WHEN ICTS MET HIGHER EDUCATION: Will Bioengineering take advantage of it?: the times are a-changing

II International Seminar on Biomaterials, Biomechanics and Regenerative Medicine
17th September 2015, Medellín

Josep A. Planell
President of the UOC,
Universitat Oberta de Catalunya

98%
study & work

70%
prior university qualification

64%
over 30 years old

More than
58,000
graduates

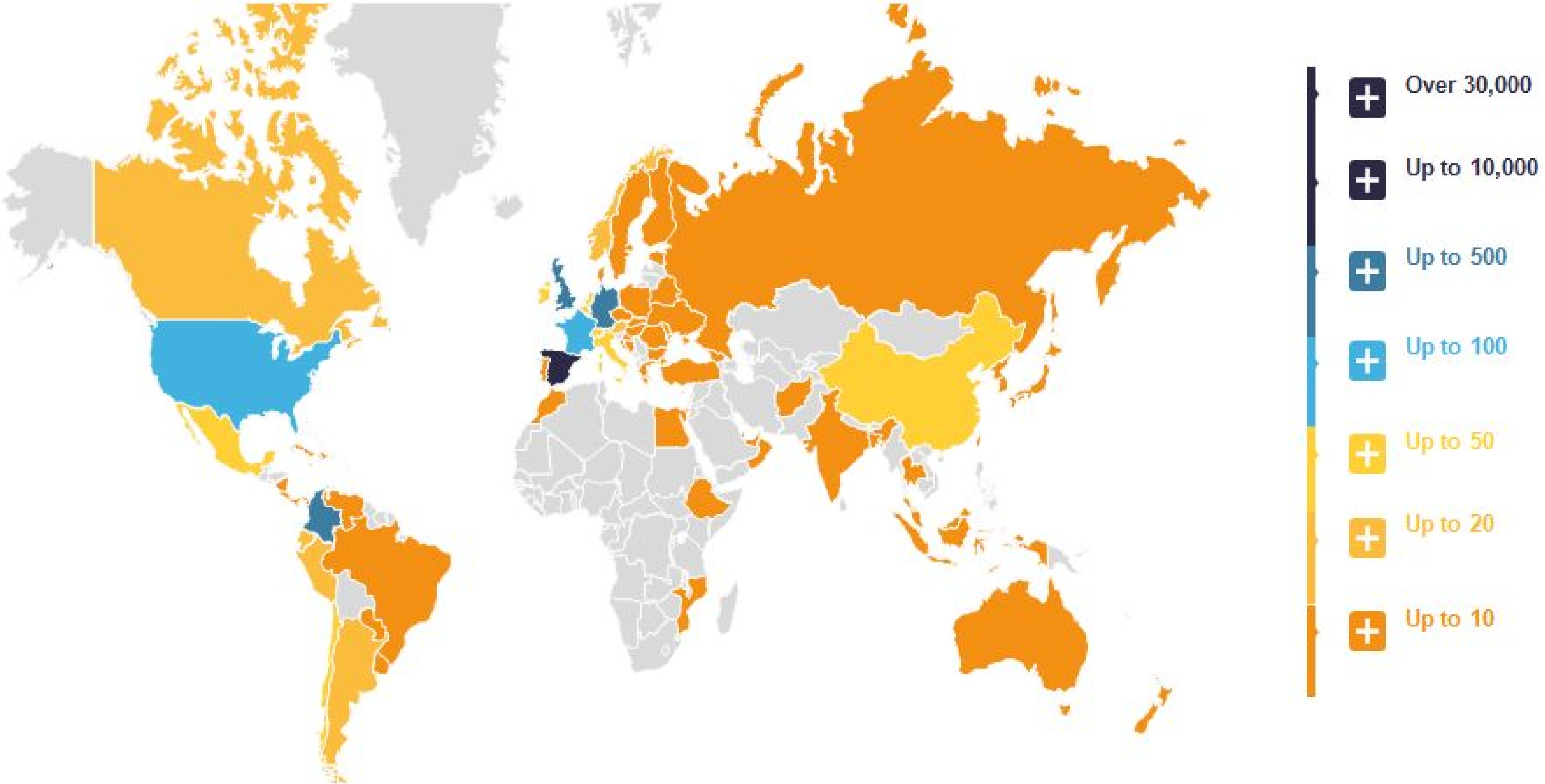
Nearly
4,000
teachers

More than
4,200
subjects taught

More than
150
programmes

More than
150
agreements

Students in more than 70 countries



Change of paradigm

Traditional society

- **Education in** critical thought and creation
- **Fields or disciplines**: philosophy, science, art, humanities
- ***To know***

Industrial Society

- **Education** professionalitzation at high level d'alt
- **Professions**: engineering, nursing, management, economy, teaching, medicine...
- ***To know & To know how to do***

Informational Society

- **Education** in? (may be on competencies, on interdisciplinarity?)
- ???? (**ocupations** that do not exist yet)
- **The student determines** what he needs to know and what he needs to do

When ICTs met Higher Education, could they just be good friends, or something else should have happened?

How long should we wait for something to happen?

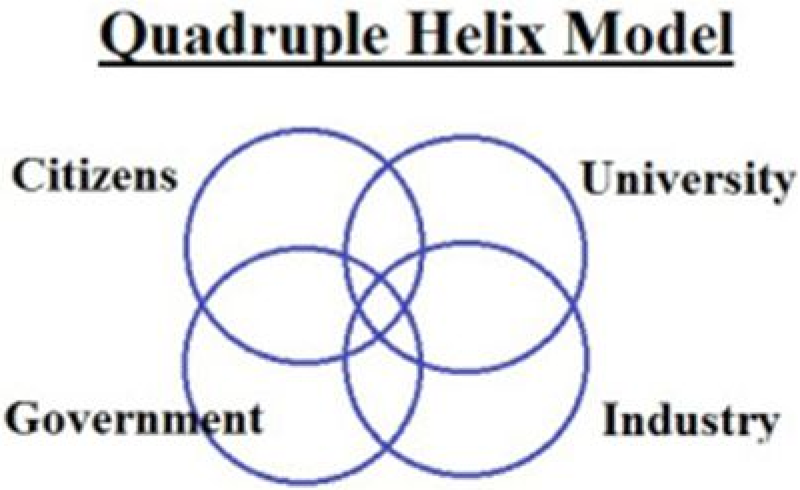
If eventually something happens, what type of relationship should we expect?




Diversity of students and uniformity facing the syllabus

Technology may help to personalize higher education

We should consider that the student is part of the quadruple helix of education



«The leaders of EU should recognize that high quality instruction is as medular for universities as pioneering research. While they coincide that researchers require a wide and long training, there is the prevalent hypothesis that great teachers are just born as such, and that high quality education just happens: such vision causes difficulties in education at all levels»

Mary McAleese, Ireland past-president and president of the High Level Group on Modernization of Higher Education of the EU

(La Vanguardia, 15th February 2014)

It is usually taken for granted that a group of students sitting in an amphitheater, in front of a professor with high expertise in the matter, and teaching his own knowledge, is sufficient warranty for high quality education.

Globalization of Higher Education

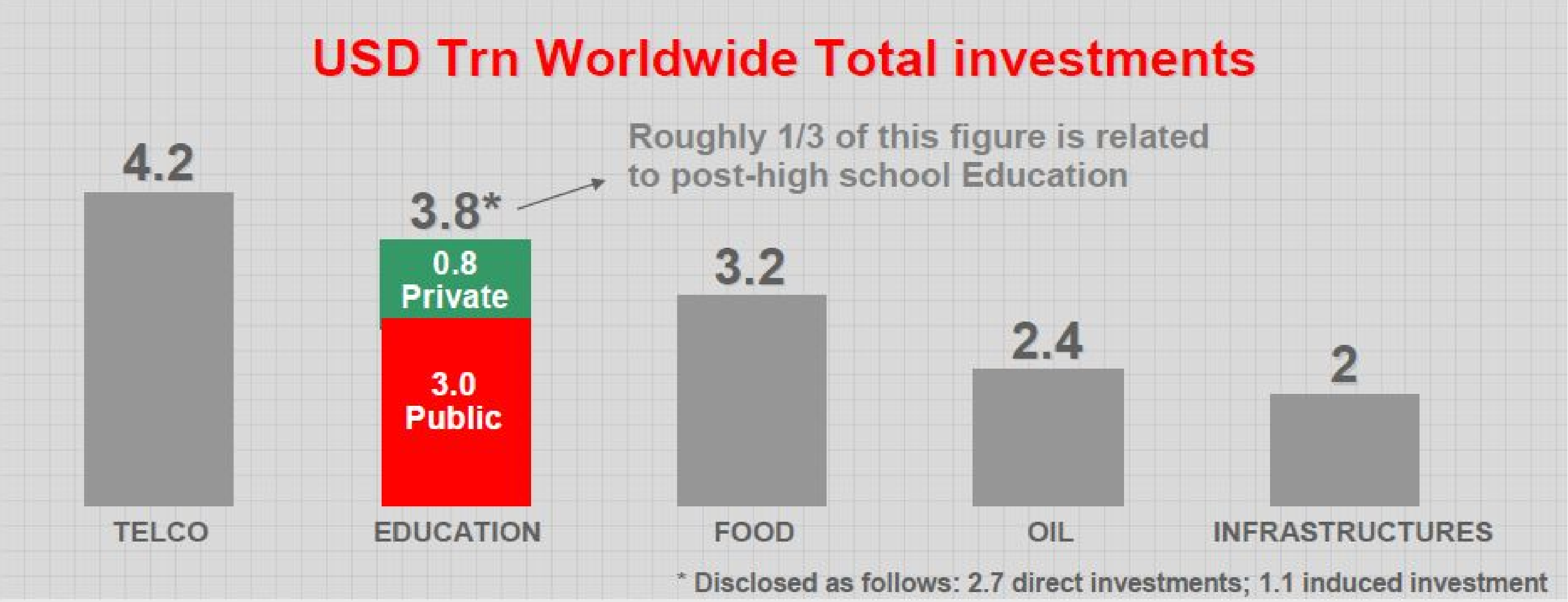
- Increased intensity of recruitment of students and faculty
- Branch campuses
- Mobilization of huge funds to create world-class universities (by upgrading existing ones or by creating and building new ones)
- Innovative efforts by on-line universities and for-profit institutions to fill unmet needs in higher education markets worldwide
- Relevance of rankings

