carbon nanotube organization
 - Non-equilibrium self-organization of complex nanostructures
 - Nanotube torsion and NEMS
 - Surface-directed self-assembly

- Polymers as molecular wires
- Theory of molecular wires

[Prof. Jacob Klein](#)

- Biological lubrication; Hydration lubrication; surface interactions; nanotribology; soft matter
 - Biological lubrication and its relation to osteoarthritis: this is the theme of a major new ERC grant (2017 - 2022)
 - Lipids and liposomes as lubrication vectors
 - Hydration lubrication and Boundary lubrication under water, and its relation to ocular (eye) lubrication
 - Surface forces under strong electric fields
 - Properties of thin liquid films including aqueous electrolytes and polyelectrolytes.
 - Hydrogels
 - Soft matter at interfaces
- Surface-forces-measurement techniques at angstrom surface separations; polymers as molecular lubricants
 - ATRP growth of polymers from surfaces
 - Polyelectrolyte brushes
- Polymers, Complex Fluids, and Interfaces - Experimental studies of the behavior of confined simple and polymeric fluids.

Collaboration with: Sam Safran

 - Nanotribology
 - Surface forces between heterogeneous surfaces
 - Confinement induced phase transitions

[Prof. Leeor Kronik](#)

- - Our group's research is focused on understanding unique properties and behavior of materials and interfaces, using first principles quantum mechanical calculations based mostly on density functional theory and many-body perturbation theory. The group is actively engaged in prediction and interpretation of novel experiments, as well as in the development of formalism and methodology. For much more detailed information, please click the homepage link below.

Prof. Meir Lahav

- Solid State Chemistry in 2- and 3-dimensions. Pyroelectricity. Ice nucleation.

Collaboration with: Prof Igor Lubomirsky Dr.David Ehre

 - Organization of molecules at surfaces and interfaces;

- Chirality, Chemistry and the origin of life
- Pyroelectricity, Electrofreezing.

Prof. Leslie Leiserowitz

- Crystallography and Chemistry in 2- and 3-dimensions
 - Grazing incidence x-ray diffraction
 - Malaria

[Dr. Michal Leskes](#)

- Our research is focused on correlating structure and function in energy storage and conversion materials by advanced magnetic resonance methods. We aim to understand how the composition of materials affects their functionality and how we can control their functionality through deviation from ideal stoichiometry. In particular we are interested in materials for energy storage, such as Li and Na ion batteries, and in the role interfacial chemistry plays in the functionality of electrode and electrolyte materials. We use a wide range of magnetic resonance techniques: solid state NMR, Electron Paramagnetic Resonance (EPR) and Dynamic Nuclear Polarization (DNP). Additionally we investigate the process of polarization transfer from electron spins to nuclear spins in solids DNP utilizing external and internal polarization agents. For more detailed information, please click below and see our home page.

[Prof. Igor Lubomirsky](#)

- Ice Nucleation on Charged Surfaces (Electrofreezing)

Collaboration with: Prof. Meir Lahav

 - Ice nucleation
 - design of polar crystals and surfaces by symmetry reduction
 - non-classical crystal growth
 - surface and bulk pyroelectricity
- Fundamentals of electro-chemo-mechanical effects
 - local symmetry reduction
 - non-classical electrostriction
 - ionic conductivity
 - elastic interactions in solids with a large concentration of point defects

[Prof. Samuel Safran](#)

- Cell Mechanics

Collaboration with: Dennis Discher, Univ. Pennsylvania

- Soft Matter Physics

Prof. Jacob Sagiv

- Supramolecular Architecture at Interfaces (with R. Maoz)
 - Supramolecular Surface Chemistry: Bottom-up Nanofabrication using Planned Self-Assembling Mono- and Multilayer Systems (with R. Maoz)
 - Constructive Lithography: Contact Electrochemical Surface Patterning on Lateral Length Scales from Nanometer to Centimeter (with R. Maoz)

[Prof. Reshef Tenne](#)

- Inorganic nanotubes from ternary "misfit" layered compounds
 - Synthesis of nanotubes from misfit layered compounds (MLC) and their structural characterization

Department of Organic Chemistry

Department Head: Prof. Milko van der Boom

The areas of research in the Department of Organic Chemistry include synthetic and mechanistic organic and organometallic chemistry, novel reactions for organic synthesis, bond activation by metal complexes, polymeric reagents and catalysis. Bioorganic chemistry includes the studies of plant antiviral agents, the molecular mechanism of action of rhodopsin, artificial ion carriers and molecular sensors. Biological chemistry includes studies on structure, function, and mode of action of biologically active peptides and proteins; thermophilic enzymes; enzymes involved in DNA repair, DNA and RNA processing; studies of ordered, compact states of nucleic acids; and biomedical applications of EPR and NMR. Computational chemistry deals with the prediction of molecular properties by first principles (ab initio) and semiempirical quantum mechanical calculations..

Research activities

[Prof. Mario D. Bachi](#)

- Organic synthesis through free radical reactions.
- Synthesis of Yingzhaosu A and related antimalarial drug candidates.
- Stereocontrol through Sulfur-Mediated Temporary Intramolecularization of Reactions.

[Prof. Yigal Burstein](#)

- Thermophilic enzymes
 - Isolation, characterization and cloning of enzymes from extremophilic

microorganisms.

- Structure, function and thermal stability relationship studies of extremophilic enzymes.
- Crystallization and determination of the three-dimensional structures of extremophilic enzymes.

[Prof. Matityahu Fridkin](#)

- Chemical-Biological and Clinical studies on novel drugs, primarily of peptidic nature, related to therapy of infectious, inflammatory and neoplastic diseases.

Collaboration with: Y. Koch I. Gozes (TAU) I. Offek (TAU) R. Catane (TEL-HASHOMER)

- Anticancer, Antibacterial Antiinflammatory
- Novel synthetic and analytical methodologies are being developed.
 - Solid-phase synthesis
 - Classical solution chemistry
 - Combinatorial technologies
- Studies include: drug design, pro-drugs, long-acting drugs and drug delivery.
Collaboration with: Y. Shechter
- Novel iron chelators as potential drugs for neurodegenerative diseases
Collaboration with: M. Youdim (Technion)
 - small-molecules
 - amino acids and peptides

[Dr. Nir London](#)

- Discovery and design of specific covalent inhibitors
- Covalent personalized medicine for cancer
- Computational ligand/drug discovery

[Prof. Gershon \(Jan\) Martin](#)

- Computational Quantum Chemistry

Collaboration with: D. Milstein, M. van der Boom, R. Neumann, M. A. Iron, L. Kronik

- High-accuracy ab initio thermochemistry: method development and applications.
- Development of novel, more universal, density functionals
- Application of density functional methods to organometallic systems, with special reference to homogenous catalysis.
- Ab initio prediction of rotation-vibration spectra beyond the harmonic approximation.
- Intermolecular interactions

[Prof. David Milstein](#)

- Organometallic chemistry and catalysis
 - Bond activation by electron-rich transition metal complexes.
 - Rational design of homogeneous catalysis and synthetic methodology based on transition metal complexes.
 - Impact of molecular order on catalysis and reactivity.
 - Generation and stabilization of elusive (potentially biologically active) molecules

[Prof. Boris Rybtchinski](#)

- Organic self-assembly: nanoreactors and nanocapsules
- Solar fuels: photoinduced water splitting for hydrogen production
- Artificial photosynthesis: light-harvesting materials for solar energy conversion

[Prof. Abraham Shanzer](#)

- Supramolecular chemistry
 - Biomimetic ion binders, diagnostic tools in imaging technologies (fluorescent probes) and potential therapeutic agents. Synthesis, using classical and combinatorial chemistry methods and evaluation.
 - Synthesis and properties of molecular based devices; molecular sensors, switches and logical gates for application in nanotechnology.
 - Surface bound functional assemblies.

