RESEARCH THAT TRANSFORMS LIVES

EDUCATE - INNOVATE - TRANSCEND

2019

Annual publication, with data and information until December 2018.
It is true: melon seeds can protect your heart

Discover
TRANSFERENCIA TEC
The science communication website of Tec de Monterrey

transferencia.tec.mx/en
For Tecnológico de Monterrey research is a strategic activity; it is the engine that generates innovative solutions for the economic, social and environmental development of our country. We are committed to the idea that scientific and applied research should be used to add value to a society in a more rapid, measurable manner.

To make that possible the objective is to develop research focused on high impact themes through open, collaborative and interdisciplinary innovation linked with national and international industries, as source of knowledge and financing; to form research talent and give innovative solutions to relevant challenges to support competitively, technology based entrepreneurship, and community’s transformation to generate a knowledge economy.

Thanks to the structure and focus of research activities in three conjunctural processes: Knowledge generation; Creation and development of products and services; and the Development of incubation and acceleration based technology industries, the vice chancellor office of Research and Technology Transfer will define their further strategic actions.

These actions must be aligned to generate and transfer knowledge through: Competitive intelligence strategies, Attraction and management of research talent, and actions focused on increasing founding.

Therefore, the challenge is to enable a positive connection to bridge knowledge generation with value creation in order to address the most demanding problems humanity is facing: water, energy, environment, food security, global health, education, sustainable growth and poverty. Scientific and applied research should transform society. Open research and innovation models are key to address these challenges with a sense of community, collective knowledge and capacity to act.

Tecnológico de Monterrey has decided to focus this scientific activity on eight main strategic research areas, encouraging innovation, knowledge generation and knowledge transfer, with the goal of trying to solve México’s and worldwide problems. These eight strategic areas include: biotechnology and food; mechatronics and engineering; information technology; sustainability; public policy and social sciences; business; medicine; and humanities and education.

This report gives an overview of Tecnológico de Monterrey’s scientific and technological activity, offering facts and figures on the impact achieved by our research faculty’s work. A general summary of the research and innovation results from 2012 to 2016 is presented, reviewing graduate programs, research areas, international collaboration networks, industrial agreements, patent application results and the institution’s standing in the major world university rankings.

These areas are aligned to the eight strategic areas. The scientific work will start, then, from a strategic area that will take concrete form in a discipline and, more precisely, around a theme, where a group of researchers, professors and graduate students meets to generate and transfer new knowledge. To fulfill the scientific objectives, we have created 39 strategic groups that sustain the academic and research activities of the six national schools programs: 1) Engineering and Sciences; 2) Business; 3) Social Sciences and Government; 4) Humanities and Education; 5) Medicine and Health Sciences and 6) Architecture and Design.

Research at Tecnológico de Monterrey fosters the learning process of our students, underpins the intellectual activities of our professors, and generates knowledge and innovative solutions that address society’s demands.

Arturo Molina, PhD
Vice Rector for Research, and Technology Transfer
## Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>Tecnológico de Monterrey</td>
<td>5</td>
</tr>
<tr>
<td>Facts &amp; Figures</td>
<td>8</td>
</tr>
<tr>
<td>Research Strategy</td>
<td>19</td>
</tr>
<tr>
<td>International Collaboration</td>
<td>48</td>
</tr>
<tr>
<td>MIT-Tecnológico de Monterrey</td>
<td>49</td>
</tr>
<tr>
<td>Research Agreement</td>
<td></td>
</tr>
<tr>
<td>Strategic Initiatives</td>
<td>51</td>
</tr>
<tr>
<td>Industrial Partnership</td>
<td>63</td>
</tr>
<tr>
<td>Education Impact</td>
<td>67</td>
</tr>
<tr>
<td>Scientific Impact</td>
<td>72</td>
</tr>
<tr>
<td>Economic Impact</td>
<td>75</td>
</tr>
<tr>
<td>Projects That Transform Mexico</td>
<td>80</td>
</tr>
<tr>
<td>Rankings</td>
<td>83</td>
</tr>
</tbody>
</table>
Find out about the trends that are shaping the future of education and learning.

**EduNews**
The most relevant news and articles in the world of education.

**EduBits**
Pedagogical experiences and good teaching practices. From teachers, to teachers.

**EduTrends**
In-depth analysis of the educational trends and experiences with the greatest potential to impact education.

**Webinars**
Virtual space to interact with an educational innovation expert.

**EduMedia**
Interviews with experts, analysis of trends, cases and good practices, teaching strategies, and much more.

Over +120,000 people get our weekly newsletter filled with curated content. Subscribe to receive in your inbox the latest stories on education, innovation and EdTech.
Eugenio Garza Sada (1892-1973) was born into a business family, the son of the man who founded the Cuauhtémoc Brewery in Monterrey in 1890. His experience at MIT was the basis for the organization of Tecnológico de Monterrey, which he established along with a group of Monterrey businessmen.

With a prophetic vision, Garza Sada devoted considerable effort to the expansion of the city of Monterrey. He was a tireless defender of private and free enterprise. His leadership in Monterrey was very clear and fruitful, both in the field of business, and in education and social welfare. Both, a successful businessman and an active promoter of community development, Eugenio Garza Sada consistently acted with great simplicity and humanity, focused on the progress of those around him, without distinction. The significance of this great man, industrialist and humanitarian, is undeniable and imperishable.

• Privately funded in 1943, non-profit, independent.

• Through educational experiences we form people who become agents of change willing to be even more competitive in order to benefit all, with a clear focus on being instead of having, on serving others instead of possessing things; people who are responsible for their own lives, aware of the fact that their actions may promote the transformation of others.
Tecnológico de Monterrey – MÉXICO

26 Campuses
26 Cities
6 Multi-campus National Schools

Research that transforms lives
F A C T S & F I G U R E S  2 0 1 8

**Professors**

9,916

**Students**

91,200

**Alumni**

317,435

57% of graduate students had an international experience

- **Out bound**
  - 11,911

- **In Bound**
  - 5,116

- **undergraduate**
  - 246,324

- **graduate**
  - 71,111

Research that transforms lives
Alumni Associations Worldwide

317,435 alumni distributed in:

- Arizona
- Austin
- Australia
- Boston
- Calgary
- California
- Chicago
- China
- Colombia
- Connecticut
- Dominican Republic
- El Salvador
- Florida
- France
- Germany
- Guatemala
- Houston
- Ireland
- Mexico
- Michigan
- Montreal
- New York
- New Jersey
- Ontario
- Panama
- Peru
- Quebec
- San Antonio, Texas
- San Francisco Bay Area
- Scandinavia
- Seattle
- Spain
- Tijuana-San Diego
- Vancouver
- Washington DC
- Others...
Research that transforms lives

RESEARCH FACTS & FIGURES 2018

PEOPLE

709
RESEARCH Faculty

6,984
GRADUATE STUDENTS

Postdocs

90

PHD STUDENTS

5,519
Undergraduate students participating in research projects

Research professors in National Researches System (SNI)

570
**RESEARCH FACTS & FIGURES 2014–2018**

**PUBLICATIONS**

**4,442**

**18,821**

**Citations**

**Citations per publication**

**4.2**

**International Collaboration**

Publications co-authored with institutions in other countries.

**46.4%**

(Average in Mexico is 39.2%)

**Publications in top 10% journals by SNIP**

(Source Normalized Impact per Paper)

**24.4%**

(Average in Mexico is 12.5%)

**Academic-Corporate Collaboration**

Publications with both academic and corporate affiliations.

**1.4%**

(Average in Mexico is 8%)
# PATENTING FACTS & FIGURES 2010–2018

<table>
<thead>
<tr>
<th>Region</th>
<th>Filed</th>
<th>Granted</th>
</tr>
</thead>
<tbody>
<tr>
<td>America</td>
<td>293</td>
<td>164</td>
</tr>
<tr>
<td>Europe</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Asia</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>PCT</td>
<td>33</td>
<td>0</td>
</tr>
<tr>
<td>Oceania</td>
<td>0</td>
<td>2</td>
</tr>
</tbody>
</table>

Total Filed: 336
Total Granted: 172
ENTREPRENEURSHIP 2018

1,950 Companies being incubated in the entrepreneurial ecosystem

68 Incubators in the incubator network
24 basic
8 high impact
36 small companies

956 small companies
4,222 graduated companies since 2002

11 technology parks
279 companies in technology parks
Through educational experiences we form people who become agents of change willing to be even more competitive in order to benefit all, with a clear focus on being instead of having, on serving others instead of possessing things; people who are responsible for their own lives, aware of the fact that their actions may promote the transformation of others.

**ENTREPRENEURIAL FORMATION**

The Entrepreneurship program led to the establishment of several support projects, including business incubators and accelerators, which continue the Tecnológico de Monterrey community’s entrepreneurial spirit.

**NETWORKS:**
Business incubator network, Business accelerator network, E+E connections network, Technological park network.