Educación en el mundo: algunas cifras

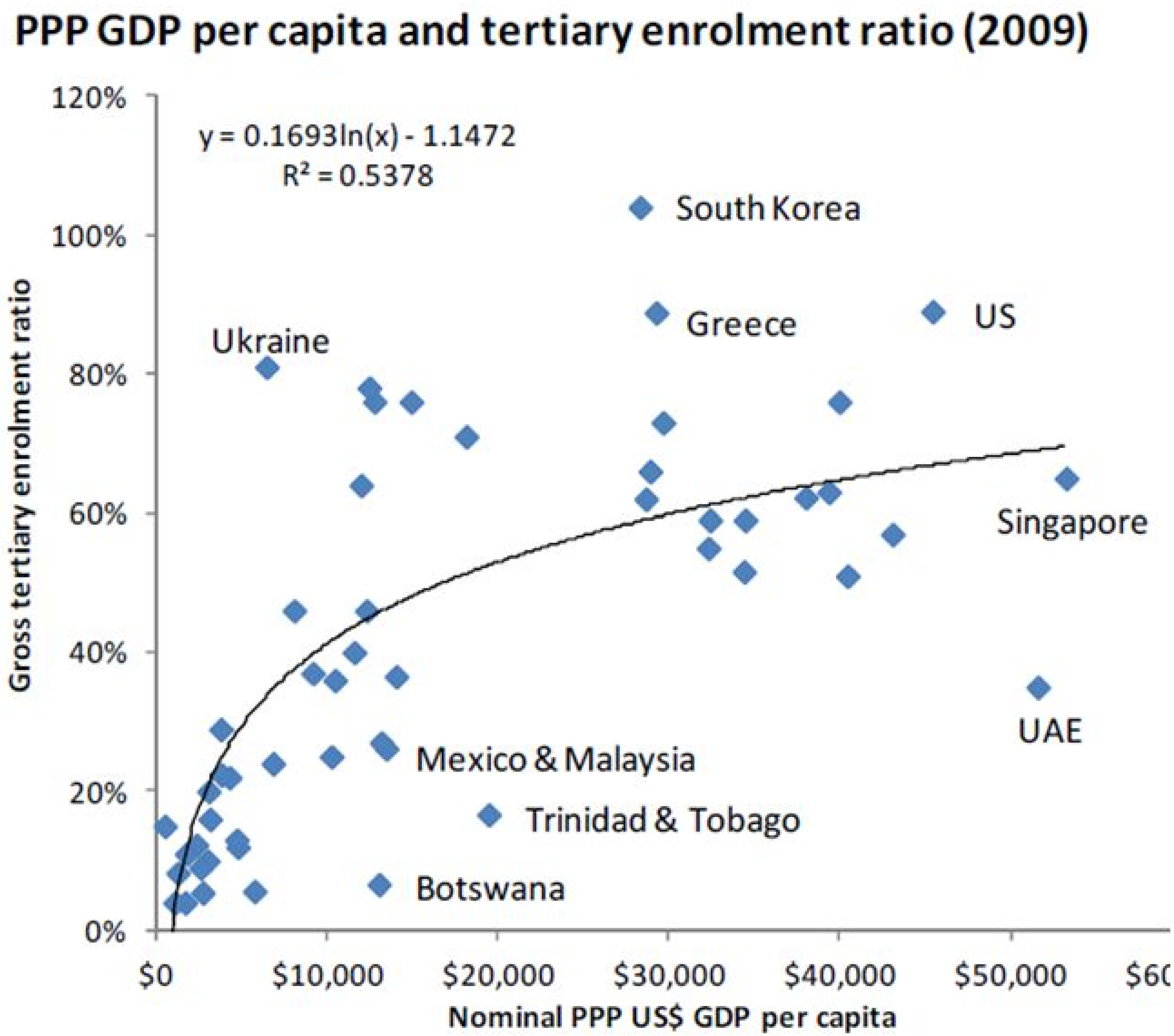
185 Mn people attending Universities (2.5% of the population)

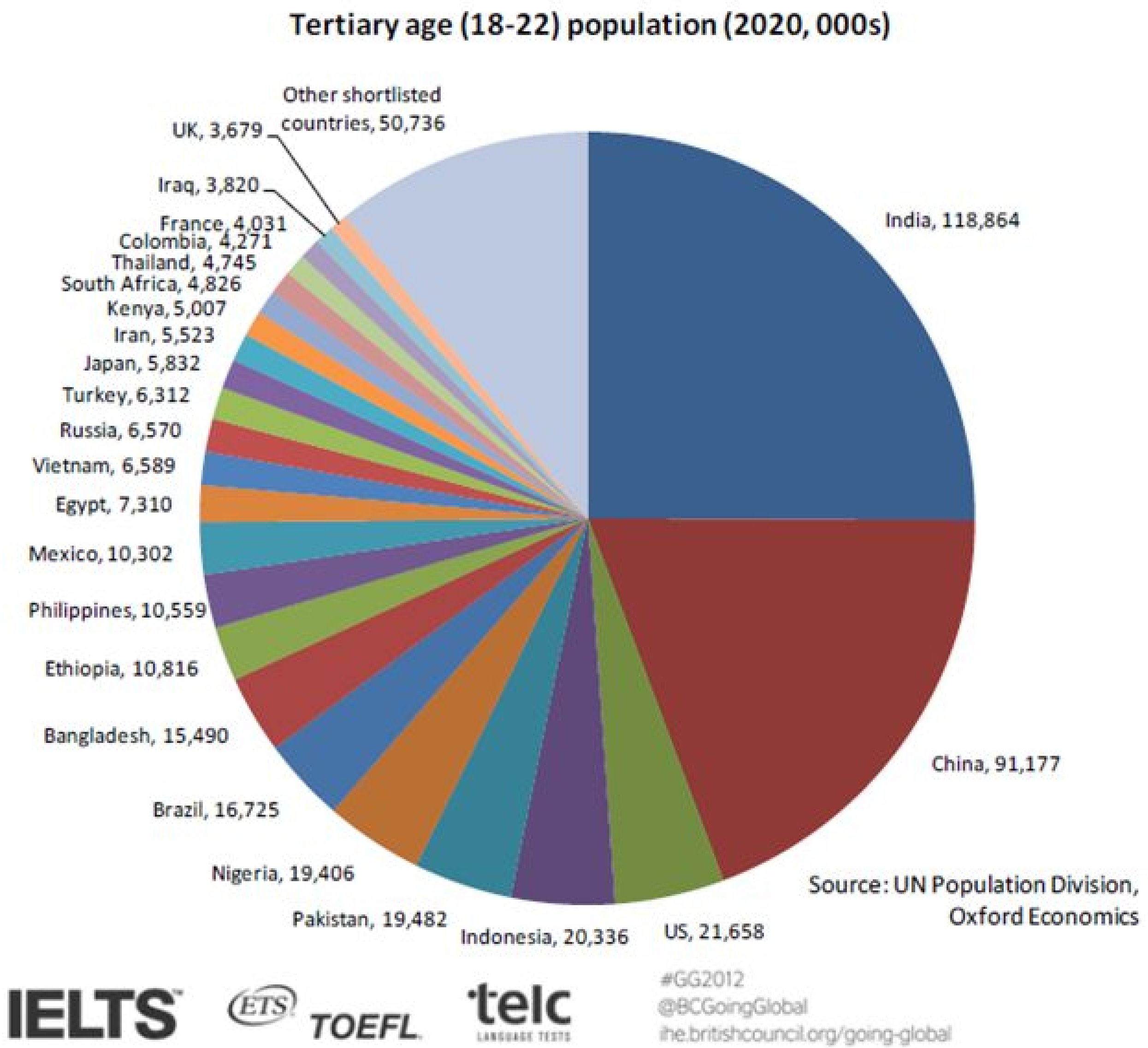
3 Mn University Students included in International mobility programmes