Department of Structural Biology

Department Head: Prof. Deborah Fass

The functions of biological systems emerge from the structures of macromolecules, their conformational dynamics, and their higher order assembly. Determination of biomolecular structures and an understanding of their conformational changes and assembly properties provide great insights into biological mechanisms. Much of the research in structural biology at the Weizmann Institute is carried out in the Faculty of Chemistry, using a diverse set of cutting-edge research tools and methods. Investigators in the Structural Biology Department rely on the primary techniques for experimental structure determination, namely X-ray crystallography, NMR, and electron microscopy, but they also employ a variety of other specialized and emerging spectroscopic methods combined with creative molecular engineering to explore macromolecular structures, energetics, and dynamics. Experimental strategies are complemented by computational and theoretical approaches. Among the specific subjects of research in the department are ribosomes, protein chaperones, viruses, extracellular matrices, and biominerals. Processes being investigated include protein aggregation in cells, conformational dynamics of enzymes, formation of skeletal tissues, cell penetration by viruses, DNA recognition by proteins, and protein folding. Efforts are also directed towards the design of potential drugs. The wide variety of research activities in the department are based on

a shared appreciation for the physical and chemical foundations of biological activities.

Research activities

[Prof. Lia Addadi](#)

- Antibodies that recognize crystal surfaces and 2-dimensional organized patterns.
 - antibody recognition of chiral crystal surfaces
 - structure of cholesterol/ceramide monolayer mixtures. Molecular organization of lipid rafts
 - Pathological crystallizations. Gout
 - antibody recognition of amyloid structures
- Mechanisms of crystal nucleation and modulation of crystal growth and properties in biomineralization (bone, mollusk shells, echinoderms).

Collaboration with: S. Weiner

- Mechanism of cell adhesion using crystal substrates.

Collaboration with: B. Geiger

[Prof. Jacob Anglister](#)

- The structure of the membrane proximal extra-cellular region of HIV-1 gp41 and its role in viral fusion
Collaboration with: F. Naider
- The structure of the V3 loop of the HIV-1 envelope protein gp120 and its interactions with chemokines receptors
Collaboration with: F. Naider
- NMR structure of alpha Interferon complex with its receptor
Collaboration with: J. Piehler
- The interactions of scorpion toxins with sodium channels and the structures of the channels extra-cellular loops
Collaboration with: M. Gurevitz, D. Gordon

[Dr. Ron Diskin](#)

- Viral glycoproteins - HIV and others
- BBSome structure and function

[Prof. Deborah Fass](#)

- disulfide bond formation for oxidative protein folding and assembly
- extracellular matrix structure and assembly
- enzyme mechanism, regulation, and inhibition

[Prof. Amnon Horovitz](#)

- Linear free energy relationships (LFER) analysis of allosteric transitions in proteins.
- Analysis of correlated mutations in proteins
Collaboration with: Ron Unger (Bar Ilan University)
- Allostery in the structure and function of GroEL and CCT chaperonins.
Collaboration with: Keith Willison (Imperial College, London); Michal Sharon;
- Chaperonin-mediated protein folding.
Collaboration with: Gilad Haran

[Dr. Emmanuel Levy](#)

- Design of protein-based super assemblies
Collaboration with: Jonathan Doye (Oxford) Samuel Safran (WIS)
- New methods to detect and measure protein interactions
- Computational analyses of protein structure

[Prof. Koby Levy](#)

- The biophysics and evolution of post-translational modifications
- The mechanisms of protein-DNA recognition: understanding the driving forces for fast assembly

[Dr. Rina Rosenzweig](#)

- Chaperone interactions with substrates
- Protein disaggregation machinery
- NMR of large proteins

[Prof. Zippora Shakked](#)

- Crystal structure and solution studies of DNA oligomers.
Collaboration with: Donald Crothers (Yale University)
 - DNA regulatory elements
 - DNA bending by adenine-thymine tracts
- Structural and biochemical studies of proteins involved in transcriptional regulation.
 - The tumor-suppressor protein p53 and its interaction with DNA and the basal transcription machinery
 - The leukemia-related RUNX1(AML1) transcription regulator

[Prof. Joel Sussman](#)

- 3D Structure Function Studies of proteins related to Autism
Collaboration with: Israel Silman
- 3D Structure Function studies of Paraoxonase
Collaboration with: Dan Tawfik & Israel Silman

- Application of ultra rapid X-ray diffraction methods to study the enzymatic mechanism of AChE in real time.
Collaboration with: Israel Silman
- Structure based drug design studies on AChE and beta-secretase, including studies of complexes with transition state analogs; potential drugs for the treatment of Alzheimer's disease; and snake neurotoxins.
Collaboration with: Israel Silman
- X-ray structural analysis and molecular biology studies on proteins from the nervous system, including acetylcholinesterase (AChE), human, torpedo, drosophila, and krait; butyrylcholinesterase; neural cell adhesion proteins with sequence similarity to ACh
Collaboration with: Israel Silman
- 3D Structure Function of proteins related to Gaucher Disease
Collaboration with: Tony Futerman & Israel Silman
- Visualization of 3D Protein Structures via new web based tool Proteopedia
Collaboration with: Jaime Prilusky & Israel Silman

[Prof. Stephen Weiner](#)

- Structure - mechanical function relations in mineralized tissues (bones and teeth) using Optical Metrology.
Collaboration with: Ron Shahar, Hebrew University of Jerusalem
- Archaeological science: revealing the microscopic archaeological record
Collaboration with: E. Boaretto,
- Biomineralization: mechanisms of mineral formation and growth in biology.
Collaboration with: L. Addadi, Leeor Kronick, Dan Oron

[Prof. Ada Yonath](#)

- Antibiotics targeting ribosomes
- Protein biosynthesis
- Ribosomal mechanisms
- Origin of life
- Next generation antibiotics

Faculty of Mathematics and Computer Science

Department of Computer Science and Applied Mathematics

Department Head: Prof. Ronen Basri

The principal interests of the department lie in the areas of computer science and applied mathematics. Research areas include (but are not limited to) algorithms, their design and analysis; biological applications, bioinformatics, system biology, biological modeling; computational complexity, probabilistic proof systems, hardness of approximation, circuit complexity, combinatorial games; computer vision, image processing; cryptography; differential equations; distributed and parallel computing; dynamical systems; fluid dynamics; logic of programs, specification methodologies; machine learning and mathematical statistics; numerical analysis; randomness and its relation to computation; robotics and motion control; visual perception and brain modeling.

The departmental computer facilities include multiple PCs, multiple unix servers, two Linux clusters with multiple nodes, and large data storage systems. In addition, the vision laboratories, robotics laboratories and computational biology laboratories have a combination of experimental equipment and large-scale computing clusters.

Research activities

[Prof. Achi Brandt](#)

- Multi-level computational methods, scientific computation.

[Prof. Irit Dinur](#)

- Probabilistically Checkable Proofs
- Hardness of Approximation

[Prof. Uriel Feige](#)

- Coping with NP-hard combinatorial optimization problems, algorithms, computational complexity, random walks, algorithmic game theory.

[Prof. Tamar Flash](#)

- Robotics, motor control and learning, movement disorders, computational neuroscience, virtual reality.