**NETWORK OF CENTERS FOR ENTREPRENEURIAL FAMILIES**

- Support the creation, development, growth, solidification, and continuity of family companies.
- Improve the competitiveness and long-term presence of the family company in Mexico.
- Bolster regional economic development through entrepreneurial families.
RESEARCH PROJECTS
FUNDED BY PUBLIC AND PRIVATE OFFICES

2014-2018
139

2014
3

2015
15

2016
30

2017
37

2018
55

Research that transforms lives
RESEARCH EXPENDITURE

TOTAL » $3,453

2010: 390 Million MXN
2011: 486 Million MXN
2012: 472 Million MXN
2013: 472 Million MXN
2014: 508 Million MXN
2015: 570 Million MXN
2016: 673 Million MXN

Research that transforms lives
RESEARCH PRODUCTIVITY: PUBLICATIONS

TOTAL 2014 – 2018: 4,442

GOAL 2020: 10,000

*Scopus
TECNOLÓGICO DE MONTERREY

RESEARCH AREAS WITH STRATEGIC FOCUS

- Biotechnology
- Mechatronics and Engineering
- Information Technologies, Electronics and Communications
- Health
- Humanities and Education
- Business
- Sustainable Development
- Public Policy and Social Sciences
- Architecture, Art and Design
RESEARCH GROUPS WITH STRATEGIC FOCUS

Biotechnology
• Bioengineering, Biosystems and Synthetic Biology
• Biomedical Engineering
• Nutrinomics
• Emerging Technologies and Molecular Nutrition

Health
• Bioengineering and Regenerative Medicine
• Bioinformatics for Clinical Diagnosis
• Metabolic Diseases
• Cancer Research
• Human Genetics
• Cardiovascular and Metabolomic Medicine
• Innovative Therapies in Visual Sciences

Architecture, Art and Design
• Sustainable Territorial Development

Humanities and Education
• Educational Research and Innovation
• Industries and Cultural Heritage: Analysis and Trends
• Ethics and Peace Studies
• Science, Technology and Society

Business
• Business Analytics
• Consumer Behavior and Value Creation
• Entrepreneurship and Leadership
• Organizational Strategy and Management in Emerging Economies
• Finance and Macroeconomics
• Social Innovation
• Retail

Public Policy and Social Sciences
• Democracy, Institutions, Security and Justice
• Regional Development, Energy and Public Economics
• Social Policy and Public Entrepreneurship
• Global Issues
• Knowledge Societies
• Social Transformation and Sustainability

Information Technologies, Electronics and Communications
• Photonics and Quantum Systems
• Machine Learning
• Intelligent Systems
• Telecommunications for the Digital Transformation

Mechatronics and Engineering
• Nano Sensors and Devices
• Robotics
• Advanced Manufacturing
• Optimization and Data Science
• Nanotechnology for Device Design
• Product Innovation
• Nanomaterials
• Automotive Consortium for Cyberphysical Systems

Sustainable Development
• Water Science and Technology
• Energy and Climate Change

Tecnológico de Monterrey
Research that transforms lives
Bioengineering, Biosystems and Synthetic Biology

Our group focuses on the development of technology platforms based on bioprocesses and synthetic biology that generate new applications, new products and new production systems.

**Leader:** José Guillermo González  - jose.gonzalez@tec.mx

- **145** Publications in Scopus
- **1** Book
- **2** Granted patents
- **10** Advised thesis
- **4** Filed patents

Biomedical Engineering

The mission of the group is to generate knowledge, new applications, and developments in the area of Pharmaceutical Biotechnology and Biomedicine by combining biological and engineering concepts.

**Leader:** Mario Moisés Álvarez  - mario.alvarez@tec.mx

- Biopharmaceutical biotechnology
- Micro and nanotechnologies
- Tissue Engineering
- Engineered biomaterials
Emerging Technologies and Molecular Nutrition

Through the convergence of different disciplines (Food Engineering, Biotechnology, Chemistry of Materials, Genomics, Microbiology and Nanotechnology) this group promotes emerging and innovative technologies in order to develop and consolidate its research.

Leader: Jorge Welti Chanes - jwelti@tec.mx

- 109 publications in Scopus
- 3 filed patents
- 5 granted patents
- 12 advised thesis

NutriOmics

This group performs cutting-edge research in nutrigenomics in order to identify phytochemicals preferably associated with Mexican native plants and foods that have the potential to prevent and treat cancer and chronic degenerative diseases.

Leader: Sergio Serna Saldivar - sserna@tec.mx

- 65 Publications in Scopus
- 5 Granted patents
- 5 Filed patents
- 18 Graduated students
- 11 Advised thesis
- 4 Research lines
Automotive Consortium for Cyberphysical System

This group focuses on the development of modern transportation systems, particularly associated with the automotive industry. The research topics of this group are: virtual prototyping, the use of new light materials and multimaterial components, the development of powertrains equipped with electric motors; the integration of structures and modular systems for vehicle design.

**Leader:** Horacio Ahuett Garza - horacio.ahuett@tec.mx

- 17 Publications in Scopus
- 3 Graduated students
- 2 Filed patents
- 3 Granted patents

Advanced Manufacturing

This group focuses on applied research related to the design and manufacture of products with high added value using disciplines such as competitive intelligence, circular economy, biomanufacturing, additive manufacturing, precision engineering and laser-based microprocessing.

**Leader:** Ciro Angel Rodríguez - ciro.rodriguez@tec.mx

**Research lines:**
- 3D printing of tissue
- Engineering scaffolds
- Electrospinning of nanofibers
- Laser microcutting and microwelding
- Soft lithography for microfluidics
- Microinjection molding
- Micromilling
- Metrology
Optimization and Data Science

This group develops approaches, formulations and solutions to specific industrial engineering problems using a quantitative point of view. This group solve production and logistics problems such as planning and production scheduling, facility location, inventory, vehicle routing, territorial design, forest management and port logistics.

Leader: Neale Ricardo Smith Cornejo - nsmith@tec.mx

- 37 Publications in Scopus
- 1 Granted patents
- 4 Filed patents
- 14 Graduated students
- 10 Advised thesis

Nanomaterials

This group focuses on the surface engineering by assisted plasma.

Leader: Joaquin Esteban Oseguera - joseguer@tec.mx

- 18 Publications in Scopus
- Research lines:
  - Prototype design and construction for the thermochemical treatment of steel parts.
  - Nitriding, carbonitriding and oxy carbonitriding of steels.
  - Thin film coatings on substrates for tribological systems, high performance components and metal.
  - Development of piezoelectric materials used as sensors.
  - Develops mathematical representation of kinetics growth in concomitant nitride layers.
  - Performs the structural characterization of a wide variety of steels and thin films.
Nanotechnology for Device Design

4 research lines: 1) The development and characterization of intelligent and morphing biocompatible polymeric materials reinforced with carbon nanotubes or nanoparticles. 2) The development of cutting edge technology to manufacture devices based on nanostructured materials. 3) The prediction of the dynamic response of linear and non-linear systems by using perturbation techniques, nonlinear modal analysis and cutting-edge experimental techniques. 4) The computer simulation of engineering components with Finite Element Analysis.

Leader: Alex Elías Zúñiga - aelias@tec.mx

82 Scopus Publications 2013 - 2017
37 Articles in journal Q1 2013 - 2017
16.4 Publications per year 2013 - 2017

Product Innovation

This group investigate state of the art concepts and generate significant contributions related to identification of demand from Rapid Growing Markets as well as characterization and application of accelerating technologies for product and process innovations. Also design and create reference models, methodologies and tools for Rapid Product Innovation and Realization.

Leader: Arturo Molina - armolinagtz@tec.mx

40 publications in journals
29 Filed patents
10 Granted patents
11 Book chapter
Robotics

This group develops devices in the areas of bio-mechatronics and autonomous vehicles. In the bio-mechatronics area, the objective is to assist the human motion during rehabilitation and to help geriatric people with wearable robotics. In the case of autonomous vehicles focus on the assistance during natural disasters by using teams of heterogeneous robots.

**Leader: José Luis Gordillo - jlgordillo@tec.mx**

- **50** Publications in Scopus
- **18** Patents
- **6** Startups

Nano-sensors and Devices

This group develops micro/nanofabrication processes and novel miniaturized sensors and devices, particularly photonic and electrochemical sensors, and micro-labs on a chip. These sensors and devices are fabricated with various materials, such as metals, polymers and carbon, and can integrate ad-hoc microelectronic systems.

**Leader: Sergio Omar Martínez - smart@tec.mx**

The group deals mainly with:
- Applications related to environmental monitoring.
- Separation and processing of biological materials used for new drugs.
- The analysis of biological fluids for the prevention, detection and monitoring of diseases.
- Development of devices for monitoring and improving cell culture.
**Intelligent Systems**

This group conducts basic and applied research to develop intelligent systems for solving problems across a wide range of application areas including optimization and logistics, ambient intelligence, web semantics, healthcare, forecasting and business intelligence, among others.

**Leader:** Hugo Terashima Marín - terashima@tec.mx

- **4** Posdocs
- **15** PhD students
- **10** Recent publications

**Research lines:**
- Nature inspired systems
- Context Intelligence

---

**Machine Learning**

The group is interested in applying computer technology for solving national priority problems. Currently, we focus mainly on issues such as security, business intelligence, education, logistics and bioinformatics.