Education represents **4.3% of world GDP**



Source: McKinsey – Global forum for leaders in Education 2011


PPP GDP per capita and tertiary enrolment ratio (2009)
y = 0.1693ln(x) - 1.1472
R² = 0.5378
South Korea
Greece
US
Ukraine
Singapore
UAE
Mexico & Malaysia
Trinidad & Tobago
Botswana
120%
100%
80%
60%
40%
20%
0%
Gross tertiary enrolment ratio
$0
$10,000
$20,000
$30,000
$40,000
$50,000
Nominal PPP US$ GDP per capita

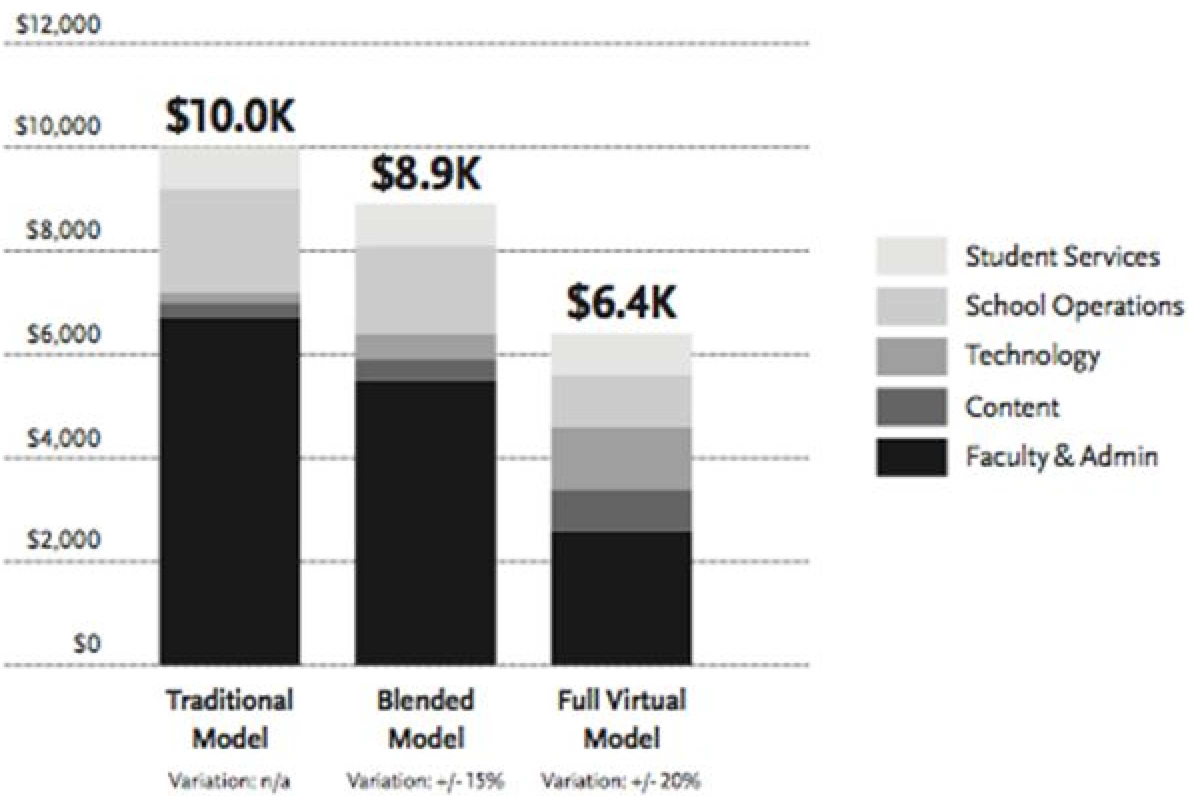

Tertiary age (18-22) population (2020, 000s)
Other shortlisted countries, 50,736
UK, 3,679
Iraq, 3,820
France, 4,031
Colombia, 4,271
Thailand, 4,745
South Africa, 4,826
Kenya, 5,007
Iran, 5,523
Japan, 5,832
Turkey, 6,312
Russia, 6,570
Vietnam, 6,589
Egypt, 7,310
Mexico, 10,302
Philippines, 10,559
Ethiopia, 10,816
Bangladesh, 15,490
Brazil, 16,725
Nigeria, 19,406
Pakistan, 19,482
Indonesia, 20,336
US, 21,658
China, 91,177
India, 118,864
Source: UN Population Division, Oxford Economics
IELTS
ETS TOEFL
telc LANGUAGE TESTS
#GG2012
@BCGoingGlobal
ihe.britishcouncil.org/going-global

The demand of higher education globally considered was about 100 million in 2009 and the estimation for 2030 is about 400 million (OCDE, 2008).

In order to satisfy this demand, it would be necessary to create 2 universities for 20.000 students every day during the next 20 years.

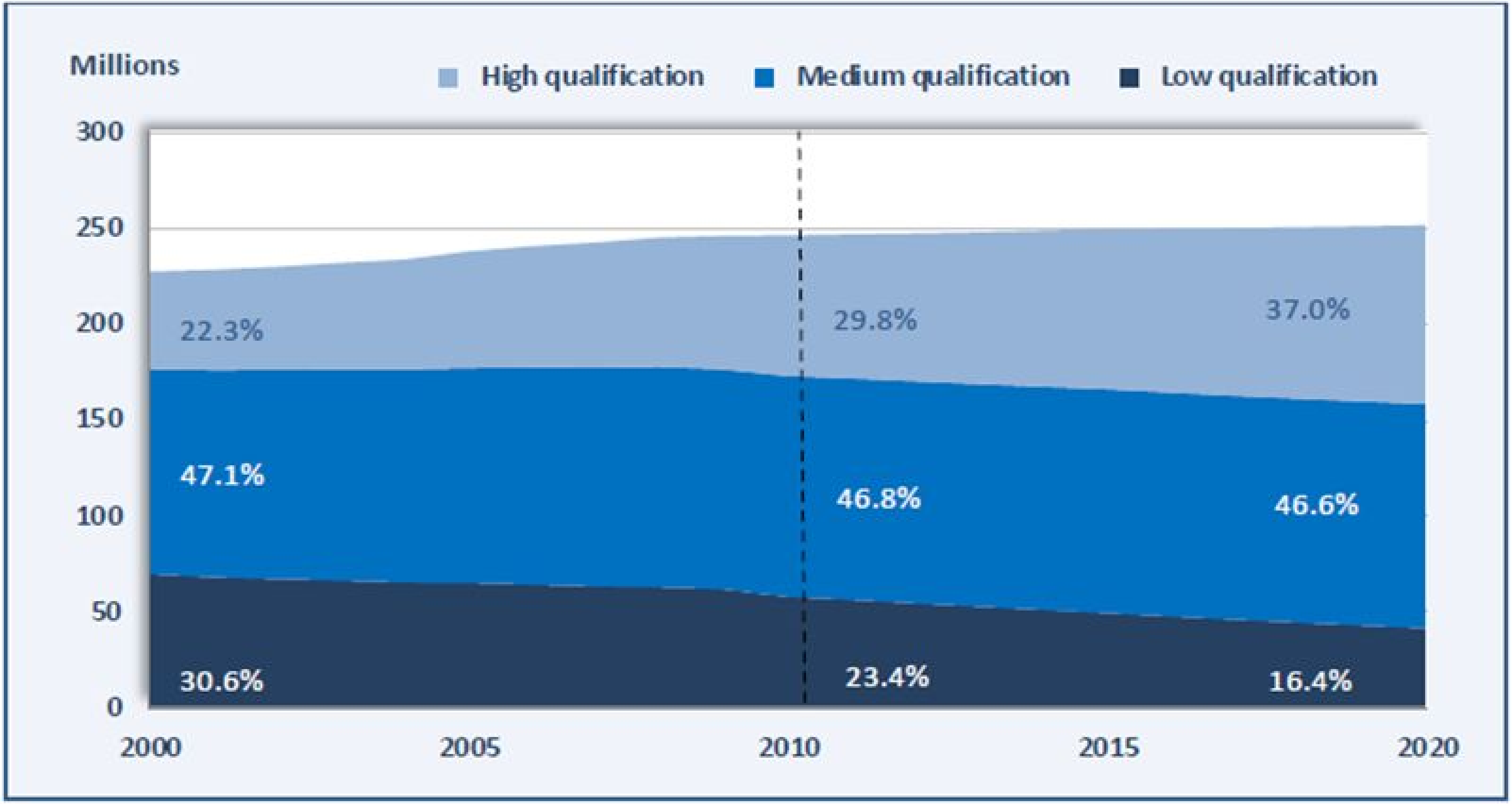
Is it really possible to create this large number of face to face universities with public funds?