[Prof. Aviezri S. Fraenkel](#)

- Complementary sequences of integers, Fraenkel conjecture
Collaboration with: David Klein, Jamie Simpson

- Combinatorial game theory
Collaboration with: Urban Larsson, Lior Goldberg, Haiyan Li, Sanyang Liu, Wen An Liu , Udi Peled, Vladimir Gurvich, Clark Kimberling, Nhan B. Ho, Eric Duchene
- Numeration systems and theory of partitions
Collaboration with: George Andrews, James Sellers
- Judaic studies

[Prof. Oded Goldreich](#)

- Randomness and Computation
 - Property Testing
 - Probabilistic proof systems
 - Pseudorandomness
- Foundations of Cryptography
- Complexity theory

[Prof. Shafira Goldwasser](#)

- Probabilistic proofs, cryptography, computational number theory, complexity theory.

[Prof. David Harel](#)

- Software and systems engineering, visual languages, biological modeling, olfaction.

[Prof. Michal Irani](#)

- Computer Vision, Video information analysis and applications, Image Processing.

[Prof. Robert Krauthgamer](#)

- Design and analysis of algorithms, including massive data sets, data analysis, and combinatorial optimization
- Embeddings of finite metric spaces, high dimensional geometry

[Prof. Yaron Lipman](#)

- Geometric modeling, geometry processing, shape analysis, computer graphics, Discrete differential geometry

[Prof. Boaz Nadler](#)

- Mathematical Statistics, Statistical Machine Learning, Statistical Signal and Image Processing, Applied Mathematics

[Prof. Moni Naor](#)

- Concrete Complexity
- Distributed Computing
- Cryptography and Complexity

[Prof. David Peleg](#)

- Distributed algorithms
- Approximation algorithms
- Fault-tolerance

[Prof. Ran Raz](#)

- Complexity Theory: In particular: Boolean circuit complexity, arithmetic circuit complexity, communication complexity, probabilistically checkable proofs, quantum computation and communication, randomness and derandomization.

[Prof. Vered Rom-Kedar](#)

- Hamiltonian systems - theory and applications
Collaboration with: M. Radnovic, A. Rapoport, E. Shlizerman, D. Turaev
 - Near-integrable systems
 - The Boltzmann ergodic hypothesis and soft billiards.
 - Chaotic scattering.
 - Resonant surface waves.
 - Perturbed nonlinear Schrodinger equation.
- Mathematical models of the hematopoietic system and their medical implications
Collaboration with: R. Malka, E. Shochat.
- Chaotic mixing of fluid flows
Collaboration with: R. Aharon, H. Gildor

Prof. Adi Shamir

- Cryptography, cryptanalysis, electronic money, smartcard security, internet security, complexity theory, the design and analysis of algorithms.

[Dr. Ohad Shamir](#)

- Machine Learning, statistical learning, online learning, learning theory, optimization

[Prof. Ehud Shapiro](#)

- Laying the Biological, Computational and Architectural Foundations for Human Cell Lineage Discovery
Collaboration with: E. Shapiro, V. Adalsteinsson, H. Brodi, M. Minden, R. Halaban, C. Klein, M. Meyerson, C. Wu, T. Zukerman, R. Shalom

Prof. Edriss S. Titi

- Fluid Dynamics and geophysical flows
 - Navier-Stokes, Euler and related geophysical models
 - Turbulence theory
 - Polymeric flows and non-Newtonian complex fluid
- Nonlinear Partial Differential Equations and Dynamical Systems
 - Infinite-dimensional dynamical systems , Reduced dynamical systems, Numerical analysis of dissipative PDEs
 - Limit behavior of fast and slow dynamics

[Prof. Shimon Ullman](#)

- Vision, image understanding, brain theory, artificial intelligence.

Department of Mathematics

Department Head: Prof. Omri Sarig

The principal research interests of the department lie in the broadly understood areas of analysis, probability, algebra, and geometry.

Topics covered in **Analysis** include operator and matrix theory, spectral theory, linear and nonlinear ordinary and partial differential equations, functional and harmonic analysis, ergodic theory and dynamical systems, control theory in its various manifestations, optimization, game theory, approximation and complexity of functions, numerical analysis, singularity theory and robotics.

Research in **Probability** theory covers random walks and graphs, motion in random media, percolation, random matrices, Gaussian fields and other probabilistic models in mathematical physics.

Areas of **Geometric** research include the structure of finite and infinite dimensional spaces, analytic, real algebraic and semi-algebraic geometry, topology of foliations and complex vector fields.

The **Algebraic** direction includes some aspects of algebraic geometry, geometric group theory, Lie Theory, representation theory, quantum groups, number theory, automorphic forms, ring theory, statistics of Young diagrams, algebraic combinatorics and enveloping algebras, invariants and crystals.

For the research done at our sister department, the Department of Scomputer Science and Applied Mathematics, see [here](#).

Research activities

[Prof. Avraham Rami Aizenbud](#)

- Algebraic geometry: Algebraic groups, Singularity theory Geometric invariant theory
- Representation theory of real and p-adic groups: Harmonic analysis on Spherical varieties, Gelfand pairs, asymptotic representation theory
- Functional analysis: Distributions and generalized functions, Microlocal analysis, Topological vector spaces.

[Prof. Zvi Artstein](#)

- Decisions under uncertainty.
- Ordinary differential equations, singular perturbations, averaging, nonautonomous systems.
- Control and optimal control, singularly perturbed systems, variational analysis.

[Prof. Itai Benjamini](#)

- Probability and geometry.

[Prof. Vladimir Berkovich](#)

- Non-Archimedean analytic geometry.
- Algebraic geometry.
- Number theory.

[Prof. Harry Dym](#)

- Classical analysis.
- Operator theory.
- Inverse problems.

Prof. Ehud Friedgut

- Combinatorics and discrete Fourier analysis.

[Prof. Stephen Gelbart](#)

- Complex and p-adic Automorphic forms and L-functions.

[Prof. Maria Gorelik](#)

- Representation theory and Lie superalgebras
Collaboration with: Dimitar Grantcharov, Victor Kac, Vera Serganova.

[Dr. Dmitry Gourevitch](#)

- Invariant distributions
Collaboration with: Avraham Aizenbud, Eitan Sayag
- Representation theory of reductive groups over local fields
Collaboration with: Siddhartha Sahi, Avraham Aizenbud, Eitan Sayag,
 - Representations of real reductive groups
 - Representations of p-adic reductive groups
 - Non-commutative harmonic analysis on homogeneous spaces, or Relative representation theory
 - Degenerate Whittaker models and Fourier coefficients of automorphic forms
 - Multiplicities in induced representations, Gelfand pairs
 - Non-commutative harmonic analysis on spherical varieties

[Prof. Anthony Joseph](#)

- Lie algebras and enveloping algebras, quantum groups. Invariant theory.

[Prof. Yakar Kannai](#)

- Partial differential equations.
- Mathematical economics

[Prof. Victor Katsnelson](#)

- Operator theory
- Harmonic analysis.
- Classical analysis
- Analytic theory of differential equations.
- System representation theory of matrix functions.

[Prof. Boaz Klartag](#)

- Analysis
- Convex Geometry
- High-dimensional effects (i.e., when the dimension tends to infinity).