**Leader:** Raúl Monroy Borja - raulm@tec.mx

- **6** Posdocs
- **2** PhD students
- **8** Graduated students
- **24** Recent publications in Scopus
Optics and Lasers

This group studies the application of light in micro-manipulation systems, quantum computing and characterization of micro and nanostructured materials including metamaterials. We develop special light profiles using lasers and other incoherent light sources.

**Leader:** Julio César Gutiérrez - juliocesar@tec.mx

- 8 professors
- 2 posdocs
- 3 PhD students
- 11 Recent publications in Scopus

Telecommunications for the Digital Transformation

The group works on signal processing for image processing as well as on the convergence between optical communications networks and wireless networks.

**Leader:** César Vargas - cvargas@tec.mx

- 13 professors
- 2 posdocs
- 8 PhD students
- 9 graduated students
- 45 Recent publications in Scopus
Energy and Climate Change

This group consolidates the research interest of the School of Engineering and Sciences in the broad area of sustainable use of energy and environmental resources.

**Leader:** Alberto Mendoza Domínguez - mendoza.alberto@tec.mx

- 24 professors
- 2 Star professors
- 7 posdocs
- 26 PhD students
- 47 recent publications in Scopus
- 8 filed patents
- 7 granted patents

Water Science and Technology

This research group implements several activities related to the management of water resources and engineering for sustainable use.

**Leader:** Jürgen Mahlknecht - jurgen@tec.mx

**This group works in the following areas:**

a) Hydrological processes focused on the management of water resources in the area basin.  
b) Environmental process focused on developing biorefineries and new green technologies.  
c) Environmental geoprocesses focused on the study of the environmental impact in the subsoil related to human activities  
d) Environmental nanotechnology focused on the development of new and advanced materials.
Cardiovascular and Metabolomic Medicine

The objective of this group is to characterize the molecular and cellular mechanisms that contribute to the development of cardiovascular and metabolic diseases in order to propose and evaluate new experimental therapies for prevention and treatment in preclinical models that will establish the scientific bases for the conduct of clinical studies with patients.

**Leader:** Gerardo García Rivas - gdejesus@tec.mx

**Relevant projects**
- Generation of functionalized nanovectors with the protein sorcin as a novel strategy for the treatment of cardiac failure and arrhythmogenesis.
- Safety and efficacy assessment of immunomodulator molecules in patients with advanced cardiac failure.

Cancer Research

This group develops research focused on the identification of useful biomarkers for the prevention, diagnosis and treatment of different cancer types, integrating genetic variability, environmental effects and lifestyle of individuals.

**Leader:** Rocío Ortiz López - rortizl@tec.mx

**Relevant projects**
- Validation of a genomic signature of triple negative breast cancer in order to determine its prognosis applicability with the survival rate of a patient.
- Immunological profiles characterization with IHC (proteins) and qPCR (mRNAs) in young women biopsies with breast cancer and their association with the clinical-pathological response.
Human Genetics

This group development of research in different areas of Human Genetics as a primary discipline in biomedical research.

**Leader:** Rocío A Rojas Martínez - augusto.rojasmtz@tec.mx

<table>
<thead>
<tr>
<th>Role</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research professors</td>
<td>4</td>
</tr>
<tr>
<td>Professor</td>
<td>6</td>
</tr>
<tr>
<td>Clinical professors</td>
<td>3</td>
</tr>
<tr>
<td>Star professor</td>
<td>1</td>
</tr>
<tr>
<td>Postdocs</td>
<td>2</td>
</tr>
<tr>
<td>Specialist</td>
<td>2</td>
</tr>
<tr>
<td>Genetist</td>
<td>1</td>
</tr>
</tbody>
</table>

**Relevant projects**
- Fetal damage from exposure to xenobiotics.
- Medicine studies of systems for congenital heart diseases.

Metabolic Disease

This group develop applied research activities oriented to the prevention, diagnosis and treatment of diseases that affect the human population through interdisciplinary solutions to the principal health problems using a translational medicine in metabolic diseases approach.

**Leader:** Arturo Santos García - arturo.santos@tec.mx

<table>
<thead>
<tr>
<th>Role</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research professors</td>
<td>2</td>
</tr>
<tr>
<td>Professor</td>
<td>9</td>
</tr>
<tr>
<td>Postdocs</td>
<td>2</td>
</tr>
<tr>
<td>Specialist</td>
<td>2</td>
</tr>
</tbody>
</table>

**Relevant projects**
- Portable device for the generation of a microenvironment during intravitreal injections for the treatment of diabetic macular edemas.
- System for the identification of potential cases of diabetic macular edema using image processing and artificial intelligence techniques.
Innovative Therapies in Visual Sciences

This group develops research within technological and innovative spheres focused in the diagnosis, prevention and treatment of ophthalmic pathologies that represent national and worldwide health problems, with a multidisciplinary and translational approach using cutting edge technologies in areas such as: cellular therapy, tissue engineering, biomedical devices, nanotechnology, bioinformatic models, biomaterials, clinical and epidemiological research.

**Leader:** Jorge Valdez García - Jorge.valdez@tec.mx

<table>
<thead>
<tr>
<th>Research Professors</th>
<th>Relevant Projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Development of artificial corneal tissue by tissue engineering techniques (corneal endothelium).</td>
</tr>
<tr>
<td>3</td>
<td>Pharmaceuticals development for affections within the ocular surface (Topical treatment for Pterygium).</td>
</tr>
<tr>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

Bioinformatics for Clinical Diagnostics

This group improves life quality of the Mexican population through the exploration and design of computational tools that employ substantial sources of clinical, radiological, epidemiological, genomic and molecular information to discover and/or identify experimentally validated biomarkers that will allow positive decision-making within clinical practice and public health.

**Leader:** Víctor Treviño Alvarado - vtreviso@tec.mx

<table>
<thead>
<tr>
<th>Research Professors</th>
<th>Clinical Professor</th>
<th>Postdoc</th>
<th>Specialist</th>
<th>Relevant Projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>Biomarkers and mutations in breast cancer.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Biomarkers identification methods</td>
</tr>
</tbody>
</table>
Bioengineering and Regenerative Medicine

*Isolate, enrich, characterize and differentiate in vitro stem cells obtained from different biological sources through the implementation of flexible bioengineering platforms for their application in regenerative medicine as a treatment for neurological, metabolic, traumatic, renal and pulmonary diseases.*

**Leader:** Jorge Moreno Cuevas - jemoreno@tec.mx

**Relevant projects**
- Sequential transplant of autologous stem cells CD133+ to the frontal motor cortex in patients with amyotrophic lateral sclerosis (ALS).
- Generation and scale-up of insulin-producing cells from mesenchymal cells from adipose tissue.

<table>
<thead>
<tr>
<th>4 research professors</th>
<th>1 specialist</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 professors</td>
<td></td>
</tr>
<tr>
<td>3 clinical professors</td>
<td></td>
</tr>
<tr>
<td>2 postdocs</td>
<td></td>
</tr>
</tbody>
</table>

SCHOOL OF HUMANITIES AND EDUCATION

Communication, Discourse and Culture

*This group study the term “cultural industry” from a broad perspective that involves the production of cultural goods and services in a non-restrictive and inclusive manner. Its study covers production generated through traditional sectors such as editorial print, analogue or advertising audiovisual, but also via digital media.*

**Leader:** María de la Cruz Castro - maricruz.castro@tec.mx

<table>
<thead>
<tr>
<th>21 Research professors</th>
<th>3 Recent books</th>
</tr>
</thead>
<tbody>
<tr>
<td>13 PhD students</td>
<td>6 Advised thesis</td>
</tr>
<tr>
<td>21 Recent publications in Scopus</td>
<td></td>
</tr>
</tbody>
</table>
**Education Research and Innovation**

This group focuses its research on innovation in education in three main areas: management of educational institutions; sociocultural contexts of the digital technology; and teaching and learning processes for a knowledge-based society in diverse areas with an emphasis on science, mathematics, engineering and technology.

**Leader:** Soledad Ramírez Montoya - solramirez@tec.mx

- **17** Research professors
- **3** PhD students
- **24** Recent publications in Scopus

---

**Science, Technology and Society**

We study the paradigm shift from the monetary base of industrial and material culture to intangible base (ideas and emotions) of the knowledge culture. We generate social innovation through creation of value based primarily, on intellectual capital.

**Leader:** Francisco Javier Serrano - fjaverserrano@tec.mx

- **7** Research professors
- **12** Professors
- **30** PhD students
Ethics and Peace Studies

Peace studies cover different approaches and disciplines to build cultures of peace. Involve a reconceptualization of what is peace and violence and personal level intervention, social and international. Ethics involves thinking about the world in which we live looking for a more just place, looking for the good and happiness of the people.

Leader: Dora Elvira García - dora.garcia@tec.mx

17 Research professors
3 PhD students
24 Recent publications in Scopus
3 Books
6 Advised thesis
6 Conferences presentations

SCHOOL OF SOCIAL SCIENCES AND GOVERNMENT

Democracy, Institutions, Security and Justice

This group generates research that strengthens democracy and its political and judicial institutions through identification and analysis of the conditions and institutions that promote or limit the consolidation of democracy.