Figure 3.1: Estimated Per-Pupil Expenditures



Battaglino, T. B., Haldeman, M., Laurans, E. (2012). The Costs of Online Learning. In Finn, C. E., & Fairchild, D. R.. Education Reform for the Digital Era (pp. 55-76). Thomas B. Fordham Institute.

Figure d **Labour force by level of qualification, 2000-20, EU-27+**



Source: Cedefop (IER estimates).

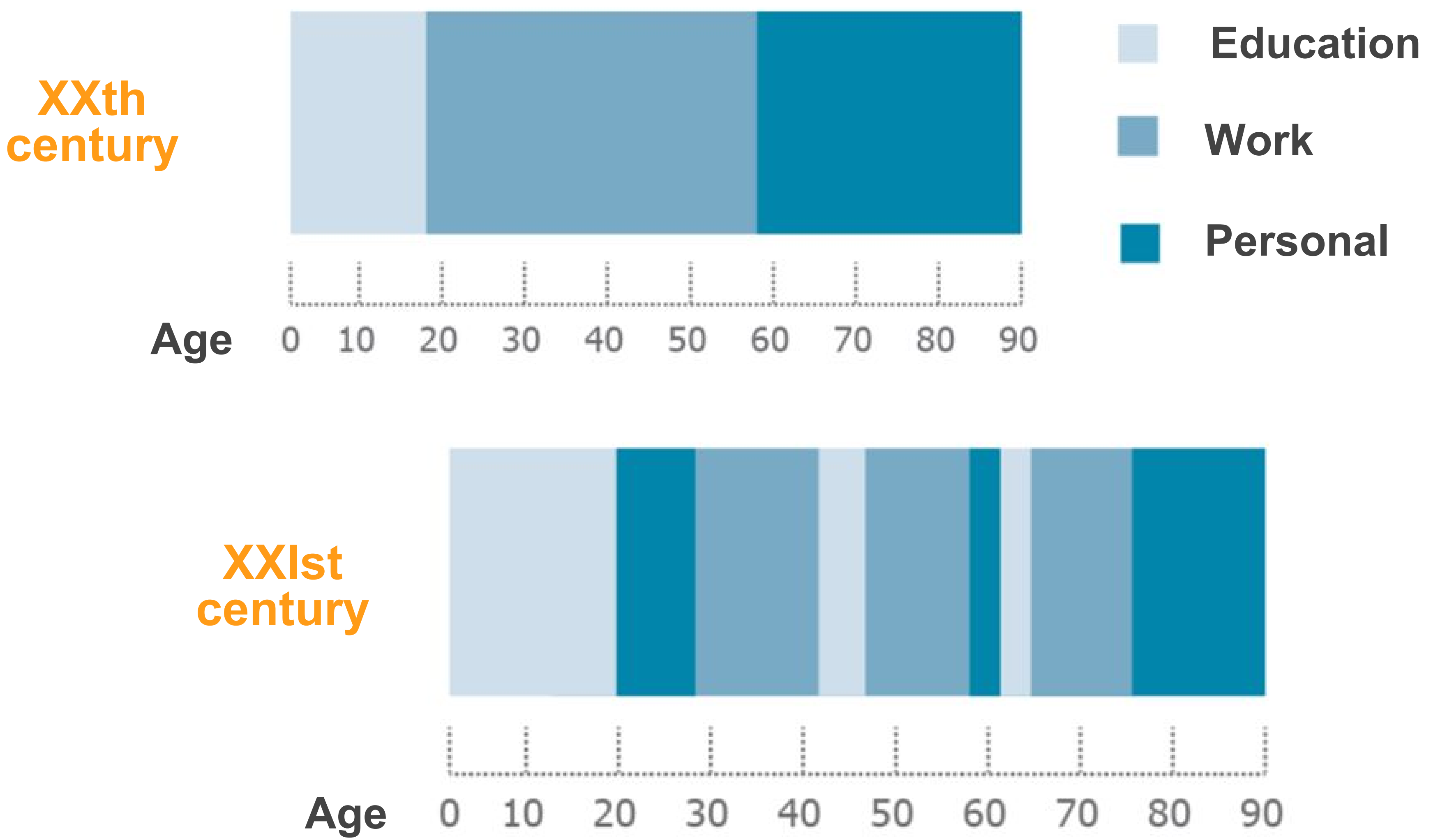
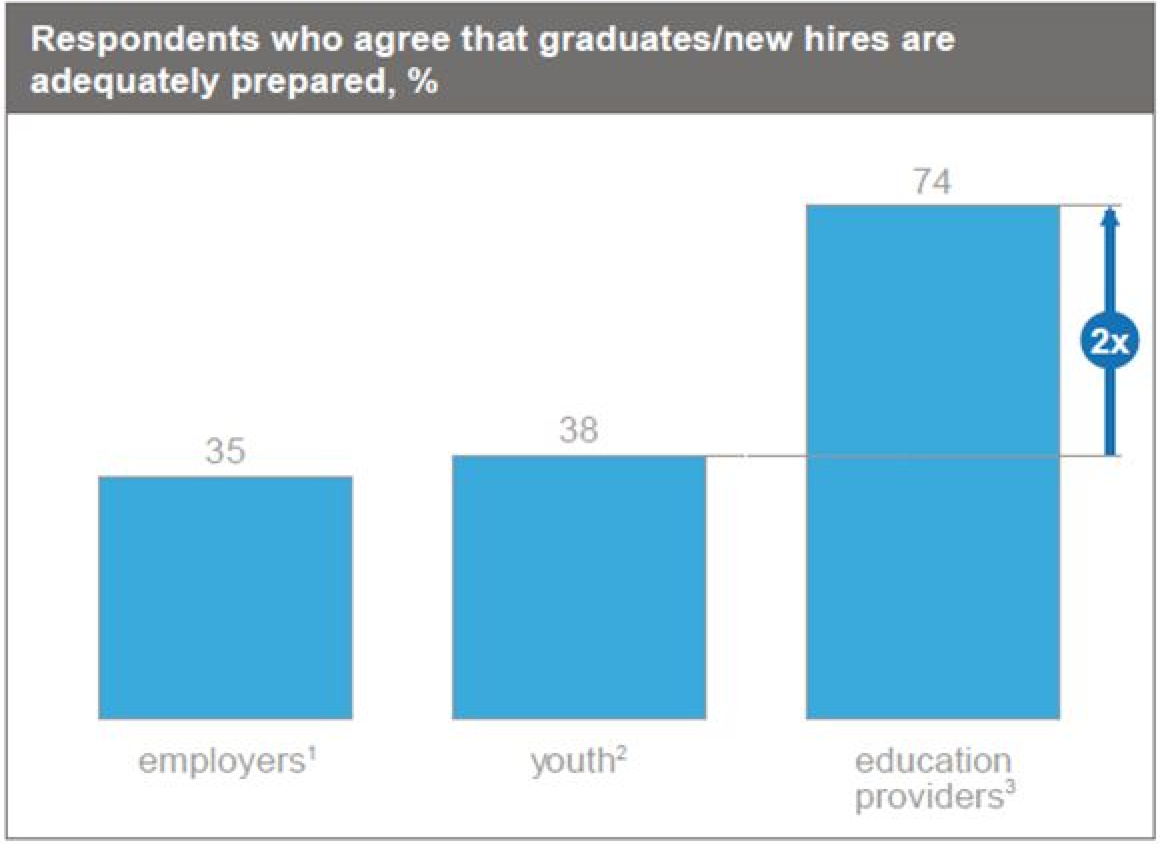

XXth century
Education
Work
Personal
Age
0
10
20
30
40
50
60
70
80
90
XXIst century
Age
0
10
20
30
40
50
60
70
80
90

Exhibit 2

Providers are twice as likely as employers and youth to rate youth as prepared



1 Overall, the entry-level employees we hired in the past year have been adequately prepared by their prehire education and/or training.
2 Overall, I think I was adequately prepared for an entry-level position in my chosen career field.
3 Overall, graduates from my institution are adequately prepared for entry-level positions in their chosen field of study.