Prof. Gady Kozma

- Harmonic Analysis
- Probability

Prof. Erez Lapid

- Authomorphic forms, representation theory, trace formula

[Prof. Dmitry Novikov](#)

- Hilbert 16th problem
- Ordinary differential equations

[Prof. Amitai Regev](#)

- Non-commutative ring theory, Algebras satisfying polynomial identities
Collaboration with: Allan Berele, Doron Zeilberger
- Combinatorics: Symmetric functions, Permutation statistics

[Prof. Gideon Schechtman](#)

- Convex geometry
- Functional analysis and geometry of Banach spaces
- Probability

[Prof. Sergei Yakovenko](#)

- Analytic theory of ordinary differential equations.
- Singularity theory. Singular foliations, limit cycles, holonomy.

[Prof. Yosef Yomdin](#)

- High Order Data Representation, Nonlinear Model Approximation. Taylor Models, High-Order Numerical methods
- Semialgebraic Complexity of functions, Signals Acquisition via non-linear model approximation
- Analytic Theory of Differential Equations, Generalized Moments, Compositions
- Zeroes distribution in Families of Analytic Functions
- Model-based image analysis, representation, compression. Model-based search, capturing, and animation

[Prof. Ofer Zeitouni](#)

- Motion in random media
- Random matrices
- Applications in nonlinear filtering, Communication and Information theory
- Logarithmically correlated random fields

Faculty of Physics

Department of Condensed Matter Physics

Department Head: Prof. Eli Zeldov

The scientific activity of the department is mainly concentrated around the experimental and theoretical research in quantum solid state physics. It includes experimental research of mesoscopic physics, quantum Hall physics, topological states of matter, high temperature superconductors, two and one dimensional superconductors, metal-insulator transition, carbon nanotubes, semiconductor nanowires, and study of material growth. The theoretical efforts concentrate on similar subjects with added work on disordered materials, cold atoms, and quantum optics.

The Braun Center for sub micron research is an integral part of the department. It is a modern and well equipped center, with growth (three MBE's) and characterization systems, which allows to conduct experiments on sub micron semiconductor structures under high magnetic fields, conventional and high temperature superconductors, and nanowires made of carbon nanotubes and semiconductor nanowires.

Research activities

[Dr. Haim Beidenkopf](#)

- Topological phases of matter:
Collaboration with: Claudia Felser, Max Planck Institute, Dresden, Germany Joseph Checkelsky, MIT, USA
 - Topological insulators
 - Weak topological insulators
 - Topological superconductors
 - Crystalline topological Insulators
 - Helical nanowires
 - Scanning tunneling microscopy
- Semiconducting nanowires
Collaboration with: Hadas Shtrikman, WIS
 - topological superconductivity
 - Majorana modes
 - low-dimensional systems
- topological nanowires
 - Nanowires grown of topological materials
 - molecular beam epitaxy (MBE)

Prof. Alexander Finkelstein

- Effects of the electron-electron interaction in low dimensional and disordered systems.

- Metal-insulator transition in 2D conductors.
- Magnetic fluctuations in high - T_c superconductors.

Prof. Yuval Gefen

- Low-dimensional interacting systems out of equilibrium.
- Interferometry and dephasing with electronic and anyonic systems.
- Weak measurement, weak values and foundations of quantum mechanics.
- Exotic excitations in the fractional quantum Hall effect and Topological Insulators.
- Edge reconstruction and edge channels in the fractional quantum Hall effect and Topological Insulators.

[Prof. Moty Heiblum](#)

- Interference and dephasing of electrons
Collaboration with: students/postdocs, D. Mahalu, V. Umansky
 - Phase measurements via a double path interferometer
 - controlled dephasing
 - Interferometers functioning in a high magnetic field, Mach-Zehnder Interferometer
- Fractional charges and their fractional statistics
Collaboration with: students/postdocs, D. Mahalu, V. Umansky
 - Charge and statistics of quasiparticles
 - Bunching of quasiparticles
 - quasiparticles and their behavior
 - shot noise measurements
- Neutral mode transport
Collaboration with: students/postdocs, D. Mahalu, V. Umansky
 - downstream and upstream neutral modes
 - hole conjugate states
 - even denominator states
- nanowires
Collaboration with: andrey kritinin, anindya das, hadas shtrikman
 - InAs wires
 - ballistic transport
 - incorporation with superconductors

[Prof. Shahal Ilani](#)

- Carbon nanoelectronics
- Interacting electrons in one dimension
- Quantum nano-electron-mechanics
- Imaging of quantum materials using nanotube scanning single electron transistor
- Hybrid 1D-2D carbon systems

Prof. Yoseph Imry

- Mesoscopic physics: persistent currents, classical and quantum fluctuations, quantum interference effects on transport, decoherence.

Collaboration with: see below.

- Effects of interaction on localization and on single-electron resonances. Many-electron effects and phase-shifts. Dephasing of Quantum interference in mesoscopics. Quantum noise and its detection. Effects of quantum fluctuations on nanosuperconductors.

Collaboration with: Y. Levinson, A. Aharony and E. Entin-Wohlman (TAU and BGU), Y. Ovadyahu and A. Schiller (HU), P. Silvestrov (Leiden), M. Schechter and P. Stamp (UBC).

[Prof. Shimon Levit](#)

- Full vector path integrals for light propagation in dielectrics.
- Interaction of Squeezed Light with Atoms and Semiconductor Nanostructures
- Non classical light.
- Resonant scattering off photonic slabs

[Prof. Yuval Oreg](#)

- Topological Quantum Materials
 - Superconducting and fractional topological phases theory and applications to quantum topological computers
 - Majorana fermions in superconducting wires and topological superconductors
 - Quantum dots and the Kondo effect and the multi channel Kondo effect
 - Disorder superconductors and normal metal super-conducting junctions
 - Glassy systems
 - Luttinger liquids in one-dimensional systems such as: carbon nano tube, edges of a quantum hall systems, edges of two dimensional topological insulator

[Prof. Dan Shahar](#)

- Physics of electron's spin
- Quantum phase transitions: General transport studies and mesoscopics of the metal-insulator, superconductor-insulator and other transitions.
- Scanning tunneling experiments at ultra-low temperatures
- Fractional and integer quantum Hall effect and related phenomena.
- Experiments on materials at ultra low-temperatures.

Prof. Adi Stern

- Quantum interference phenomena in the fractional Quantum Hall effect. Electronic

transport in strong magnetic fields.

- Non-abelian electronic states - quantum Hall states, topological superconductors and Majorana fermions.
- Fractionalized topological phases - how to construct them, how to measure them, and how to use them for topological quantum computation
- Low density two dimensional electronic systems.
- One dimensional electronic systems - electronic transport in the presence of interactions.

[Dr. Binghai Yan](#)

- Topological Materials
 - Topological Insulators
 - Dirac and Weyl Semimetals
 - New topological states of matter
- Transport and optical response in topological systems
 - Spin Hall effect and anomalous Hall effect
 - Magneto-transport
 - Nonlinear optical response
- 2D Materials for electronic, spintronic and optical properties

[Prof. Eli Zeldov](#)

- Scanning nanoSQUID magnetic microscopy
- Scanning nanoscale thermal microscopy
- Imaging of dissipation mechanisms in quantum systems
- Magnetism and dissipation in graphene
- Quantum anomalous Hall effect
- Magnetic phenomena in topological insulators
- Magnetism at oxide interfaces
- Superconductivity
- Vortex matter and dynamics

Department of Particle Physics and Astrophysics

Department Head: Prof. Yosef Nir

The Department of Particle Physics and Astrophysics is engaged in both experimental and theoretical research, in various directions. These include elementary particle physics, field theory, string theory, theoretical astrophysics, observational astrophysics, particle astrophysics, relativistic heavy ion physics, molecular physics, nuclear physics, plasma physics, and radiation detection physics.

