

Biomedical Sciences

Biomedical sciences combine the fields of biology and medicine in order to focus on the health of humans.

This is a very broad rubric and includes the following:

- Biochemistry: studies the chemical composition of cells and the chemistry behind biological processes
- Molecular biology: studies the molecular makeup and processes of living organisms
- Biophysics: studies mechanical and electrical energy in living cells and tissues
- Cell biology: studies cell-level organization and processes
- Cytopathology: Studies cell obtained by different means from human and sometimes animal bodies, using microscope and recent technologies to evaluate morphology, molecular pathology changes by molecular diagnostics. Also cytopathology involves cancer screening such cervical, breast, colon and prostate cancers.
- Computational biology and Bioinformatics: uses computer modeling and data analysis to understand biological systems
- Developmental biology: studies the growth and development of organisms and focuses on diseases of abnormal development
- Epidemiology: studies the incidence and transmission of diseases in a population and population characteristics (behaviors, environment, etc.) that associate with diseases
- Genetics: studies DNA and genes of humans and animals, as well as diseases caused by abnormal or mutated DNA.
- Hematology: studies of the blood, such as blood cells, and mechanisms of coagulation.
- Histopathology: Studies tissues for disease diagnosis, using histological, histochemical, immunohistochemical analysis or molecular techniques for diagnostics.
- Immunology: studies the immune system
- Microbiology: studies characteristics of microorganisms such as bacteria and their role in human health
- Neuroscience: studies on function and structure the nervous system, including the brain
- Oncology (a.k.a. cancer biology): studies the causes and characteristics of cancer
- Parasitology: studies parasites
- Pathology: studies the underlying causes and bodily effects of disease through examination of organs, tissues, and cells
- Pharmacology: studies effects of drugs on biological systems

- Physiology: studies how various body systems function at macroscopic, microscopic and molecular levels
- Virology: studies viruses and viral diseases

Bio-Electrics

Field of research that works to establish a synergy between electronics and biology

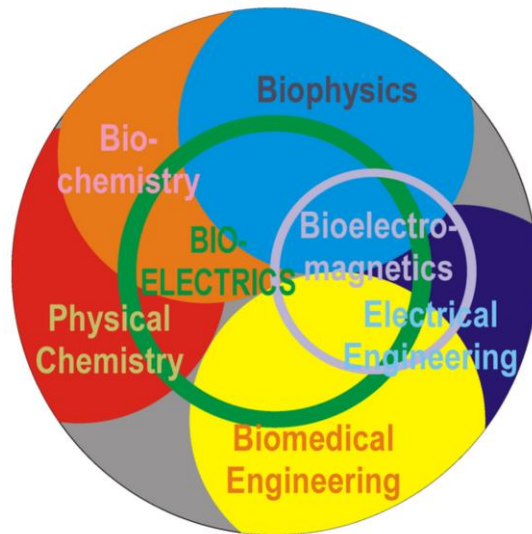
Bioelectric research is conducted at only a few universities around the world:

International Consortium on Bio-Electrics:

- Old Dominion University
- University of Missouri
- University of South Florida
- Karlsruhe Institute of Technology (Germany)
- Kumamoto University (Japan)
- Leibnitz Institute for Plasma Science and Technology (Germany)
- Institute of Oncology Ljubljana (Slovenia)
- Academy of Sciences of the Czech Republic
- University of Toulouse (France)
- Institut Gustave-Roussy and University of Paris (France)
- Radiation Sources Laboratory (Italy)
- N.C. State University

and at GlaxoSmithKline (GSK): multinational based in England is the frontrunner in the pharmaceutical industry to research bioelectric applications in medicine.

Old Dominion University has one of the first bioelectric centers in the world and is among the leading developers of applications for bioelectrical methods.