Source: McKinsey survey, Aug–Sept 2012, 2013


ONE SIZE FITS ALL?
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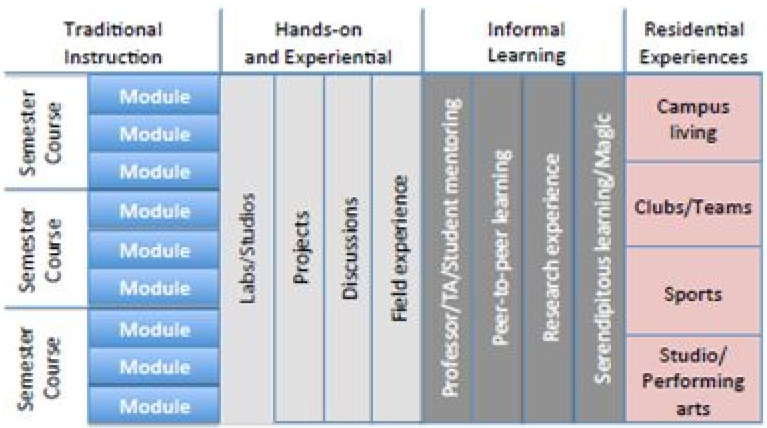
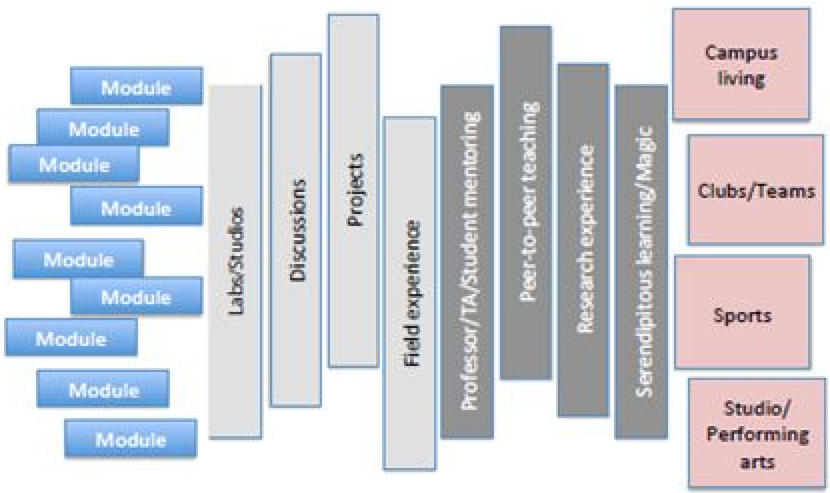
(1964)

Come gather 'round people
Wherever you roam
And admit that the waters
Around you have grown
And accept it that soon
You'll be drenched to the bone
If your time to you
Is worth savin'
Then you better start swimmin'
Or you'll sink like a stone
For the times they are a-changin'.
Come mothers and fathers
Throughout the land
And don't criticize
What you can't understand
Your sons and your daughters
Are beyond your command
Your old road is
Rapidly agin'
Please get out of the new one
If you can't lend your hand
For the times they are a-changin'.