Research activities

[Prof. Ofer Aharony](#)

- Weakly coupled versions of the AdS/CFT correspondence and possible derivations
Collaboration with: S. Minwalla, G. Gur-Ari, R. Yacoby
- General properties of field theories with quenched disorder
Collaboration with: Z. Komargodski, S. Yankielowicz, V. Narovlansky
- Dualities between field theories in various dimensions
Collaboration with: G. Gur-Ari, S. Minwalla, S. Razamat, N. Seiberg, B. Willett, R. Yacoby, A. Feldman, S. Jain
- Conformal bootstrap at large N and quantum gravity
Collaboration with: F. Alday, A. Bissi, E. Perlmutter

Prof. Tal Alexander

- Circum-nuclear accretion disks
- The growth of black holes in the early universe
- Gravitational wave sources
- Massive black holes
- Dynamic of galactic nuclei
- Stellar phenomena in the center of the Milky Way

[Prof. Micha Berkooz](#)

- Theoretical high energy physics
 - String theory, Field theory, Gravity
 - Particle Phenomenology
 - Conformal field theory applications in condensed matter systems
 - Quantum information and black holes

[Dr. Kfir Blum](#)

- Theoretical particle physics
- Particle cosmology
- High-energy astrophysics

[Prof. Amos Breskin](#)

- Noble-liquid neutron and gamma radiography concepts for detection of concealed explosives and nuclear materials (Homeland security)
- Photon imaging detectors
- Noble-liquid detector concepts for Dark-matter searches, neutrino physics and medical diagnostics

- Advanced gas-avalanche electron multipliers
- Particle tracking detectors for future particle and astroparticle experiments
- Methods of Nano-dosimetry for precise evaluation of radiation effects at the DNA level
- Methods for rapid evaluation of core fluids content in oil and gas wells

[Dr. Shikma Bressler](#)

- ATLAS experiment
 - Data analysis - Searches for physics beyond the standard model
 - Lepton flavour violating decays of the Higgs and Z bosons
 - Asymmetry in electron/muon final states
 - Generic data driven searches
 - Instrumentation - Upgrade of the ATLAS muon spectrometer
 - Production and testing of the sTGC chambers
 - Performance studies
 - Installation in the ATLAS cavern
- Detector physics

Collaboration with: RD51 collaboration

 - Basic R&D
 - The role of resistive materials in gaseous detectors
 - Charge and light amplification in Liquid Argon
 - Applicative R&D
 - Physics applications - future calorimeters in accelerators and neutrino physics experiments
 - Civil applications - muon tomography for hazardous material detection, volcanology, medicine and more

[Dr. Ran Budnik](#)

- Other:
 - Future concepts for Cosmic Ray precision detection
- Dark Matter detection:
 - The XENON Dark Matter project: Data analysis, physics interpretations, development and construction of the future detector XENON1T
- Detector physics:
 - Novel effects in LXe detectors
 - Future concepts and technologies for rare event detection

Prof. Ehud Duchovni

- Hardware: the construction of sTGC (stripped Thin Gap Chambers) for the ATLAS new small wheel
- Search for "Physics Beyond the Standard Model" by studying super energetic

events with large number of jets

- Search for micro black holes
- Search for RPV SUSY
- Search for RPC SUSY
- Search for very heavy resonance decaying into jets

[Prof. Yitzhak Frishman](#)

- Confinement and screening.
Collaboration with: Jacob Sonnenschein
- Non-abelian gauge theories.
Collaboration with: Marek Karliner, Jacob Sonnenschein
- From current to constituent quarks.
Collaboration with: Marek Karliner

[Prof. Avishay Gal-Yam](#)

- Cosmic explosions
 - Core-collapse supernova explosions: their origins, nature, physics and population statistics
 - Thermonuclear supernova explosions (SNe Ia): their nature and rates
 - Gamma-Ray Bursts: their origin and relation to supernovae
 - New types of cosmic explosions

[Prof. Doron Gepner](#)

- Rational conformal field theory and solvable lattice models.

[Prof. Eilam Gross](#)

- Higgs Physics with the ATLAS detector at the LHC
Collaboration with: Students: Michael Pitt and Jonathan Shlomi
 - Search for Charged Higgs Boson
 - Search for Higgs Decay to Charm Quarks
 - Charm Tag
 - Striations in High Energy Physics

[Prof. Shmuel Gurvitz](#)

- Multi-dimensional tunnelling.
Collaboration with: Xin-Qi Li, D. Sokolovski
 - Two-potential approach to tunneling problems
 - Cluster decay
 - Modified tunneling Hamiltonian
 - Tunneling of the Bose-Einstein Condensate

- Time-dependent quantum transport in mesoscopic system.
Collaboration with: A. Aharony, O. Entin-Wohlman, Xin-Qi Li, Wei-Min Zhang
- Number and energy resolved master equations for quantum transport
- Relaxation and dephasing in persistent current
- Zeno effect and quantum description of classical apparatus

[Prof. Haim Harari](#)

- Neutrino Physics (Particle Physics, cosmology, astrophysics implications)
- Patterns of quarks and leptons (masses, mixing, substructure)

[Prof. Uri Karshon](#)

- Heavy quark production at the HERA e-p collider.
- Gluon density in the proton and partonic structure of the photon.
- Tests of QCD dynamics in high energy e-p collisions.

[Dr. Boaz Katz](#)

- Open questions in theoretical astrophysics including:
 - How do stars explode to produce supernovae? (I think there is an actual chance to finally answer this soon due to accumulating data and new ideas!)
 - The three body problem (surprisingly connected to supernovae)
 - Where do Cosmic Rays come from and how are they accelerated?

[Prof. Michael W. Kirson](#)

- Theory and systematics of nuclear structure.
- The shell model and interacting boson model for nuclei.

[Prof. Zohar Komargodski](#)

- Particle Physics and Quantum Field Theory

[Dr. Doron Kushnir](#)

- Problems within the field of high-energy astrophysics and gravitational waves astronomy. Especially supporting the ideas that:
 - Supernova explosions of type Ia are due to direct collisions of white dwarf stars.
 - Core-collapse supernovae are thermonuclear explosions.

[Prof. Yitzhak Maron](#)

- Study of High-Energy-Density Plasmas:
 - Experimental platform: Z-pinch systems, with and without externally applied magnetic fields

- Development of non-invasive spectroscopic diagnostic methods (from visible to x-rays) for matter under extreme conditions.
- Design and build up of fast (ns) and ultra-fast (sub ns) spectroscopic systems.
- Study of Instabilities and turbulence phenomena.
- Radiation transport in non-equilibrium plasmas.
- Conversion of electric and magnetic-field energy into particle kinetic energy and radiation.
- Close collaboration with Universities and National laboratories in the US (Cornell, Sandia National Laboratory, National Ignition Facility, and Naval Research Labs).
- High-Power-Laser matter interaction:
 - Warm dense matter (solid-state density with temperatures of the order of the Fermi energy) formed by intense laser-matter interaction.
 - Intense-laser-beam guiding by plasma channels.
 - Experiments are performed in major European facilities: Jena University and HZDR - Drezden (Germany), École polytechnique - LULI (France).