8 Research professors
8 Associate professors
4 Doctoral students
Global Issues

This research group consists of scholars working on key contemporary issues of global governance across three main fields: global economic governance, global sustainable development and regional conflicts and cooperation.

Knowledge Societies

We study the paradigm shift from the material and monetary base of the industrial culture to intangible concepts (ideas and emotions) of the knowledge culture. This new field relies on several specialized areas of knowledge: ethics, epistemology, history of knowledge, knowledge economics, sociology of knowledge, political science and psychology of knowledge as well as technology and law.
Social Transformation and Sustainability

Through diverse interdisciplinary theoretical perspectives, this group looks for ways and strategies to ensure the continuation of social processes in the future. It studies basic resources such as water, its relation to life in the cities and its general role in sustainability.

12 Research professors
5 Research lines

Social Policy and public entrepreneurship

This group tries to solve some questions by studying entrepreneurship and public productivity, the models of participation and construction of public policy solutions and the technological impact within the public policy. To reach these goals, we study economics, law, political science, demography, sociology and technological innovation.

4 Research professors
3 Research lines
Regional Development, Energy and Public Economics

This research group seeks to contribute to decision-making in public policy in regional development, energy sector and public economy.

8 Research professors
7 Doctoral students

BUSINESS SCHOOL

Business Analytics

We study the use of business analytics and digital technologies to understand and improve business performance and process efficiencies.

Leader: Raúl Francisco Montalvo Corzo - rmontalvo@tec.mx

4 Research professors
4 Doctoral students
1 Adjunct researcher
Consumer Behavior and Value Creation

We study consumer behavior in order to develop effective business strategies that promote responsible consumption and social welfare.

Leaders: Raquel Minerva Castaño González - rcastano@itesm.mx
Lorena de la Paz Carrete Lucero - lcarrete@itesm.mx

Entrepreneurship and Leadership

This research group focuses, enhances and disseminates scholarship on entrepreneurship and leadership which strengthen economic and social development in Mexico.

Leader: Ajnesh Prasad - prasad@itesm.mx
José Ernesto Amorós Espinosa - amoros@tec.mx
Retail

This group seeks to develop the retail trade in Mexico in order to achieve international competitiveness by developing strategic thinking that improves competitiveness through: store experience, operational optimization, use of technology and brand value.

Leader: María Elena Vázquez Lira - mevl@tec.mx

Finance and Macroeconomics

We contribute to the development of Mexican companies through their integration into national and international financial markets. We promote a better understanding of the relation between companies and global macroeconomic conditions.

Leader: René Cabral Torres - rcabral@tec.mx
Social Innovation

We engage in basic and applied research aimed at understanding the functioning of corporate social responsibility within the context of both large multinational corporations as well as small and medium-sized enterprises. In addition, we study social, multifaceted entrepreneurship.

Leader: Bryan William Husted Corregan - bhusted@tec.mx

Strategy and Management of Organizations in Emerging Economies

In the context of emerging economies, we focus on the research processes and practices related to: strategy development and implementation, organizational capabilities, knowledge transfer, governance and human resources management. We apply strategies and management theories through models and tools designed for decision making and sustainable development for organizations in emerging economies.

Leader: Anabella del R. Dávila Martínez anabella.davila@tec.mx
Sustainable Territorial Development

It is the space dedicated to the generation of knowledge and aims to develop research that addresses the great challenges of society and its territory, thus strengthening the strategic axes that School of Architecture, Art and Design has defined: "City and Territory" and "Design for the social innovation."

Leader: Carlos Cobreros - ccobreros@tec.mx

3 Core researchers

14 Adjunct researchers

3 Research lines
- Resilience and adaptation to climate change
- Analysis of territorial dynamics
- Equitable cities
INSIGNIA PROFESSORS

Insignia award is the largest distinction in research for a Tec de Monterrey professor. It is the principal recognition of Investigation and Innovation prize Rómulo Garza, and is granted every year by Tecnológico de Monterrey and Xignux.

This award recognizes the researchers scientific career, their contributions to the institutional life and the community, and their professional distinctions over the years.

Romulo Garza Prize was created 40 years ago in memory of Mr. Rómulo Garza, who was an important research promoter in the community.

Dr. José Luis González Velarde

His has a master in Mathematics from the Instituto Politécnico Nacional and a doctorate in Industrial Engineering and Operations Research from the University of Texas, Austin. His specialties include computational optimization and algorithm design for logistics and manufacturing. He has participated in over 15,000 peer-reviewed publications and has had his work published in important journals. Has supervised more than thirty master’s level theses and five doctorate level ones. He is member of the National System Researchers, level 3.

gonzalez.velarde@tec.mx
Research that transforms lives

2017

Dr. Bryan William Husted
Professor at EGADE Business School Monterrey.
Leader of the Strategic Research Group in Social Innovation.
Has written academic articles in several journals.

2016

Dr. Mario Moisés Álvarez
Leader of the Strategic Research Group in Cellular and Engineering Biofeedback. His research specialties include design of bioreactors, transport phenomena and mathematical modeling of biological systems. Has published more than 100 articles in prestigious international journals in his field.

2015

Dr. Marco Antonio Rito Palomares
Leader of the Strategic Research Group in Bioprocesses and Synthetic Biology. Member of the Mexican Academy of Sciences and president of the Mexican Society of Biotechnology and Bioengineering, NL. Has published more than 80 research papers and book chapters and holds five patents.

2014

Dr. Julio César Gutiérrez Vega
Leader of the Strategic Research Group on Optics. Has authored and co-authored more than 185 articles in international journals, conference proceedings and books. The first Mexican to be named senior member of the International Society of Optics and Photonics.

2013

Dr. Sergio Román Othon Serna Saldivar
Leader of the Strategic Research Group in NutriOmics. His research specialties are the processing of cereals and oil-producing seeds. Has published seven books, 29 book chapters, 98 articles in journals, and holds two patents.

2012

Dr. David Muñoz Rodríguez
He was the leader of the Strategic Research Group in Electronic Communications and Networks. He is also a senior member of the Institute of Electrical and Electronics Engineers. He has published in prestigious international journals and holds several patents.
Roberto Joaquín Santillán Salgado
SNI 3

He is a full time professor at EGADE Business School Monterrey and member of the Strategic Research Group in Finance and Macroeconomics. He was a Ph.D. in Business Administration. He is leader of the American Academy of Financial Management. He has published in prestigious international journals. He belongs to National Researchers System, level 3.

roberto.santillan@tec.mx

Alberto Mendoza Domínguez
SNI 2

He is Professor and Leader of the Research Group in Energy and Climate Change of the School of Engineering and Sciences at Tecnológico de Monterrey. He obtained his PhD from the Georgia Institute of Technology. His main research interests are in the field of air pollution science and engineering. His current interests are in chemical characterization of fine particulate matter (including black carbon), source apportionment studies, use of satellite data for air quality studies, application of statistical tools for environmental data mining (with emphasis on air quality data), air quality forecasting and valorization of residues through thermal conversion processes. He is member of the National Researchers System, level 2.

mendoza.alberto@tec.mx

Alex Elias Zúñiga
SNI 2

He has a PhD in Mechanical Engineering by Nebraska University. He has important research projects in mechanical vibrations and constitutive models of compounds materials. He is member of the National Researchers System, level 2 and leader of the Research Group of Nanomaterials. He has published several articles in indexed journals and was consultant in companies like Prolac, Whirlpool and Vitro. For 8 years he was head dean of Engineering and Science School in Tecnológico de Monterrey. Now he is professor of Advanced methods of material resistance, mechanical vibrations, intelligent materials, and computational material design, among others.

aelias@tec.mx

Dra. Carmen Hernández Brenes
SNI 2

She is an active researcher specializing in emerging technologies for stabilization of essential nutrients: food design based on nutrigenetics. Currently she is a research professor in the Department of Biotechnology and Food Engineering and the Biotechnology-FEMSA Center. In her scientific career, she has published numerous articles in refereed journals, has applied for an international patent and is the author of several book and books chapters. At the undergraduate level, she teaches courses in Human Nutrition, Food Safety (HACCP Certified Alliance) and Sensory Evaluation; and at the postgraduate level, the Enzymology and Biocatalysis course. She belongs to National Researchers System, level 2.

chbrenes@tec.mx

SNI: National Researchers System

Dra. Dora Elvira García González
SNI 3

She is the leader of the Research Group Transformation and Sustainability. She specializes in ethics, political philosophy, hermeneutics and the philosophy of culture. Her research lines include ethics, the culture of peace, human rights, water, and sustainable cities. She investigates strategies, methods and tactics to self-sustain human social processes in the present and in the future. She has been a visiting scholar at the University of Granada, Spain, the National University of Comahue and the University of Barcelona. She also serves as the academic leader of strategic projects in the humanities since 2009 and the coordinator of the UNESCO group in ethics and human rights. She is member of the National Researchers System, level 3.