Figure 1. Unbundling of education





Institute-wide Task Force on the Future of MIT Education

Final Report

July 28, 2014

Figure 8a. Student takes a class for personal edification

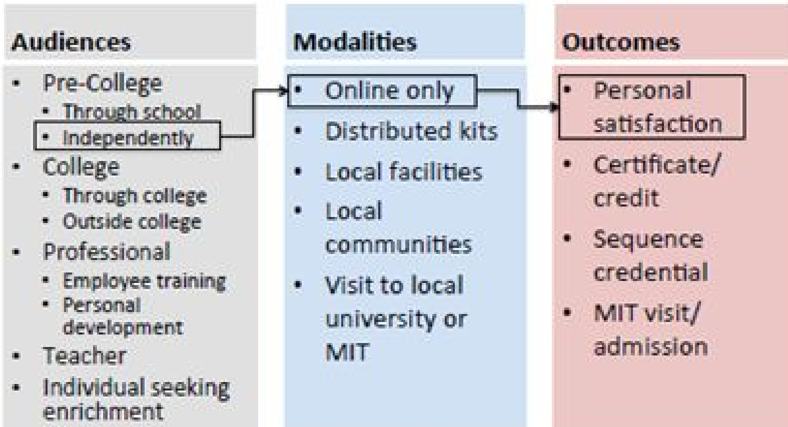


Figure 8d. Student takes a class in SPOC form while embedded in institution

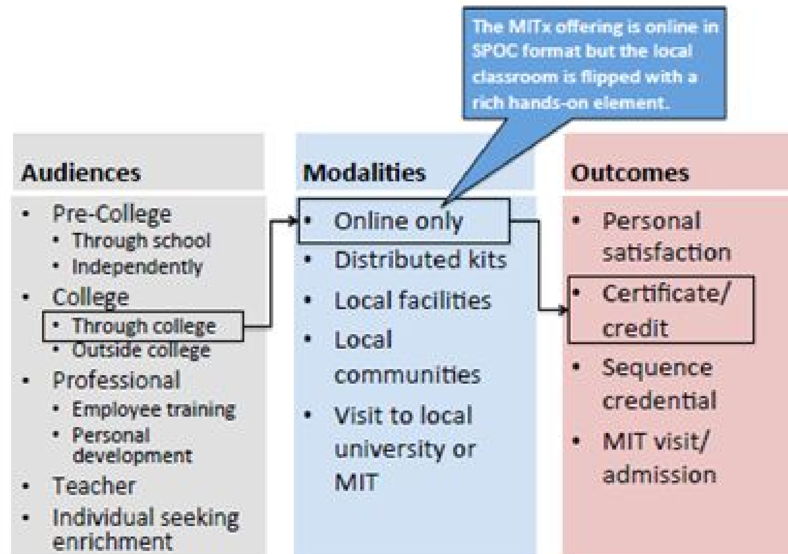


Figure 8f. Professional takes a class while embedded in a company

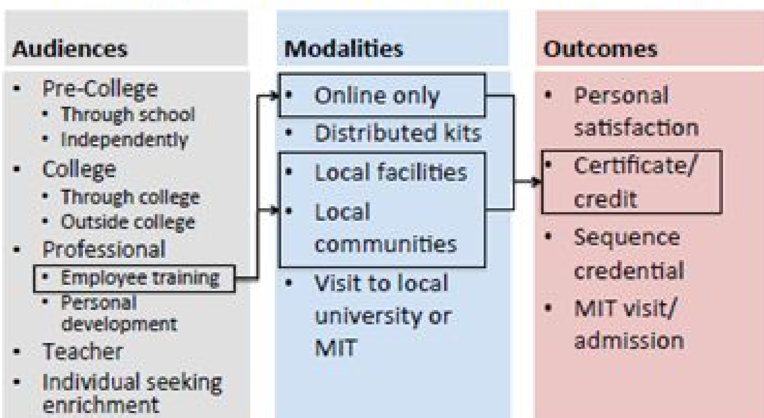


Figure 28. How we have evolved: Headcount 1981 vs. 2011

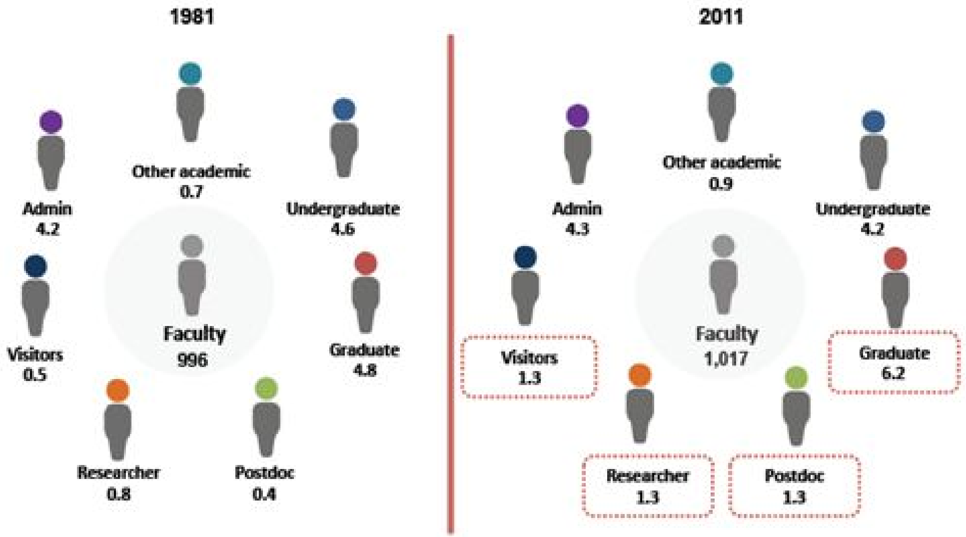
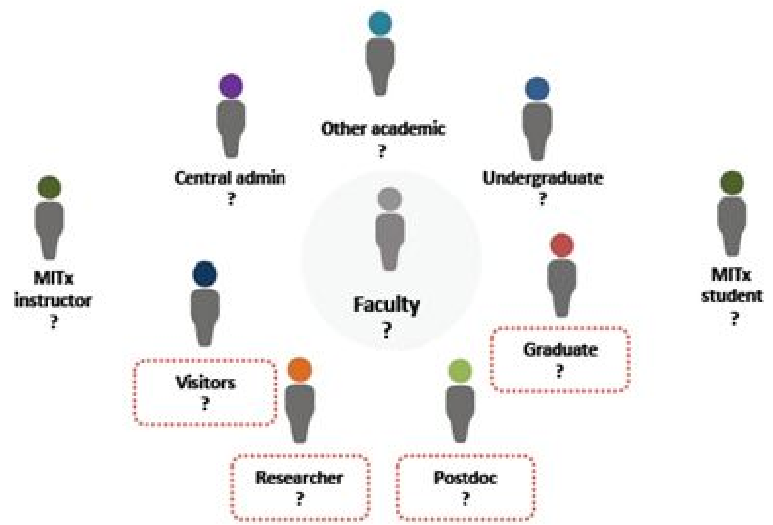
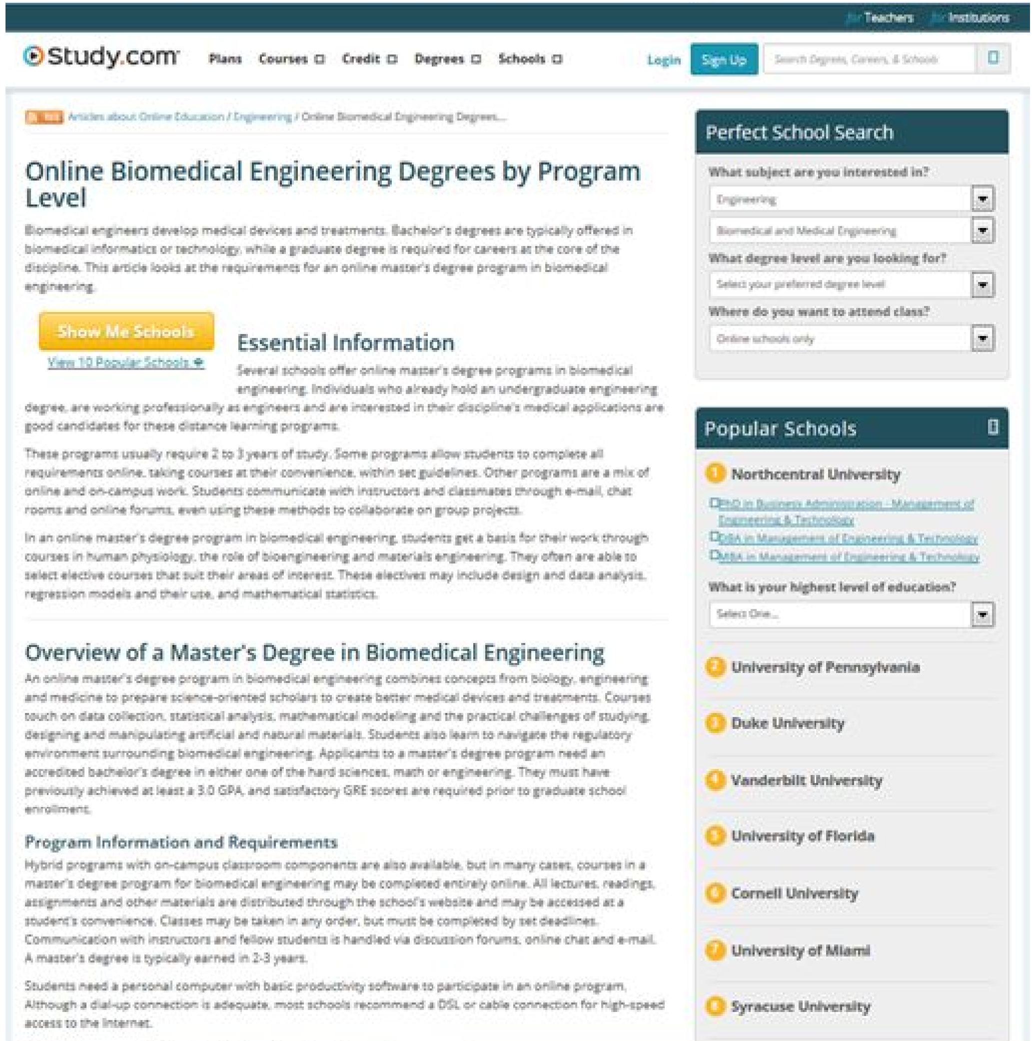


Figure 29. Looking forward: What will we look like in 2020?





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Articles about Online Education / Engineering / Online Biomedical Engineering Degrees...

Online Biomedical Engineering Degrees by Program Level

Biomedical engineers develop medical devices and treatments. Bachelor's degrees are typically offered in biomedical informatics or technology, while a graduate degree is required for careers at the core of the discipline. This article looks at the requirements for an online master's degree program in biomedical engineering.

Show Me Schools

View 10 Popular Schools

Essential Information

Several schools offer online master's degree programs in biomedical engineering. Individuals who already hold an undergraduate engineering degree, are working professionally as engineers and are interested in their discipline's medical applications are good candidates for these distance learning programs.

These programs usually require 2 to 3 years of study. Some programs allow students to complete all requirements online, taking courses at their convenience, within set guidelines. Other programs are a mix of online and on-campus work. Students communicate with instructors and classmates through e-mail, chat rooms and online forums, even using these methods to collaborate on group projects.

In an online master's degree program in biomedical engineering, students get a basis for their work through courses in human physiology, the role of bioengineering and materials engineering. They often are able to select elective courses that suit their areas of interest. These electives may include design and data analysis, regression models and their use, and mathematical statistics.

Overview of a Master's Degree in Biomedical Engineering

An online master's degree program in biomedical engineering combines concepts from biology, engineering and medicine to prepare science-oriented scholars to create better medical devices and treatments. Courses touch on data collection, statistical analysis, mathematical modeling and the practical challenges of studying, designing and manipulating artificial and natural materials. Students also learn to navigate the regulatory environment surrounding biomedical engineering. Applicants to a master's degree program need an accredited bachelor's degree in either one of the hard sciences, math or engineering. They must have previously achieved at least a 3.0 GPA, and satisfactory GRE scores are required prior to graduate school enrollment.

Program Information and Requirements

Hybrid programs with on-campus classroom components are also available, but in many cases, courses in a master's degree program for biomedical engineering may be completed entirely online. All lectures, readings, assignments and other materials are distributed through the school's website and may be accessed at a student's convenience. Classes may be taken in any order, but must be completed by set deadlines. Communication with instructors and fellow students is handled via discussion forums, online chat and e-mail. A master's degree is typically earned in 2-3 years.

Students need a personal computer with basic productivity software to participate in an online program. Although a dial-up connection is adequate, most schools recommend a DSL or cable connection for high-speed access to the Internet.

Perfect School Search

What subject are you interested in?

Engineering

Biomedical and Medical Engineering

What degree level are you looking for?

Select your preferred degree level

Where do you want to attend class?

Online schools only

Popular Schools

1 Northcentral University

- PhD in Business Administration - Management of Engineering & Technology
- DBA in Management of Engineering & Technology
- MBA in Management of Engineering & Technology

What is your highest level of education?

Select One...

2 University of Pennsylvania

3 Duke University

4 Vanderbilt University

5 University of Florida

6 Cornell University

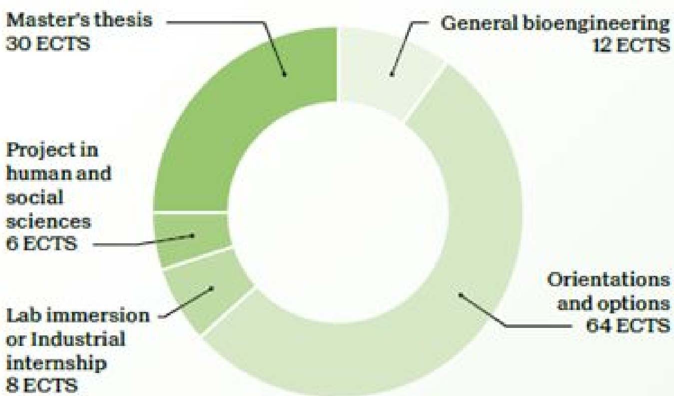
7 University of Miami

8 Syracuse University

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

Master of Science in
BIOENGINEERING

2-year program - 120 ECTS



Students must choose at least 12 ECTS in one of the orientations A to E and at least 3 credits in domain F.

Students can also opt for a 30 ECTS Minor. Minors recommended with this Master:

- Biotechnology
- Biomedical Technologies
- Neuroprosthetics

This program includes an 8-week compulsory internship in industry.