(<http://www.pulsedpower.eu/>)

Name	Location	Product	Note
BioElectrics	Frederick, MD	Pain relief patches for various uses	http://www.bielcorp.com/ BIEL
ONCOSEC	San Diego, CA	Cancer treatment through bio electric methods (clinical trials)	www.oncosec.com ONCS
Thimble Bioelectrics	San Francisco, CA	Pain treatment through electric methods	http://www.thimblebioe.com/

Biotechnology

IBIS World Summary:

Main activities in the industry are:

- DNA coding, mapping and sequencing
- Processing biotechnologies
- Subcellular organisms engineering
- Cell and tissue culture engineering
- Protein sequencing, synthesis and engineering

Additional resources

- www.bio.org
 - Biotechnology Industry Organization
- www.oecd.org
 - OECD Biotechnology
- www.wipo.int
 - World Intellectual Property Organization

<u>Biotechnology Industry Size</u>	<u>According to IBIS World</u>
<u>Revenue</u>	\$93.0bn
<u>Profit</u>	\$5.0bn
<u>Annual Growth rate (08-13)</u>	4.2%
<u>Expected annual growth rate (13-18)</u>	8.9%
<u>Exports</u>	\$7.0bn
<u>Businesses</u>	1,888
<u>Key Drivers</u>	<ul style="list-style-type: none"> • Investor uncertainty • Research and development expenditure • Number of adults aged 65 and older • Price of corn • Population
<u>Market Segmentation</u>	57% Human health technologies 15% Agriculture and aquaculture technologies 12% Industrial technologies 8% Animal health, marine and terrestrial microbial technologies 8% Environmental remediation and natural resource recovery
<u>Industry Structure</u>	
<u>Life Cycle Stage</u>	Growth. Will grow faster than GDP.
<u>Capital Intensity</u>	Medium.
<u>Regulation Level</u>	Heavy.
<u>Barriers to entry</u>	Medium.
<u>Competition</u>	Medium.
	Biotechnology is a young and quickly growing industry. Highly diversified industry. Growth in agricultural and pharmaceutical demand boost revenues in this industry. Companies in this industry are targets for Mergers and

	Acquisitions, because some of them focus on developing very specialized drugs.
	High upfront cost and high R&D expenses were reasons for a decline in growth (limited expenditures caused by the recession). However, capital markets recovered and will increase growth. FDA approval process was shortened recently, making it possible for companies to bring out new products faster.
	Funding for R&D spurs growth. Small companies relied on funds from larger firms to finance R&D expenses through internal resources.
	Government funding through US Pandemic and All-Hazards Preparedness Act of 2007 guarantees money for advanced medical R&D. Government cuts may cause fewer projects to be funded.
	Big pharmaceutical companies target biotechnology firms due to their diversified product line.
<u>Outlook</u>	The industry is still developing. Growth is expected to pick up in the next five years. M&A and favorable legislation will drive demand.
	Healthcare will also drive demand for this industry. An aging population needs more medication. Tax breaks for small biotechnology companies (Patient Protection and Affordable Care Act). After FDA approval a company is guaranteed a 12-year market exclusivity for their products.
	Ⓞ Demand for ethanol and other biofuels will support growth in the industry's agricultural segment.
<u>Supply Chain</u>	
<u>Buying Industries</u>	<ul style="list-style-type: none"> • Agriculture, Forestry, Fishing and Hunting in the US • Animal Food Production in the US • Petroleum Refining in the US • Fertilizer Manufacturing in the US • Brand Name Pharmaceutical Manufacturing in the US • Generic Pharmaceutical Manufacturing in the US • Veterinary Services in the US • Diagnostic & Medical Laboratories in the US • Public Administration in the US

<p><u>Selling Industries</u></p>	<ul style="list-style-type: none"> • Inorganic Chemical Manufacturing in the US • Organic Chemical Manufacturing in the US • Plastic Pipe & Parts Manufacturing in the US • Hose & Belt Manufacturing in the US • Glass Product Manufacturing in the US • Electrical Equipment Manufacturing in the US • Medical Instrument & Supply Manufacturing in the US • Glasses & Contact Lens Manufacturing in the US • Chemical Wholesaling in the US
<p><u>Products and Services</u></p>	<ul style="list-style-type: none"> • healthcare (including animal health) • crop production and agriculture • industrial • environmental <p>57% Human health technologies 15% Agriculture and aquaculture technologies 12% Industrial technologies 8% Animal health, marine and terrestrial microbial technologies 8% Environmental remediation and natural resource recovery</p> <p>of \$93.0bn</p>
<p><u>Demand</u></p>	<ul style="list-style-type: none"> • Prompting innovation • Driving demand
<p><u>Market segmentation</u></p>	<p>30% Federal, state and local governments 30% Pharmaceutical and medical manufacturers 20% Agriculture and food sectors 15% Resource industries 5% Universities</p>
<p><u>Markets</u></p>	<p>Alabama (0.8%) California (30.6%) Colorado (2.9%) Georgia (3.2%) Indiana (0.8%) Maryland (12.3%) Massachusetts (17.6%) Michigan (2.9%) Missouri (1.7%) North Carolina (20.2%) Ohio (0.8%)</p>