dora.garcia@tec.mx

Dr. Guillermo Torre Amione
SNI 3

He is the leader of the Research Group in Molecular Medicine. His research focuses on applied clinical investigation in the areas of heart failure and cardiac transplantation. His lab conducts a variety of clinical research protocols, including multinational studies and investigator-initiated protocols. He is also Chief of the Heart Failure Division, Department of Cardiology at Houston Methodist Hospital, dividing his time between an active clinical practice and research on heart failure. Dr. Torre’s clinical and basic laboratories are committed to the development of better therapies focused on the modulation of immune responses in patients with heart failure and cardiac transplant. He received the SCOPUS Award for the most-highly cited author on medicine in 2012. He belongs to National Researchers System, level 3.

gtorre@tecsalud.mx

Research that transforms lives
Dr. Carlos Manuel Urzúa Macías
SNI 3
With a PhD in economics, he specializes in economic theory and econometrics. He was Secretary of Finance in the Mexico City government (2000 to 2003). He has worked as a consultant to the World Bank, as well as the United Nations Economic Commission for Latin America and the Caribbean, the United Nations Development Programme and the Organisation for Economic Co-operation and Development. He has published eight books on economics, two books on poetry, and written dozens of articles in various international journals. He is member of the National Researchers System, level 3. curzua@tec.mx

Dra. Marisela Rodríguez Salvador
SNI 2
She has a PhD on Business Management at the Polytechnic University of Catalonia (1999). She belongs to the pioneers groups on the field of Competitive Technology Intelligence on Iberoamerica. In 2001 she established the research area of Competitive Technology Intelligence for Innovation at Tecnológico de Monterrey, campus Monterrey. She has provided consulting services, courses and conferences for more than 100 organizations in Latin America and Europe. She has published more than 100 articles in top refereed journals and conference proceedings in Europe, USA, and Latin America. And has several national and international awards including Romulo Garza award (2011) and Tec Woman (2014). She is member of the National System Researchers (level 2) and she became the first woman at Tecnológico de Monterrey belonging to the Mexican Academy of Sciences. marisrod@tec.mx

Dr. Janet Gutiérrez Uribe
SNI 2
She received her PhD in Engineering with specialty in Biotechnology from Tecnológico de Monterrey in 2006, and her Master with specialty in Biotechnology for the same institution in 2003. She has imparted class in Biotechnology area and coordinated the Biotechnology Research Center. She has several articles in important journals, such as publish and filed patents. Her research areas are the identification of substance with antioxidant, anticancer and anticholesterol activities in Mexican food. Actually she is member of the National Researchers System, level 2, and belongs to Tecnológico de Monterrey NutriOmics Research Group. jagu@tec.mx

---

SNI: National Researchers System
<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Affiliation</th>
</tr>
</thead>
<tbody>
<tr>
<td>César Vargas Rosales</td>
<td>SNI 2</td>
<td>Received a PhD in Electrical Engineering from Louisiana State University in 1996, and made a research stay at the University of California, Berkeley. He is a professor in the Doctorate in Information and Communication Technologies and member of the Research Group in Telecommunications and Networks of the School of Engineering and Sciences at Tecnológico de Monterrey. He is member of the National Researchers System, level 2. His research interests are on the following areas: Adaptive receivers for reconfigurable networks, clustering and topology maintenance in ad-hoc and sensor networks, security in interdomain routing, intrusion and attack detection using information theory, Network coding for security in reconfigurable networks, quantum information processing.</td>
</tr>
<tr>
<td>Jorge Welti Chanes</td>
<td>SNI 3</td>
<td>He has a PhD in Chemistry with specialty in Food Technology by Universidad de Valencia, España. He is leader of the Research Group of Emerging Technologies and Molecular Nutrition. Food, Pharmaceutical and Bioproducts Development, from Tecnológico de Monterrey. He is member of the National Researchers System, level 3, and the Mexican Science Academy (AMC). He has published 14 books and more than 180 papers in indexed journals. His research area is focused in process engineering, water activity, fruits processing, emerging technologies and social impact technologies development.</td>
</tr>
<tr>
<td>Dra. Anabella del Rosario Dávila Martínez</td>
<td>SNI 2</td>
<td>is a full-time professor and the leader of the Research Group of Strategy and Management of Organizations in Emerging Economies. Previously, she was the Ph.D. in Business Administration Program Director and Research Director at EGADE Business School Monterrey. Dr. Davila has been a guest professor and invited researcher at several national and international universities, and she is currently an active member of the Academy of Management and of the National Researchers System, level 2. Her teaching and research expertise includes institutionalism, labor culture, human resource strategic management, sustainability, and human development.</td>
</tr>
<tr>
<td>Dr. Bryan William Husted Corregan</td>
<td>SNI 3</td>
<td>He is the leader of the Research Group Social Innovation. He has worked at the Instituto de Empresa, Madrid, Military School in Bolivia and School of Business at York University. He currently holds a joint appointment with the Schulich School of Business, York University, where he is a member of the Haub Chair in Business and Sustainability. His main research interests are in: business and international management business, economics and econometrics, finance, technology and Innovation management, and marketing. He received the SCOPUS Award for the most-hyped cited author on Social Sciences in 2011. He is member of the National Researchers System, level 3.</td>
</tr>
<tr>
<td>Dra. María de la Cruz Castro Ricalde</td>
<td>SNI 2</td>
<td>She has taught at the Tecnológico de Monterrey, campus Toluca, since 1987. She received her PhD from the Universidad Iberoamericana in 1996 and she also completed another one in the Basque Country University, in Spain, where she specialized in Journalism and Cinema. She had worked on essays about women filmmakers in Mexico and Mexican contemporary Literature, with particular focus on Gender and Cultural Studies. She belongs to “Diana Moran”, a Mexican researching group centered on Literary Theory and Criticism, since 1998. Since 2006, she coordinates the book collection “Desbordar el canon. Escritoras mexicanas del siglo XX”, awarded by the Fondo Nacional para la Cultura y las Artes (FONCA) in 2006 and 2009. Maricruz is recognized by the highest scientific council in México, belonging to the National Researchers System, level 2.</td>
</tr>
<tr>
<td>Dra. Rocío Ortiz López</td>
<td>SNI 3</td>
<td>She graduated in Químico Farmacobiólogo Faculty from Universidad Veracruzana. She had her Masters and PhD in Molecular Biology from Universidad Autónoma de Nuevo León (UANL). She realized a training in molecular diagnosis from Baylor College of Medicine in Houston, Texas. Her expertise areas are the use of Biomarkers in breast cancer and cervix cancer, and the genomic applications in biotechnology. She belongs to National Researchers System, level 3.</td>
</tr>
</tbody>
</table>

SNI: National Researchers System
The center focuses on the training of researchers and specialist consultants seeking to participate in the identification and resolution of issues raised by the challenges of globalization of design and product engineering, intelligent manufacturing processes and reconfigurable and logistics systems. CIDyT is based on the use of its intellectual capital, infrastructure and strategic alliances with key technology providers and universities of international prestige for maximum results.

There are three main areas: bioprocess engineering, food biotechnology and pharmaceutical biotechnology. The research is focused not only on knowledge generation, publication of scientific articles and preparing human resources’ level of excellence, but also on the generation of patents, technology solutions for industry, technology transfer and the generation and incubation of new technology-based businesses.

Center specialized in research, innovation and transfer in the area of health. The principal lines of investigation include: cardiology, cell therapy, hematology and cancer, ophthalmology, nutrition, health system management.
INTERNATIONAL COLLABORATION

BIOTECHNOLOGY
Cornell University
Texas A&M University
St. Jude Children’s Research Hospital
UMD Maryland
University of the Andes

MECHATRONICS AND ENGINEERING
Massachusetts Institute of Technology
Rice University
Mechatronics University Of California, Irvine
UMD Maryland
NUS university of Singapore
University of the Andes

INFORMATION TECHNOLOGIES,
ELECTRONICS AND COMMUNICATIONS
University Of California, Berkeley
Carnegie - Mellon University
UMD Maryland

SUSTAINABLE DEVELOPMENT
Arizona State University
University of Calgary
University Of California, Berkeley
UMD Maryland

PUBLIC POLICY AND SOCIAL SCIENCES
Princeton University
Fudan University
UMD Maryland

BUSINESS
Babson College
Northeastern University
UMD Maryland

HEALTH
Johns Hopkins University
Houston Methodist Leading Medicine
USP Universidade de Sao Paulo
UMD Maryland

HUMANITIES AND EDUCATION
University Of California, Berkeley
UNESCO
UMD Maryland

Research that transforms lives
In the next five years, the following impact indicators are anticipated:

- **10** future professors in internships at MIT in nano topics
- **10** researcher professors from Tec de Monterrey in elite research groups
- **10** graduate students in co-advising with MIT researchers
- **50** undergraduate students in short training stays in micro and nanofabrication techniques
- **2** distinguished professors from MIT
- **50** scientific articles of high impact published in co-authorship with MIT researchers

Tecnológico de Monterrey has signed an agreement with one of the most prestigious universities in the world in a vanguard topic, nanotechnology. In 2014, effectively, an important event in Tec history took place: an agreement in perpetuity was signed with the Massachusetts Institute of Technology, MIT.