	Orientation							Credits
General bioengineering								**12**
Analysis and Modelling of Locomotion								3
Biomicroscopy I								3
Fundamentals of Neuroengineering								4
Materials Science								3
Principles and Applications of Systems Biology								3
Stem Cell Biology and Technology								3
Orientations and options								**64**
Regenerative Medicine	A							
Biomechanical Engineering		B						
Systems Bioengineering			C					
Nanoscale bioengineering				D				
Biophotonics and bioimaging					E			
Law, Organization and Economics in LST						F		
Scientific Thinking							G	
Advanced Analysis I, II								8
Advanced Bioengineering Methods Laboratory				D				4
Artificial Organs and Systems								4
Biomaterials	A	B						3
Biomechanics of the Cardiovascular System		B						3
Biomechanics of the Musculoskeletal System		B						5
Biomedical Optics								3
BioMEMS	A							2
Biomicroscopy II	A				E			4
Biomolecular Structure and Mechanics			C	D				4
Biophysics I, II								6
Chemical Biology - Tools and Methods				D				3
Computational Motor Control		B						4
Data Analysis and Model Classification								4
Diffraction Methods in Structural Biology				D				4
Dynamical System Theory for engineers			C		E			4
Economics of innovation in the biomedical industry						F		3
Flexible bioelectronics								3
Fundamentals of Biomedical Imaging					E			4
Fundamentals of Biophotonics					E			3
Fundamentals of biosensors and electronic biochips				D				3
Genomics and Bioinformatics	A		C					4
Image Processing I, II					E			6
Introduction au droit et à l'éthique en STV						F		3
Lab methods: Animal Experimentation								2

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MSc in Biomedical Engineering with Biomaterials and Tissue Engineering

The Biomaterials and Tissue Engineering stream is offered jointly with the Department of Materials and focuses on the design and synthesis of new materials that will be used as implants or prostheses. Key to implant development is the understanding of how the material design affects biological response. An example is total joint replacement: understanding materials selection and properties and the advantages and disadvantages of their use and long term effects. Another example is the design of temporary templates (scaffolds) that can act as guides for tissue repair and can signal stem cells depending on their surface chemistry and topography. Depending on their design, materials can be degradable, can stimulate tissue growth at the cellular level and can release drugs at controlled rates. The design of the material is very specific to the tissue that is being repaired or the drug being delivered. Techniques for imaging the cell-material interactions are also important.

Course structure

Numbers in brackets are taught hours. C=core element. S=specialist element. Click on a module to see its syllabus

Compulsory modules

- MSE315 Biomaterials (30) S
- MSE418 Advanced tissue engineering (30) S
- MSE417 Advanced biomaterials (30) S
- BE9-MSPHYS Systems physiology (30) C
- BE9-MSTDA Statistics and data analysis (30) C
- BE9-MBIMG Biomedical imaging (30) C
- BE9-MMDC Medical Device Certification (20) C
- BE9-MJCLUB Journal club (10) C

Option modules (at least two must be chosen)

- BE9-MBMX Biomechanics (30) S
- E4.55 MEMS and nanotechnology (30) S
- BE4-MAMI Advanced medical imaging (30) S
- BE3-HIPR Image processing (30) S
- BE9-MHEDM Health economics and decision making (30) S
- BE9-MOBMX Orthopaedic biomechanics (30) S
- BE9-MAPMDA Advanced physiological monitoring and data analysis (30) S

Project

Back to Bioengineering
Back to Study
Back to MSc programme

Biomaterials stream

- Option modules
- Core modules

Curriculum

The curriculum is divided into four different categories:

- Core and Foundation – develop a foundation in biomedical engineering
- Depth – gain more knowledge in a particular interest area
- Breadth – focus on advanced and applied mathematics

Core (7 credits required)

- BIOM 570 – Bioengineering (3 cr.)
- BIOM/MECH 576 – Quantitative Systems Physiology (4 cr.)
  OR
- BMS 300 – Principles of Human Physiology (4 cr.)

Foundation (12 credits required)

- BIOM 526 – Biological Physics (3 cr.)
- BIOM 531 – Materials Engineering (3 cr.)
- BIOM 532 – Material Issues in Mechanical Design (3 cr.)
- BIOM 543 – Membranes for Biotechnology and Biomedicine (3 cr.)
- BIOM 573 – Structure and Function of Biomaterials (3 cr.)
- BIOM 525 – Cell/Tissue Engineering (3 cr.)

Depth (minimum of 8 credits required)

- CBE 430 – Process Control and Instrumentation (3 cr.)
- ECE 512 – Digital Signal Processing (3 cr.)
- MECH 502 – Advanced/Additive Manufacturing Engineering (3 cr.)
- MECH 530 – Advanced Composite Materials (3 cr.)
- BIOM 532 – Material Issues in Mechanical Design (3 cr.)
- BIOM 592* – Seminar (1 cr.)
  *Can be repeated up to 4 times at 1 cr. per semester

Breadth (3 credits required)

- STAT 511 – Design and Data Analysis for Researchers I (4 cr.)
  OR
- STAT 512 – Design and Data Analysis for Researchers II (4 cr.)
- STAA 511 – Regression Models and Applications (2 cr.)
- STAA 552 – Generalized Regression Models (2 cr.)
- STAA 562 – Mathematical Statistics with Applications (2 cr.)
- STAA 572 – Nonparametric Methods (1 cr.)
- STAA 573 – Analysis of Time Series (2 cr.)
- BIOM 592* – Seminar (1 cr.)
  *Can be repeated up to 4 times at 1 cr. per semester

Minimum Admission Requirements

- B.S. in engineering, life sciences, or natural sciences from a regionally-accredited institution
- GPA of 3.0 or higher in engineering or life science courses
- Calculus 1, 2, and 3
- Ordinary Differential Equations
- Physics 1 and 2 (calculus-based preferred)
- At least one semester of Life Science (biology, physiology, etc.)

Completion Requirements

- A minimum of 30 semester credits
- 7 credits of Core courses, 12 credits of Foundation courses, at least 8 credits of Depth courses, and 3 credits in the Breadth area
- 24 semester credits must be earned at Colorado State University, 21 of which must be earned after formal admission.
- 24 credits earned at CSU must be at the graduate level (500-level or above), excluding independent study, research, internship, or practicum credits.
- 15 credits of biomedical engineering (BIOM) courses
- Your program of study must be approved by an advisor prior to completing 15 credits toward the degree.

Contact our Student Success Team to get started!

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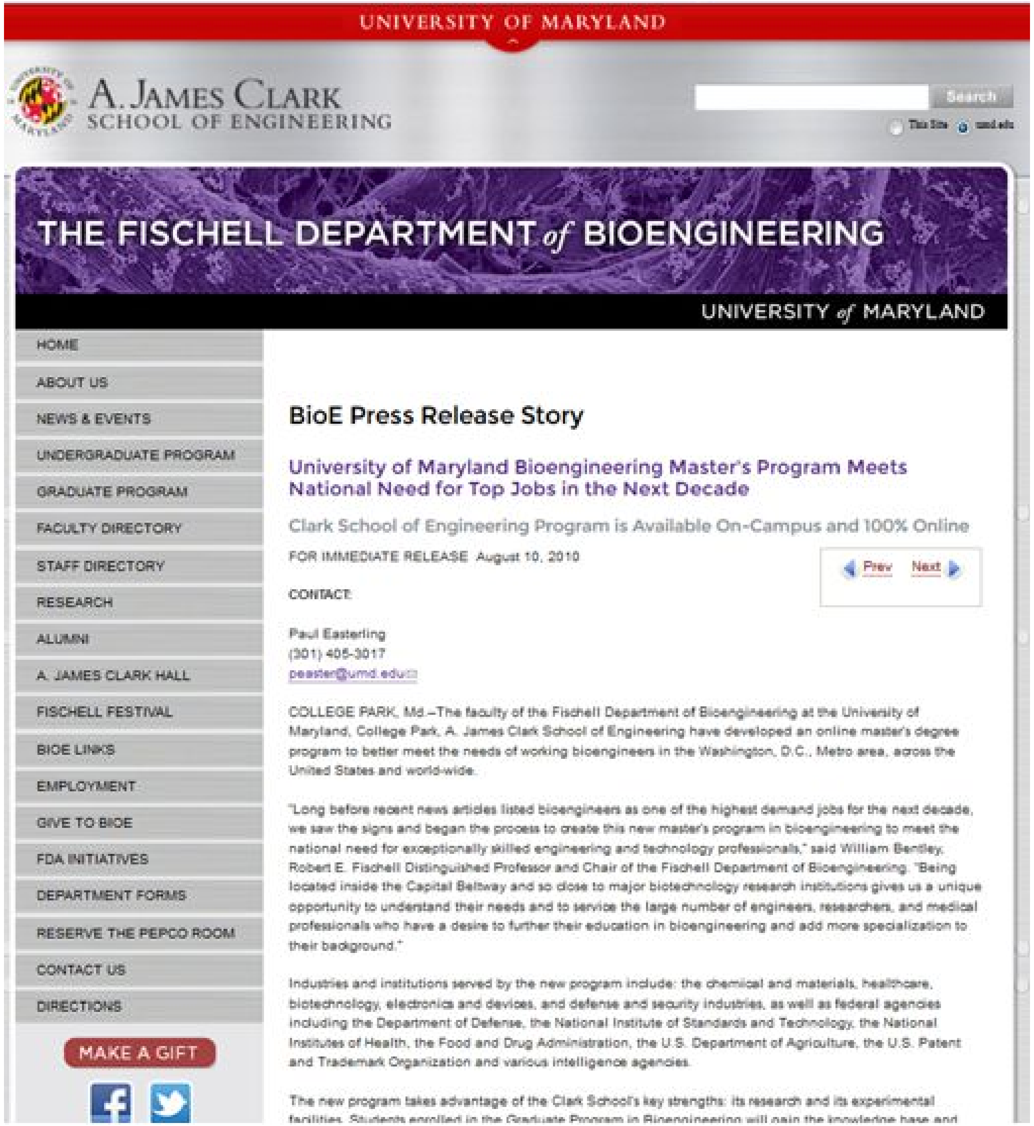

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BioE Press Release Story

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Clark School of Engineering Program is Available On-Campus and 100% Online

FOR IMMEDIATE RELEASE August 10, 2010

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(301) 405-3017
peaster@umd.edu

COLLEGE PARK, Md.–The faculty of the Fischell Department of Bioengineering at the University of Maryland, College Park, A. James Clark School of Engineering have developed an online master's degree program to better meet the needs of working bioengineers in the Washington, D.C., Metro area, across the United States and world-wide.