	<p>Oregon (0.5%) Texas (1.5%) Washington (2.9%) Wisconsin (1.3%)</p> <p>Geographic location is promoted by</p> <ul style="list-style-type: none"> • Availability of venture capital and local entrepreneurship; • The availability of federal and state government funding, the level of industry regulation and local tax laws; • A strong research presence (primarily related to the presence of universities and government agencies); • Proximity to a pool of highly skilled personnel (again this is often provided by universities); • Proximity to large private enterprises in a number of related industries; • Proximity to subject of research (i.e. rural areas for agricultural studies and oceans for marine and aquatic studies) <p>California voted for state financing of embryonic stem cell research. NC: research triangle (Duke University, North Carolina State University and the University of North Carolina-Chapel Hill) George/ Atlanta: Center for Disease Control (CDC) is a government agency focusing on</p>
<u>Business Locations</u>	
<u>Market Concentration</u>	<p>There are many hundreds of companies and a few large pharmaceutical, chemical and agricultural firms. The top 4 companies generate about 40% of the annual industry revenue</p> <p>“many large, cash-rich firms in complementary industries (like traditional chemical pharmaceutical manufacturing) have opted to acquire smaller companies that have already built viable products and business models.” (IBIS p.27).</p>
<u>Key Success Factors</u>	<ul style="list-style-type: none"> • Ability to raise financing • Ability to educate the wider community • Concentration on core business • Must comply with required product standards • Access to highly skilled workforce

	<ul style="list-style-type: none"> • Ability to quickly adopt new technology •
<u>Competition</u>	<p>Medium level. Companies compete based on:</p> <ul style="list-style-type: none"> • Intellectual property (IP) • Pricing and customer service • Product performance • External competition
<u>Barriers to Entry</u>	<p>Medium.</p> <p>Strong IP rights prevent companies to enter the market. New companies are typically spin-offs of and require high startup cost. It is common for companies to enter the market by acquiring existing companies.</p>
<u>Globalization</u>	<p>Medium level. United States is a net importer of advanced technologies</p>
<u>Major Companies (but see below for a longer list)</u>	<p>Monsanto Company 6.6%</p> <p>Genentech Inc. 11.2%</p> <p>Gilead Sciences Inc. 7.0%</p> <p>Amgen Inc. 15.0%</p> <p>Others 60.2%</p>
<u>Technology Change</u>	<p>High. Changes and new developments in technology are immediately used in this industry. However, regulations and public opinions buffer the change (e.g. stem cell research).</p>
<u>Capital Intensity</u>	<p>Medium. Laboratories require large amounts of space. Highly specialized employees are a big cost.</p>
<u>Revenue Volatility</u>	<p>Medium. It is relatively young industry and in its growth stage. But it is heavily dependent on government regulations.</p>
<u>Regulation & Policy</u>	<p>Heavy.</p> <ul style="list-style-type: none"> • US Food and Drug Administration (FDA), • Environmental Protection Agency (EPA) • US Department of Agriculture (USDA). • US Patents and Trademarks Office (USPTO)
<u>Industry Assistance</u>	<p>US Department of Health and Human Services (HHS) supports stem cell research.</p> <p>National Institutes of Health (NIH) spent about \$123.0 million to fund human-embryo research grants.</p> <p>National Science Foundation (NSF) helps to promote the advances of this industry.</p>

Includes the fields of:

- Animal cell culture,
- Biochemistry,
- Cell biology,
- Embryology,
- Genetics,
- Microbiology, and
- Molecular biology
- Bioinformatics, a new brand of computer science
- Bioprocess engineering
- Biorobotics
- Chemical engineering

Other Companies:

- Amgen
- Gilead Sciences
- Celgene
- Biogen Idec
- Alexion Pharmaceuticals
- Shire Plc (not on Bloomberg)
- Vortex Pharmaceuticals
- Actelion
- Seattle Genetics
- Cubist Pharmaceuticals
- United Therapeutics
- Ipsen Group
- Regeneron
- OncoSec Medical Incorporated

More companies (small and large) are described on an accompanying Excel file