[Prof. Giora Mikenberg](#)

- Trigger and data acquisition for LHC experiments.
Collaboration with: E. Duchovni, E. Gross, L. Levinson, D. Lellouch
- Search for Higgs bosons and SUSY particles at LHC.
Collaboration with: E. Duchovni, E. Gross, L. Levinson, D. Lellouch
- Search for Supersymmetry at LEP.
Collaboration with: E. Duchovni, E. Gross, L. Levinson, D. Lellouch
- Detector development and study of physics for LHC.
Collaboration with: E. Duchovni, E. Gross, L. Levinson, D. Lellouch
- Search for the standard-model and SUSY Higgs-bosons at LEP.
Collaboration with: E. Duchovni, E. Gross, L. Levinson, D. Lellouch
- Reconfigurable computing.
Collaboration with: E. Duchovni, E. Gross, L. Levinson, D. Lellouch

[Prof. Mordehai Milgrom](#)

- Departure from Newtonian dynamics as an explanation of the dark-matter problem in galactic systems.
- High energy astrophysics: x-ray sources, gamma-ray sources.
- Black holes at the centers of galaxies

[Prof. Alexander Milov](#)

- Detector upgrades for ATLAS and PHENIX
- Collective dynamics.
- Heavy boson production and boson-jet correlations

- Global event characterization
- Analysis of the Heavy Ion data from the ATLAS experiment at the LHC

[Prof. Yosef Nir](#)

- Particle cosmology (dark matter, leptogenesis, baryogenesis)
- Higgs physics
- Flavor physics
- CP violation
- Neutrino physics

[Prof. Eran Oded Ofek](#)

- Gravitational lensing and microlensing
- Astronomical algorithms and high contrast imaging.
- Design and construction of W-FAST - Two telescopes system to explore the visible-light sky on sub-second time scales and search for Oort cloud objects.
- Transients and supernovae; shock breakout observations and measuring the properties of supernova progenitors; Eruptions prior to supernova explosions and interaction between the supernova ejecta and its circumstellar matter; Design of the ULTRASAT UV space telescope.
- Search for isolated black holes in the Galaxy via astrometric microlensing.

[Prof. Gilad Perez](#)

- What gives masses to the particles? We believe that it is related to electroweak symmetry breaking which raises the hierarchy problem, the huge gap between the weak and Planck scales. The LHC experiments is addressing some of these questions and at the same time rising new ones. Recent cosmological-observation raised additional puzzles: What is the source of dark matter and energy? We explore experimental and theoretical methods to improve our knowledge regarding these issues. We also propose to use optical atomic clock spectroscopy to Search for Higgs-mediated interactions in atoms at table top experiments
 - Interpreting a 750 GeV Diphoton Resonance, By Rick S. Gupta, Sebastian Jager, Yevgeny Kats, Gilad Perez, Emmanuel Stamou. arXiv:1512.05332 [hep-ph].
 - Is the Higgs Mechanism of Fermion Mass Generation a Fact? A Yukawa-less First-Two-Generation Model, By Diptimoy Ghosh, Rick Sandeepan Gupta, Gilad Perez. arXiv:1508.01501 [hep-ph].
 - A Universe without weak interactions, By Roni Harnik, Graham D. Kribs, Gilad Perez. hep-ph/0604027. Phys.Rev. D74 (2006) 035006.

[Prof. Igal Talmi](#)

- Theory of nuclear structure

Collaboration with: Shalom Shlomo, Texas A & M University

[Prof. Itzhak Tserruya](#)

- Electron pair production in relativistic heavy ion collisions: search for quark-gluon plasma and chiral symmetry restoration.
Collaboration with: I. Ravinovich
- R&D, construction and installation of an HBD (Hadron Blind Detector) for the PHENIX experiment at RHIC.
Collaboration with: I. Ravinovich
- Study of ultra-relativistic heavy-ion collisions using the PHENIX detector at RHIC (Relativistic Heavy Ion Collider) at Brookhaven National Laboratory and the CERES detector at CERN
Collaboration with: I. Ravinovich

[Prof. Vladimir Usov](#)

- Physical processes in relativistic electron-positron plasma.
Collaboration with: G.Z. Machabeli
- The theory of nonthermal radiation from compact astronomical objects (pulsars, white dwarfs, gamma-ray bursters etc.).
Collaboration with: A.K. Harding, D.B. Melrose, M. Milgrom, A.G. Muslimov, A.E. Shabad
- Physical processes in very strong magnetic fields.
Collaboration with: A.E. Shabad
- Physical processes at the surface and astrophysical appearance of strange-quark-matter stars.
Collaboration with: K.S. Cheng, T. Harko, M. Milgrom, F.Weber
- Hydrodynamics and high-energy physics of colliding stellar winds in binary systems.
Collaboration with: N.N. Pilyugin

[Prof. Eli Waxman](#)

- Theoretical astrophysics
 - Neutrino and cosmic-ray astrophysics
 - Cosmic explosions (Fast radio bursts, Neutron star mergers, Gamma-ray bursts, Supernovae)
- The ULTRASAT UV satellite project
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[Prof. Daniel Zajfman](#)

- Atomic and Molecular Physics
Collaboration with: Oded Heber

- Ion trapping, storage rings, photodissociation, photodetachment, cluster physics.

Department of Physics of Complex Systems

Department Head: Prof. Elisha Moses

The Department of Physics of Complex Systems has research programs in fundamental and applied physics. Research in optics and atomic physics includes nonlinear optics, ultra fast optics and high harmonic generation, quantum optics, slow light, discrete optics, nano optics and nonlinear microscopy, laser cooling and trapping of atoms and ions, studies of Bose Einstein condensation, precision spectroscopy and quantum information processing. Theoretical and experimental research in soft condensed matter is concentrated on equilibrium and non-equilibrium statistical physics, clustering of data, bioinformatics and systems biology, electrokinetics of ions and charged particles in low dielectric liquids, colloids, soft materials and complex fluids. Experimental and theoretical hydrodynamics concentrates on turbulence, spatio-temporal chaos, turbulent Rayleigh-Benard convection, liquids at interfaces, droplet impact, sedimentation and dynamics of single micro-objects, such as polymers, vesicles, capsules and hydrodynamics of their solutions. Turbulence theory is developed in general and in applications to cloud physics. Classical and quantum chaos, statistics of nodal lines in quantum systems and turbulence are studied theoretically. Mathematical and computational methods for archaeological research are developed. Theoretical physical biology deals with modeling living information systems, their molecular components and the way they evolve. Experimental bio-physics deals with bio-molecules, neural cultures, neurophysics, physics of the brain, physics of bio-systems and decision making in ant colonies.

Research activities

[Prof. Nir Davidson](#)

- Ultracold atoms
- Quantum degenerated atomic gases
- Quantum nonlinear dynamics and chaos
- Laser physics
- Slow and stored light
- Atomic optics and interferometry

[Prof. Eytan Domany](#)

- Computational Physics: equilibrium and non-equilibrium statistical mechanics of spin glasses
Collaboration with: A. P. Young (UCSC)
- Development of tools and algorithms for large scale data analysis. Bioinformatics.