The agreement consists of developing capacities in nanotechnology in concordance with the great gamble this world class institution is making with its project MIT.Nano.

In this context, the agreement contributes to Tecnológico de Monterrey’s new strategy of attracting talent, infrastructure, and strategic partnerships. These alliances will allow Tecnológico de Monterrey to confront the great challenge it is facing to position itself as a research university. These kinds of agreements contribute mainly to:

- Developing and attracting highly specialized and world-quality human assets.
- Maximizing the scientific production and leadership of Tec’s researchers.
- Boosting creativity and active learning to take advantage of the most important research network in the world.
- Developing and improving proficiency and capacities to deal with highly competitive industry, environmental sustainability and the improvement of society’s quality of life.

**MIT – TECNOLÓGICO DE MONTERREY**

Research Agreement

Research that transforms lives
MIT - TECNOLÓGICO DE MONTERREY
Research Agreement

MIT.NANO Research Areas:
Personal Medicine
Energy Systems
Ubiquitous Computing
Multiscale Manufacturing
Sustainable Infrastructure
Quantum Science and Technology

TEC.NANO Research Areas:
Personal Medicine
Energy systems
Multiscale Manufacturing
Quantum Science and Technology
STRAATEGIC INITIATIVES: TEC.NANO

Initiative with the aim of supporting research in areas of nanoscience and nanotechnology through interdisciplinary projects in:

• Biotechnology
• Mechatronics
• Sustainability
• Information and Communication Technologies
• Health
• Education
• Entrepreneurship
• Public Policy
STRATEGIC INITIATIVES: TEC.NANO

Ongoing Projects at Tecnológico de Monterrey

• Chemical and electrochemical synthesis of metallic nanoparticles
• New constitutive models of nanostructured materials
• Intelligent surgical meshes
• 3D printing for scaffolds in tissue engineering
• Surface engineering
• Biomems: C-MEMs, dielectrophoresis, CD-microfluidics
• Micromachines and micro-factories
• Development of micromixers for mass transfer in microfluidic cells
• Nanoelectronics (nanosystems; low-power consumption, statistical circuit theory)
• Quantum information processing
• Design of nanostructures for sensor development
• Design of nanoplatforms for controlled release of genetic material and drugs
• Nano-optics: Interaction of light with nano-systems
• Interactions between nano-optical systems
STRATEGIC INITIATIVES: ENERGY

Our goal is to contribute to the competitive development of the energy sector in México.

Research:
• Research in political economy of the Mexican energy reform
• Assessment of social impact, urban risk and strategic opportunities at the local level with energy projects
• Public policy analysis for renewable energy
• Impact analysis of hydraulic fracture technology

Outreach:
• Regional strategic plan for the energy sector
• Capital budgeting in gas & oil
• Identifying business opportunities for the value chain energy sector
BI-NATIONAL LABORATORY ON SMART SUSTAINABLE ENERGY MANAGEMENT AND TECHNOLOGY TRAINING

Supported by CONACYT and Energy Sustainability Program to develop:

**INFRASTRUCTURE**
- Remote Laboratories
- Virtual laboratories
- In site laboratories

**RESEARCH**
- 4 Binational research networks
- 9 Research projects

**TRAINING**
- MéxicoX platform
- Decision Makers
- Managers
- Engineers
- Technicians

**ACCREDITATIONS**
- 450 Certified and authorized persons

With the participation of companies, institutions and universities in collaboration with Tecnológico de Monterrey
RESEARCH PROJECTS:

1. INTERCONNECTION OF THE ELECTRIC SYSTEMS OF MEXICO AND UNITED STATES
2. TECHNOLOGICAL CHALLENGES FOR THE INTEGRATION OF RENEWABLE ENERGIES TO THE MEXICAN GRID
3. RESTRUCTURATION OF THE MARKET, EFFICIENCY OF RENEWABLE ENERGIES IN THE MEXICAN ELECTRIC FIELD
4. CHANGE IN ENERGETIC MARKETS IN MEXICO AND THE EVOLUTION OF ENERGY MARKETS IN THE USA, LESSONS AND OPPORTUNITIES
5. ADVANCED TECHNOLOGIES TO ALLOW A HIGH PENETRATION OF RENEWABLE RESOURCES IN THE DISTRIBUTION SYSTEM
6. BIOENERGY IN MEXICO
7. ENERGETIC EFFICIENCY
8. TECHNOLOGICAL PLATFORM FOR DECISION-MAKING
9. EDUCATIONAL RESEARCH
Research that transforms lives

16 thousand people training in México through 10 MOOC related with the electric energy value chain

450 certified and authorized persons (3% of the MOOC participants)

155 Masters / Specialities
- Energetic Engineering
- Energetic Administration
- Administration of the Energy and his Renewable Sources

29 doctorate students

6 Postdocs

10 SNIs researchers
2 SNIs Instituto de Investigaciones Eléctricas
5 SNIs Tecnológico Nacional de México
3 UC Berkeley researchers
5 ASU researchers
STRAEGIC INITIATIVES: EDUCATION

Serve as a reference for how to educate in order to have an impact on learning processes at different levels:

- Educational policy
- Management of educational institutions
- Curriculum design
- Processes of teaching and learning in the classroom (intensive use of educational technology as a learning mediator)

Projects:

- Assessment for improving external educational evaluation system for public schools with low academic achievement
- Virtual Learning Center
- Center for improvement and educational innovation
- Institutional repository
- Resource Center for Academic Writing
- Culture of legality in primary and secondary schools

Research that transforms lives
Last year, the Observatory of Educational Innovation won the “Open Education Awards for Excellence”, category OER Collection.

The Open Education Consortium is a global network of educational institutions, individuals and organizations that support an approach to education based on openness, including collaboration, innovation and collective development and use of open educational materials.

WE IDENTIFY AND ANALYZE THE EDUCATIONAL TRENDS THAT ARE SHAPING THE FUTURE OF LEARNING AND EDUCATION

OBSERVE
IDENTIFY AND ANALYZE HIGH-IMPACT EDUCATIONAL TRENDS.

FOSTER
BOOST AND PROMOTE INNOVATION IN THE TECNOLÓGICO DE MONTERREY AND GLOBALLY.

SHARE
COMMUNICATE EFFICIENTLY AND TIMELY WHAT HAPPENS IN EDUCATIONAL INNOVATION.

https://observatorio.itesm.mx/
Research that transforms lives

EDU TRENDS
In-depth analysis of trends with the greatest potential to impact on Higher Education.

CEDDIE connection
The Educational Innovation and Teaching Development Center (CEDDIE) support the diffusion, definition, and application of TEC21 Model, with the creation of revolutionary ways of teaching development through research and educational innovation.

The TEC21 initiative is created to align the efforts and modernize, adapt and guarantee the high academic quality standards of Tecnológico de Monterrey.

Some innovation projects of CEDDIE are:

- The film as didactic resource
- “Gamification”: a fun approach to learning
- Design acting
- The life game

WEEKLY REVIEW
Our Weekly Review is a curated media synthesis of the most relevant articles and stories on education technology and innovation.

EDU BITS
Brief reports on education and innovation issues, events and interviews with key experts and ed leaders.
The International Conference on Educational Innovation

is a forum designed to help you learn more about the trends and practices that are currently revolutionizing education around the world.

Through this important event, that has been organized every year since 2006, the Tecnológico de Monterrey is focusing on promoting and facilitating experimentation and innovation among teachers, directors, entrepreneurs and all those interested in education, offering them the opportunity to learn more about the best national and international experiences, connecting them with experts and showcasing what other teachers are doing in the area of educational innovation.

Objectives

- To learn about the trends and practices in educational innovation that are transforming education around the world.
- To network with world-class experts.
- To identify resources to help improve the teaching-learning process.
- To share their teaching experiences.
- To collaborate with colleagues and institutions on topics of common interest.
- To consolidate joint working agreements.
- To be recognized by their colleagues for their innovation in teaching.

http://ciie.itesm.mx/en/
STRAEGIC INITIATIVES: ENTREPRENEURSHIP

• Fostering the entrepreneurial spirit among students and professors

• The Eugenio Garza Laguera Institute for Entrepreneurship is the largest entrepreneurship ecosystem in Latin America.

• All the entrepreneurship initiatives contribute to generating jobs and to strengthening the national economy by means of knowledge transfer to create wealth and the growth of companies.

• INCmty is an entrepreneurship and innovation festival in which Mexican entrepreneurs, innovators and investors participate. Since 2013, INCmty is the most important celebration of the entrepreneurial spirit. The 2017 edition, was attended by 9000 people from 24 countries, to more than 800 activities.

• Strategic collaboration: Babson College’s Global Consortium
INDUSTRIAL PARTNERSHIPS
EXAMPLES OF RESEARCH INDUSTRIAL PROJECTS

Navistar

Project: Road Load Data Acquisition
The project has a multi-year horizon and has the primary purpose of developing RLDA (Road Load Data Acquisition) systems that allow collection of information, data and knowledge about the behavior of vehicles on Mexican roads, with the aim of providing feedback to the design process and finding different failure causes in durability and load during operation.