- Analysis of high-throughput biological data (in particular, gene expression data)
Collaboration with: Several research groups at Weizmann, in the USA and in Europe; see below.
 - Controlled experiments on cell lines and mice (with D. Givol, V. Rotter, Y. Groner, L. Sachs; D. Gazit (Hadassa))
 - Development of antigen chips, applications for autoimmune diseases (with I. Cohen)
 - Studies human cancer samples; leukemia (with E. Canaani; G. Rechavi S. Izraeli (Sheba))
 - Colorectal cancer; (with D. Notterman (UMDNJ), F. Barany (Cornell), P. Paty (MSK), A. Levine (Princeton))
 - Prostate cancer; (with Z. Eshhar, A. Orr (TA Sourasky));
 - Glioblastoma; (with M. Hegi, R. Stupp (CHUV))
 - Breast and cervical cancer (with J-P Thiery, F. Radvanyi, X. Sastre, C. Rosty (Inst Curie))

[Prof. Nirit Dudovich](#)

- Attosecond Physics
- Strong field light matter interactions

[Prof. Gregory Falkovich](#)

- Nonlinear waves and wave turbulence.
- Theory of fluid turbulence. Fundamental aspects and applications.
Collaboration with: Anna Frishman, Princeton Vladimir Lebedev, Moscow
- Particles in random flows.
- Viscous Electronics
Collaboration with: Leonid Levitov, Boston

[Dr. Ofer Feinerman](#)

- Collective behavior of ants.
- Information sharing in cooperative groups.
- Collective decision making.

[Dr. Ofer Firstenberg](#)

- Quantum optics with interacting photons: photonic quantum gates and fluids of light.
- Coherent optical processes in hot and cold atoms.
- Atomic sensors.
- Quantum memories.

[Prof. Asher Friesem](#)

- Diffractive Optical Elements and Planar Optics.
- Photonic Devices.
- Novel Laser Configurations.

[Prof. Ulf Leonhardt](#)

- Forces of the quantum vacuum
- Analogues of the event horizon
- Geometry and light
- Invisibility cloaking and perfect imaging

[Prof. David Mukamel](#)

- RNA and DNA denaturation.
- Collective phenomena in systems far from thermal equilibrium.
- Coarsening processes and slow dynamics.
- Systems with long range interactions

[Prof. Dan Oron](#)

- sub-diffraction limited imaging
- Quantum dot enabled photovoltaics
- ultrafast dynamics of semiconductor quantum dots
- Optics of biogenic crystals

[Prof. Roei Ozeri](#)

- Quantum metrology and precision measurements
- Ultra-cold ions and atoms
- Quantum Computing
- Ultra-cold collisions and interactions

Prof. Adam Schwimmer

- String theory.
- Conformal field theory.
- Dynamics of gauge theory.

[Prof. Uzy Smilansky](#)

- Mathematical methods for Archaeological research.
- Semi-classical quantization.
- Chaotic scattering.

- Quantum chaos.

[Prof. Joel Stavans](#)

- Statistical Mechanics
- Single-Molecule Biological Physics.
 - RNA interference
 - Homologous recombination
- Genetic Networks and Systems Biology
 - Regulation of gene expression by small RNAs
 - Developmental decision making
 - Noise and adaptation

[Prof. Victor Steinberg](#)

- Physical hydrodynamics, hydrodynamics of complex fluids, dynamics of single flexible micro-objects (molecules, membranes, etc) in complex fluid flows
 - Hydrodynamics of polymer solutions, Elastic turbulence and Turbulent mixing by polymers.
 - Hydrodynamics and rheology of complex fluids (vesicle, capsule, worm-like micelle, etc suspensions)
 - Dynamics and conformation of single polymer molecule, vesicle, micro-capsule, etc in complex fluid flows.
 - Measurement of velocity and vorticity fields by sound scattering in a turbulent flow.
 - Convective turbulence in a fluid near the gas-liquid critical point.
 - Microfluidics: mixing, cell separation, random flows.
 - Development of non-invasive local sensors for measurements of stress field in fluid flow

Dean for Educational Activities

Department of Science Teaching

Department Head: Prof. Anat Yarden

The Department is composed of groups working in mathematics, physics, chemistry, computer science, earth and environmental sciences, life sciences, and science and technology for junior-high school. In all these areas there are extensive research and development projects, aimed at (1) studying science and mathematics learning and teaching and their development, (2) producing and implementing improved and up-to-date learning and teaching materials that integrate the use of modern technologies, and (3) providing professional development for teachers, all over Israel. Work is based on an underlying philosophy that considers curriculum development and implementation, teacher professional development, research and evaluation as an interrelated and continuous long-term activity. Research studies focus on cognitive, socio-cultural and affective aspects of learning, teaching and learning to teach science and mathematics, using various research methodologies: quantitative, qualitative and mixed methods.

The department operates four national centers for science teachers (physics, chemistry, biology and science and technology in junior high school) specializing in; the development of leadership among science teachers and in continuous professional development for science teachers using effective models. Another avenue promoted by the department for professional development of science teachers is carried out through the Rothschild-Weizmann Program for Excellence in Science Teaching, which provides science teachers unique opportunities to expand and update their knowledge in science and in science education. In addition, the department runs numerous Professional Learning Communities of science teachers all over Israel. Projects in the department are funded by the Israel Science Foundation (ISF), the German Israeli Foundation (GIF), the Trump Foundation and the Israeli Ministry of Education through the Amos de-Shalit Israeli Center for Science Teaching (MALAM). In addition, the department is involved in several EU projects aiming at enhancing science education both in the formal as well as in the informal level.

Research activities

Prof. Abraham Arcavi

- Research on cognitive characteristics of non academically oriented math students.
Collaboration with: Dr. Ronnie Karsenty
- Design of curriculum materials as a research based activity
Collaboration with: Dr. Sue Magidson
- Long-term design of a new curriculum for grades 10, 11 and 12 for non-academically oriented students.
Collaboration with: Dr. Nurit Hadas

[Prof. Michal Armoni](#)

- Teaching the foundations of computer science to young students
 - Theoretical foundations of computer science
 - Basic concepts in algorithm and program design
- Fundamental ideas in computer science: Identifying the core ideas of the discipline, examining their teaching and learning processes
 - Reductive thinking: Reduction as a tool for problem solving
 - Nondeterminism: a tool for abstraction
 - Reversing
 - Abstraction

[Prof. Mordechai Ben-Ari](#)

- Teaching and learning computer science
Collaboration with: Francesco Mondada, Ecole Polytechnique Federale de Lausanne
 - Educational robotics
 - Mathematical logic for computer science

[Prof. Ron Blonder](#)

- Nano scale science and technology education
- Self-efficacy of science teachers

[Prof. Ruhama Even](#)

- The professional education and development of mathematics teachers
 - Subject-matter Knowledge for Teaching Mathematics
 - Knowledge about Students for Teaching Mathematics
 - Educating Educators to Work with Practicing Secondary School Mathematics Teachers (MANOR)
 - ICMI Study on the Professional Education & Development of Teachers of Mathematics
- The interactions among math curriculum, teachers, and classrooms
 - Teaching the Same Probability Syllabus in Classes of Different Levels
 - Using The Same Algebra Textbook in Different Classes
 - Junior-high school math curriculum and implementation
- Mathematics education research and practice issues

Prof. Bat Sheva Eylon

- High school curriculum development
 - Translation and adaptation of selected units from the course "Visual Quantum Mechanics" developed by the Physics Education Research Group in Kansas State

University.