Bocar

Is a Company that produce pieces and complex assembles for automotive industry. The research projects related to this area in Tec de Monterrey are:

• Production optimization based in simulation
• On line measurement
• Diagnosis of a high speed mechanized center

Roberto Rocca Research Chair

• Energy efficiency in electric and thermal industrial applications
• Energy conversion and power electronics
EXAMPLES OF RESEARCH INDUSTRIAL PROJECTS

Industrial Consortium in Energy

Companies: Schneider Electric, Ternium, TenarisTamsa, AMI-GE, Cerrey, Prolec-GE, Nutec Bickley, Tenova, Acciona Energy, Diram
Main research areas: Power electronics, design of electrical equipment, optimal dispatch of energy in interconnected power systems, combustion systems, heat transfer and modeling and simulation of industrial processes

Examples of projects:
• Power control optimization of AC electric arc furnaces
• Heat transfer simulation of windings in power transformers for estimation of hot spots
• Compliant mechanisms in miniature circuit breakers

FEMSA

Project: Emerging Contaminant Biodegradation by Enzymatic Processes
This project focuses on the study of the potential use of enzymatic processes for bioremediation of aquatic systems by enzymes extracted from a microorganism obtained from the northwestern region of Mexico, to implement processes of degradation of various compounds. The investigation is focused on kinetics, the major way of degradation of the analysis of interest and toxic by-products.

Metalsa

Project: Design and development of electric propulsion system and semi-active suspension for a light load vehicle
In this project Tecnológico de Monterrey designed a control system for a semi-active suspension in an embedded architecture based on a CAN network. The goal of the algorithm is comfort and individual surface grip on each corner of the car, besides a control system that coordinates each independent corner. The control system is based on the specification and modeling of electrohydraulic dampers, including tolerance to some faults. The system was validated in a commercial vehicle.
Leadership has been one of the fundamental pillars at Tecnológico de Monterrey since its foundation. Don Eugenio Garza Sada found in quality education the opportunity to develop leaders focused on the transformation and development of Mexico.

The world needs leaders prepared to face the challenges of this new era. This is why we are committed to a leadership oriented to human flowering, developing leaders with a positive vision that contribute to the flourishing of others.

The Leadership Institute was born with the mission of doing science in leadership, to put itself at the service of the community, becoming a legacy for Mexico and society, developing a new model of responsible and responsive leadership that allows addressing the challenges that the world faces; in addition to complying with one of the 6 institutional strategies: Boosting Leadership Development.

The Leadership Institute has four lines of action:

**Research**: Develops an international group of leadership experts who collaboratively generate knowledge in the field and make Tec a benchmark in leadership research.

**Leadership Development**: Generates value proposals that contribute to the development of the leaders of our Institution, the community of leadership experts, students and organizations.

**Leadership Observatory**: Provides a participatory space that encourages the analysis, generation, development and dissemination of leadership models, tools and resources for the internal and external community of the Institution.

**Strategic Projects**: Develop projects that encourage reflection, dialogue and analysis generating a new vision of leadership aligned with the 2030 vision of Tec.

The director of Leadership Institute is Santiago Vázquez Blanco. Website: [https://tec.mx/es/instituto-de-liderazgo](https://tec.mx/es/instituto-de-liderazgo)
EDUCATION IMPACT

Education Model

Innovation

Team Work

Global Vision

Values

Integrity

Humanistic Empathy

Research that transforms lives

MODELO EDUCATIVO

TEC21
EDUCATION IMPACT

Inspiring Professors
Student Selectivity
Strategic Initiatives
Entrepreneurial Spirit
Flexible Curricula
Learning Experiences

Research that transforms lives
EDUCATION IMPACT
Graduate Programs

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>PhD</td>
<td>11</td>
</tr>
<tr>
<td>Master</td>
<td>32</td>
</tr>
<tr>
<td>Specialties</td>
<td>22</td>
</tr>
</tbody>
</table>

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Business</td>
<td>10</td>
</tr>
<tr>
<td>Social Sciences and Government</td>
<td>6</td>
</tr>
<tr>
<td>Humanities and Education</td>
<td>8</td>
</tr>
<tr>
<td>Engineering and Science</td>
<td>21</td>
</tr>
<tr>
<td>Medicine and Health</td>
<td>20</td>
</tr>
</tbody>
</table>
Effect of Agave americana and Agave salmiana Ripeness on Saponin Content from Aguamiel.

Ana María Leal-Díaz, Liliana Santos-Zea, Hilda Cecilia Martínez-Escobedo, Daniel Guajardo-Flores, Janet Alejandra Gutiérrez-Uribe, and Sergio Othón Serna-Saldivar

Journal of Agricultural and Food Chemistry 2015 63 (15), 3924-3930 DOI: 10.1021/acs.jafc.5b00883

Validación de bioactividad de peptidos de frijol
Reimagine Education is a prestigious international competition rewarding innovative initiatives aimed at enhancing student learning outcomes & employability. It culminates in a global conference for those seeking to shape the future of education. These contest was planned as an alternative to the new education necessities. Every year we receive among 1000 proposals from more than 30 universities. Tecnológico de Monterrey participated with 16 projects in 2016, and 18 in 2017, resulting winners in both years with 3 projects.

**2017**

"Open Innovation Laboratory for Rapid Realization of Sensing, Smart and Sustainable Products". **Awards**: Latin America Award (Bronze Winner) - Engineering and IT Award (Gold Winner) - Hybrid Learning Award (Silver Winner). **Project**: The proposed Open Innovation Laboratory has three major pillars: specific Learning Techniques to enhance education; Design Methodologies to guide the design process, and a Rapid Product Realization Platform, that includes emergent technologies for product development. Using this Open Innovation Laboratory, it is possible to demonstrate students apply technical skills and experiences during the development of innovative and sustainable products. The laboratory promotes interactive collaboration between internal and external actors during the innovation process to develop Sensing, Smart, and Sustainable products and services. It also supports the maker movement to stimulate an entrepreneurship culture and foster companies incubation and economic development. **Authors**: Arturo Molina, Dante Chavarria, Martin Bustamante, Jhonattan Miranda, Edgar López, Manuel Macias, Julieta Noguez, Miguel Ramirez, Martin Molina y Pedro Ponce.

"Touching Math: From concepts to reality through 3D tools". **Awards**: Latin America Award (Bronze Winner) - Presence Learning Award (Bronze Winner) - Natural Sciences Award (Gold Winner). **Project**: The goal is to improve the teaching-learning process of mathematics by increasing spatial visualization skills using augmented reality, virtual environments and 3D impressions. A new way of teaching important mathematical concepts is presented by adding the senses of touch and sight to the learning process, showing the student a way of describing reality through mathematical language in a natural way and achieving a meaningful learning of mathematics. The results indicate an increase in motivation and increased learning, in addition to developing skills of mathematical visualization and interpretation of concepts in students. **Authors**: Linda Medina, Gerardo Aguilar, Sergio Ruiz, Saúl Juárez, Marlén Aguilar, Martín Pérez, Jaime Castro, Moisés Alencastre y Lourdes Muñoz.

"Research Path: Inducing Curiosity, Research and Innovation in Undergraduate Students". **Award**: Cultivating Curiosity Award (Silver Winner). **Project**: Rather than push students into predictable outcomes, Research Path pedagogy uses curiosity to pull them across new horizons. The Research Path objective is for under-graduate students to earn what they learn by integrating into research, developing hotly-demanded research skills, and graduating with concrete research results. 864 students have participated since 2004. 304 have graduated, and 100% of these are working or doing graduate studies. Students opt-in after third semester, complete eight credit-bearing seminars and internships, and document a capstone project with a peer-reviewed publication, intellectual property, business venture, or scientific reports. Results include 52 journal articles with 638 citations. **Authors**: Nathalie Galeano, Francisco Cantú, James Fangmeyer, Rogelio Soto y Rubén Morales.

**2016**

"Incubation Cells: Researchers and Entrepreneurs". Project from James Fangmeyer Jr., Francisco Cantú, Silvia Patricia Mora and Nathalie Galeano, professors from Campus Monterrey. The project consists in the incubation of technological base business, using the patents rights results of thesis of PhD and Masters of Tecnológico de Monterrey alumni. This patents are registered by the students and their professors, with the aim of become them in real business. The Incubation Cells Program role is to provide them business, financial, legal, informatics and marketing advising. Also, this program can provide information about seed capital networks, research resources, and even technological parks office space. This project won the first place in the Nurturing Employability Award category.

"Semester i – A new way of learning". Project from Eduardo Bastida Escamilla and Luis Enrique Herrera del Canto, professors from Campus Santa Fe. The project explains the Semestre i methodology, one of the most innovative initiative of competence-based teaching and learning challenge, and part of Modelo Educativo Tec21. This project won the first place in Hybrid Learning Innovation-Poster in Latam region.

"Professor Avatar: Telepresence Model". Project from Luis Eduardo Luevano Belmonte and Eduardo López de Lara Díaz, from Campus Zacatecas, and Eduardo González Mendivil from Campus Monterrey. The Project consist in a telepresence model for increase the distance education learning-teaching process, and contribute to the humanization and revaluation of the professor and student’s social presence in the distance education model. The project won second place in Best us of Information and Communication Technology Tools.
SCIENTIFIC IMPACT
RELEVANT PUBLICATIONS (2018)


The Allergic Rhinitis and its Impact on Asthma (ARIA) score of allergic rhinitis using mobile technology correlates with quality of life: The MASK study European Journal of Allergy and Clinical Immunology (2018), Vol. 73 p. 505-510.


Peroxidases-assisted removal of environmentally-related hazardous pollutants with reference to the reaction mechanisms of industrial dyes
**SCIENTIFIC IMPACT**

**RELEVANT PUBLICATIONS**


**METHODOLOGY:** The 20 most cited publications in Scopus with query:

((AF-ID (60018640))) OR (AF-ID (60007966)) OR (AF-ID (60109718)) OR (AF-ID (60001285)) AND (LIMIT-TO (PUBYEAR, 2018))
Research that transforms lives

SCIENTIFIC IMPACT

Papers and Citations in Scopus

PAPERS AND CITATIONS IN SCOPUS

PUBLICATION AREAS
ECONOMIC IMPACT
Technology Transfer Office Network

12 P&TTOS
10 Certified P&TTOS

PATENT APPLICATIONS IN MÉXICO
228 PATENTS GRANTED
92 INDUSTRIAL DESIGNS GRANTED
UTILITY MODELS GRANTED
TRADE MARKS LICENCING

Research that transforms lives
ECONOMIC IMPACT
Technology-based companies incubated by professors and students per sector
2011 - 2018

Life Sciences
Services
Information Technology
Engineering

24 Incubated companies
ECONOMIC IMPACT
Examples of tech-based companies

Onko Solutions S. de R.L. de C.V.
A high technology company that aims to establish a progressive dynamic for the development and commercialization of technology based on the use of innovative technology in medical devices. At present Onko is commercializing a cervical cancer medical diagnosis device that is reliable, affordable, portable, user-friendly, and minimally intrusive. 
Jesus Seanez de Villa
jesusseanez@gmail.com

WeaRobot S.A.P.I. de C.V.
Devoted to designing, developing and producing rehabilitation devices. The use of muscle and brain signals to control robotic rehabilitation can help greatly in the rehabilitation of limbs to supplement control over crucial parameter movement therapy. Aukora Foundation (the social partner of WeaRobot) is an online open innovation platform and crowdfunding offering free prosthetics, orthotics and exoskeletons.
Ernesto Rodríguez Leal
ernesto.rodriguez@itesm.com

Bio-Recombine Technologies, S. de R. L. de C.V.
A biotechnology company devoted to designing, developing and producing biomolecules of high commercial value (recombinant proteins) to serve the biopharmaceutical market developing vaccines and drugs, and the diagnostic and food sectors through diseasing enzymes with high commercial value.
Luis Mario Rodríguez
lmrm7@hotmail.com

EZKATEC S. de R.L. de C.V.
A biotechnology company devoted to innovating, researching and developing probiotic formulations that do not require cold chain for the dairy and pharmaceutical industries. The technology is an integrated high performance process to obtain biomass of probiotic lactic acid bacteria (probiotic), a dairy-based nutritional serum product that improves the quality and health of the general population.
Ernesto Aguirre Ezkauriata
eezkauriata@itesm.mx
ernesto.aguirre@ajtzakbio.com

Automatische Technik S.A.P.I. de C.V.
Its the first mexican Company oriented in the production of Delta robotic arms. They can be used to pack, unpack or re-pack any kind of products in small boxes. This company offers solutions oriented to increase production and reduce operation costs, besides, this technology help companies to level up their economies and increase their products quality.
Juan Pablo Martínez
contacto@atechnik.com.mx

Global Nano Aditives, S.A. de C.V.
A nanotechnology company devoted to the development of nanofluids for coolants and lubricants. These refrigerants contain nanoparticles dispersed and stabilized to provide better heat conduction properties and wear reduction; applications in electrical transformers, automotive systems, and the metalworking industry in general. This technology was recognized as a TechConnect Global Innovation Awardee at the “TechConnect National Innovation Summit”, Washington, D.C., 2014.
Edgar Ramon Raygoza
edgar.raygoza@gmail.com

Research that transforms lives
ECONOMIC IMPACT
1. Technology Parks and Industrial Sectors

Technology Parks Network (and Major Impact Sector)

- Technology Park Sonora Norte
- Technology Park Chihuahua
- Technology Park Sinaloa
- Science and Technology Park Guadalajara
- Technology Park Leon
- Technology Park Queretaro
- Science and Technology Park Cuernavaca
- Technology Park San Luis Potosi
- Technology Park Puebla

TICs Automation
TICs Aerospace
TICs Automotive
TICs Electronics
TICs Design
TICs Animation/Digital Art
Biotechnology (Agro)
Science and Technology Park Guadalajara

Research that transforms lives
ECONOMIC IMPACT
Incubator and Accelerator Networks

112 Incubators

17 Accelerators

Research that transforms lives
A new ophthalmic drug for the treatment of macular edema
The project consists of the development of an ophthalmic drug for the treatment of diabetic and non-diabetic macular edema, which can cause vision loss, by means of a non-invasive platform, reducing risks for the patient.

High value products from avocado: Avosafe® y Avocardio®
The project discovered avocado molecules, such as acetogenins, which have antibacterial and antimicrobial properties and which served as the basis for the development of Avosafe® and Avocardio® products, with large applications in the pharmaceutical and food industries. In addition, it has also proven the antithrombotic properties of avocado, which can help prevent heart attacks and embolisms.

SWIT: The generation of sustainable wealth
The SWIT Model (Sustainable Wealth creation based on Innovation and enabling Technologies) aims at articulating the biosphere’s three major dimensions: economic, social (human) and environmental. The idea is to generate wealth for a region through projects that are environmentally recoverable, socially responsible, and economically viable.
Bartering: midwives' houses in the state of Chiapas

This project seeks to put an end to the high maternal mortality rate in Tenejapa, Chiapas, by designing and building “Midwives’ houses”, a space with better conditions, through a barter of knowledge and experiences.

CEMEX-Tec Center: a driving force for the development of sustainable communities

The CEMEX-Tec Center is an alliance whose purpose is to collaborate in synergy to drive Mexico’s urban and rural communities toward better living conditions, promoting their all-round development with a vision of sustainability. This project addresses all aspects of human development from the social, economic, and environmental perspectives, the three pillars of sustainability.
PROJECTS THAT TRANSFORM MÉXICO 2018
https://youtu.be/vRuj8XycimY

PROJECTS THAT TRANSFORM MÉXICO 2017
https://www.youtube.com/playlist?list=PLnncon5XHt5pZFpir1YIsAVZCW9xP1UEe

PROJECTS THAT TRANSFORM MÉXICO 2016
https://www.youtube.com/playlist?list=PLnncon5XHt5onevVMgQxz75WSrdYpLns9
Research that transforms lives

No. 5 in Social Science & Management
No. 250 in Engineering & Technology

No. 33 Position Worldwide
Among top 3 Mexican universities contributing to México’s
Research that transforms lives
BUSINESS SCHOOL RANKINGS

Research that transforms lives

TRIPLE CROWN ACREDITATION
Research that transforms lives

No. 1
Maestría en Administración Empresarial (on line) at Tecnológico de Monterrey

2016
500+
GRUP - Global Research University Profiles

No. 5
Country rank

No. 21
in Latin America

No. 736
World rank

2019

No. 6
in México

No. 40
in Latin America

No. 1021
Worldwide

2019

LinkedIn
Top Attractors

2015 - 2016
No. 4
Universities the top attractors hire from the most frequently

No. 1
Maestría en Administración Empresarial (on line) at Tecnológico de Monterrey

2015 - 2016

The Princeton Review

2018
No. 14
in the TOP 25 Entrepreneurship Undergraduate Schools Ranking in the USA
Research that transforms lives

2018
1000 - 1500
Best Global Universities

2017
No. 17
in Student Mobility Worldwide

2017
No. 1
Scientific Leadership in México
Universities that produce more billionaires

2017

No. 440
Worldwide

2016

No. 36
Universities that produce more billionaires

2016

No. 184
Worldwide
QS STARS

QS Stars is a rating system that helps you select the right university based on your interests. It provides a detailed look at an institution, identifying which universities rate highest in the specific topics that matter to you, like facilities, graduate employability, social responsibility, inclusiveness, and more.

QS Stars Ratings for Instituto Tecnológico y de Estudios Superiores de Monterrey

Overall ★★★★★
Research ★★★
Employability ★★★★★
Teaching ★★★★★
Facilities ★★★★★
Internationalization ★★★★★
Innovation ★★★★★
Social Responsibility ★★★★★
Specialist Criteria ★★★★★

Source: https://www.topuniversities.com/universities/instituto-tecnologico-y-de-estudios-superiores-de-monterrey
TIMES HIGHER EDUCATION

BRICS and Emerging Economies 2019

The New York Times

Employer Reputation 2016/2017
We create disruptive models for the future of learning

www.teclabs.io