- Preparing texts and materials for elective units for physics majors (lasers, chaos). Using computerized networks (internet and intranet) for distance learning of these courses.
- Development of modules for student activities in Mechanics, Electricity and Magnetism and Optics.
- Development of modules for inquiry learning in the context of "mini-projects".
- Development of a new course on Light and Waves for 10th and 12th grades.
- Development of physics programs for the Arab population.
- Elaboration of the national physics syllabus and the matriculation examinations.
- Preparation of materials for e-learning in mechanics and electricity that can be used in various models that integrate in-class and distance learning of physics.
- Research, evaluation and planning
 - Collaboration with:** U. Ganiel
 - Research of problem-solving processes in high school physics.
 - Study of concept learning and misconceptions in high school physics.
 - Study of processes involved in integration of technology in physics learning.
 - Formative and summative evaluation of new courses.
 - Research and development of various strategies for integration of microcomputers in physics learning processes.
 - Investigation of learning processes and teaching methods in teacher training programs.
 - Study of long-term professional development of teachers and leader-teachers.
 - Application of microcomputers in physics teaching
 - Collaboration with:** U. Ganiel
 - Development of open environments for promoting physics reasoning and inquiry learning.
 - Developing custom made programs for specific learning activities within the physics curriculum.
 - Teacher development: National center for physics teachers
 - Collaboration with:** E. Bagno, U. Ganiel
 - In-service teacher training courses.
 - In-school projects for promoting the teaching of physics through the use of computers.
 - Long-term didactical courses introducing teachers to current research in physics education and its implications to the learning/teaching process.
 - Long-term frameworks for leader teachers: Three-year courses for basic training and forums for acting teacher-leaders.
 - Resource materials and frameworks for teacher development.
 - An annotated database of selected internet resources relevant to high school physics in Israel (in Hebrew).
 - One-day national conference and workshops for physics teachers in Israel.
 - A prize for outstanding teachers or teams of teachers (together with the physics

department and the Amos de-Shalit fund).

- Preparation of learning materials for 7-9 grade
 - Introduction to Science and Technology.
 - Vacuum and particles: The particulate model of matter.
 - About Fibers
 - Interactions, Forces and Motion
 - Scientific and Technological Communication.
 - Projects as Tools for Learning.
 - The Materials' Cycle in Earth's Crust.
 - The World of Water.
- Computerized Materials
 - Computerized courses and resources for the teaching the topics of "Energy - a Multidisciplinary View", "Nutrition and Health", "Nature as a Model for Imitation - The Bionic Man".
 - Computer simulations for studying units dealing with "Systems".
 - A Computerized environment for analyzing videotapes of motion.
 - Computer programs accompanying the study of Earth-Sciences in grades 7-9.
 - Computer program accompanying the study of the "cell" as a longitudinal strand (with the Center of Educational Technology).
 - "The Golden Way" - A Navigational Tool for Project Based Learning in Science and Technology (with the Association for the Advancement of Science Education in the Upper Galilee).
- In-service courses in science and technology for junior-high school teachers
Collaboration with: Z. Scherz, I. Hopfeld, N. Orion, O. Kedem, Y. Ben-Hur
 - Design and implementation of 3-year courses for teachers.
 - Preparation of leading science and technology educators.
 - Conducting regional long term activities in several regional teacher centers.
 - Conducting in-service teacher courses for the Arabic population.
 - A National Teacher Center for Junieur High School Teachers (in collaboration with Tel Aviv University).
- Research and Evaluation
Collaboration with: Z. Scherz, N. Orion, S. Rosenfeld, U. Ganiel
 - Research on teacher and teacher-leader development in science and technology.
 - Investigation of various instructional strategies for understanding central concepts in the science and technology syllabus for junior-high school, and development of learning and thinking skills.
 - Investigation of project based learning (PBL) focusing on learning styles and the integrated development of concepts and skills.
 - Investigation of longitudinal development of conceptual frameworks and learning capabilities.
 - Investigation of learning through the course "systematic inventive thinking".

[Prof. David Fortus](#)

- Enhancing Motivation to Learn Science
 - Policy Implementation
 - School Culture & Philosophy
 - Teaching Style
 - Curriculum
 - Assessment
 - Parents & Peers Influence
- IQWST - Investigating and Questioning our World through Science and Technology
Collaboration with: J. Krajcik - Michigan State University, B. Reiser - Northwestern University, L. Sutherland-Adams - Activate Learning
 - Coordinated curriculum materials
 - Scientific Practices
 - Literacy
 - Project-Based Science
 - Large-Scale Evaluation
 - Professional Development
- ELeVATE - Exploring Learning in Various Approaches to Teaching Energy
Collaboration with: J, Krajcik - Michigan State University, K. Neumann & J. Nordine - Leibniz Institute for Science and Mathematics Education (IPN), Germany
 - energy
 - curriculum
 - assessment
 - preparation for future learning (PFL)
 - NGSS

Prof. Avi Hofstein

- Research and evaluation
Collaboration with: R. Mamlok
 - Formative and summative of curriculum units that are developed by the chemistry group and the science for all students
 - Teachers' and students' perceptions and attitudes towards science and technology.
 - Non science oriented students' conception of key ideas and concept in chemistry
 - The development of modules for non-science oriented students
 - Analysis of learning difficulties and misconception in chemistry in the Israeli Bagrut
 - Development of argumentation skills in inquiry laboratories
 - Misconception regarding bonding and structure of molecules
 - Assessment of students' perception of the chemistry classroom and laboratory learning environment
- High school chemistry curriculum development and implementation
Collaboration with: Rachel mamlok-Naaman,
 - The development and implementation of text books and teachers' guide
 - Preparation of resources and units for the teaching of Industrial chemistry in

Israel.

- Development of new instructional techniques to teach chemistry in high schools.
- Inquiry type experiments and
- The use of internet for instruction.
- Development of CAI (computer Assisst Instruction)
- Development of introductory (basic) modules for a new syllabus in high school chemistry. (
- Development of modules for non-science oriented students in high schools

[Prof. Nir Orion](#)

- Earth and environmental sciences education: research, development and implemntation from K-12.
- The outdoor as a learning environment

[Prof. Anat Yarden](#)

- Promoting the use of authentic scientific texts in secondary schools
Collaboration with: Prof. Zohar Livnat, Bar-Ilan University
- Using bioinformatics tools and databases for learning biology and biotechnology in high schools
- Developing coherent understanding of molecular genetics and evolution
Collaboration with: Prof. Ravit Golan Duncan, Rutgers University
- Advancing biology teachers' professional development
Collaboration with: Dr. Irit Sadeh, Ministry of Education
- Collective reasoning around texts across disciplines towards deliberative democracy
Collaboration with: Prof. Baruch Schwarz, Hebrew University; Prof. Boris Koichu, WIS; Prof. Michal Tabach, Tel-Aviv University; Dr. Einat Heyd-Metzuyanim, Technion

[Prof. Edit Yerushalmi](#)

- Development implementation and evaluation of a 2-year interdisciplinary program for high school chemistry and physics students on
Collaboration with: A. Hofstein, S. Livne, Y. Roth, R. Blonder, A. Yarden, S. Safran, B. Eylon, B. Geiger
- Instructional strategies intended to develop reflective problem solving skills in high school physics students
Collaboration with: C. Singh, E. Cohen, E. Bagno, B. Eylon
 - Study of the effects of self-diagnosis tasks on learning from physics problem solving.
 - Development, implementation and evaluation of web-based test preparation modules aimed at organizing students' knowledge and developing awareness of common misconceptions (Mechanics, Electricity and Magnetism).

- Development, implementation and research of long-term professional development frameworks for physics high school teachers

Collaboration with: R. Safadi, E. Bagno, A. Rozen

- Workshops for Arab high school physics teachers intended to develop reflective problem solving skills in their students through alternative assessment activities. Workshop approach: Collaborative inquiry into students' self diagnostic activities.
- Models for collaborative action research workshops for high school physics teachers.
- Long-term didactical courses introducing pre-service teachers to current research in physics education and its implications to the learning/teaching process.
- University physics faculty perceptions of learning and teaching problem solving.

Collaboration with: C. Henderson, K. Heller, P. Heller, V. Quo, E. Cohen