"Long before recent news articles listed bioengineers as one of the highest demand jobs for the next decade, we saw the signs and began the process to create this new master's program in bioengineering to meet the national need for exceptionally skilled engineering and technology professionals," said William Bentley, Robert E. Fischell Distinguished Professor and Chair of the Fischell Department of Bioengineering. "Being located inside the Capital Beltway and so close to major biotechnology research institutions gives us a unique opportunity to understand their needs and to service the large number of engineers, researchers, and medical professionals who have a desire to further their education in bioengineering and add more specialization to their background."

Industries and institutions served by the new program include: the chemical and materials, healthcare, biotechnology, electronics and devices, and defense and security industries, as well as federal agencies including the Department of Defense, the National Institute of Standards and Technology, the National Institutes of Health, the Food and Drug Administration, the U.S. Department of Agriculture, the U.S. Patent and Trademark Organization and various intelligence agencies.

The new program takes advantage of the Clark School's key strengths: its research and its experimental

Partnership Grant) and the Center for Genomic and Phenomic Studies in Autism (NIH). We rank in the top tier of all U.S. BME departments in terms of research funding per faculty.

Our undergraduate program, which began in 1974, is among the most established in the world and offers specialized options that emphasize biochemical engineering, electrical engineering and mechanical engineering. Year after year, the students in our freshman class have proven to be among the best at USC, with average SAT scores that are consistently higher than the average SAT scores of all USC freshmen. Our department also claims a large share of all Trustee and Presidential Scholarships awarded to the brightest freshmen entering USC. Upon graduation, our students generally continue with post-bacalaureate training in medical, dental or graduate school, or take on jobs in some of the thousands of biomedical companies located in Southern California.

We thank you for taking the time to visit our site, and we certainly look forward to seeing you at USC.

Michael C.K. Khoo, Ph.D.
Professor of Biomedical Engineering and Pediatrics
Interim Chair

Master's Program Application Deadlines

FALL - January 15	SPRING - September 15

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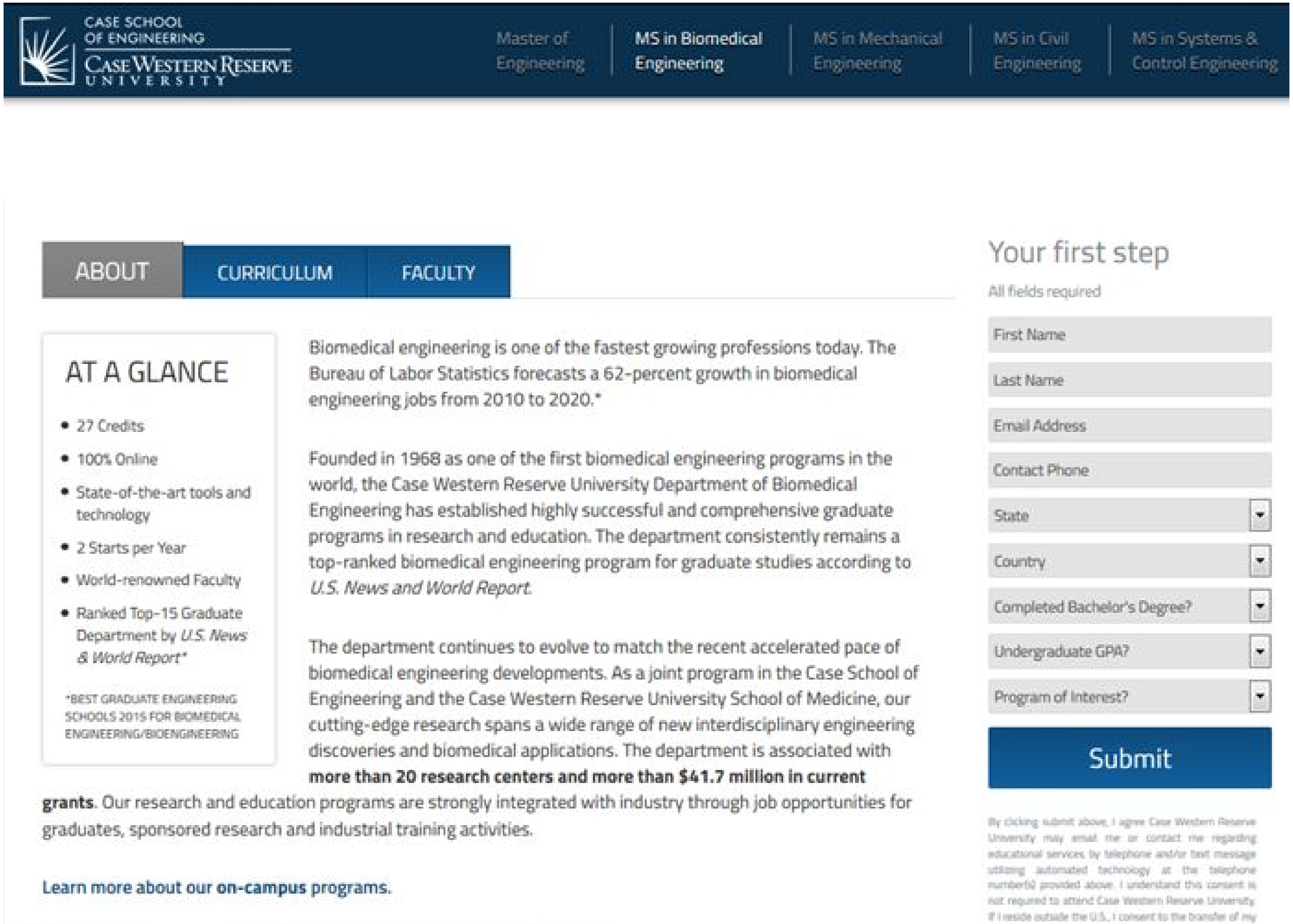

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*BEST GRADUATE ENGINEERING SCHOOLS 2015 FOR BIOMEDICAL ENGINEERING/BIOENGINEERING

Biomedical engineering is one of the fastest growing professions today. The Bureau of Labor Statistics forecasts a 62-percent growth in biomedical engineering jobs from 2010 to 2020.*

Founded in 1968 as one of the first biomedical engineering programs in the world, the Case Western Reserve University Department of Biomedical Engineering has established highly successful and comprehensive graduate programs in research and education. The department consistently remains a top-ranked biomedical engineering program for graduate studies according to *U.S. News and World Report.*

The department continues to evolve to match the recent accelerated pace of biomedical engineering developments. As a joint program in the Case School of Engineering and the Case Western Reserve University School of Medicine, our cutting-edge research spans a wide range of new interdisciplinary engineering discoveries and biomedical applications. The department is associated with **more than 20 research centers and more than $41.7 million in current grants**. Our research and education programs are strongly integrated with industry through job opportunities for graduates, sponsored research and industrial training activities.

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Should on-line learning try to mimic face-to-face education?

Since excellent lectures are accessible on-line, should we expect a disintermediation process in higher education?

In case that the present intermediation role of university teachers or professors looses its meaning, what will be the future role of most of them?

What is the education model that should be adequate for the new cohorts of students entering university

On-line learning, favored by technology incorporation into pedagogy, is becoming well established, even in present face-to-face universities. These changes will introduce modifications in present academic profiles (“disintermediation”).

Students will need to be educated and trained to work in professions that do not exist when they are still in college.

Education will have to be considered from the point of view and needs of the student (demand) and not from the point of view and availability of the university (offer).

Future specific modular courses may become training/learning services offered through internet by providers that do not need to be universities.

History of Biomaterials

- First Generation Biomaterials: materials used industrially in other applications that are requested to be inert in the human body environment. “Biocompatibility” tests.

- Second Generation Biomaterials: designed to be bioactive and resorbable.

- Third Generation Biomaterials: by combining these two properties, they are being designed to stimulate specific cellular responses at the molecular level in order to help the body to heal itself.

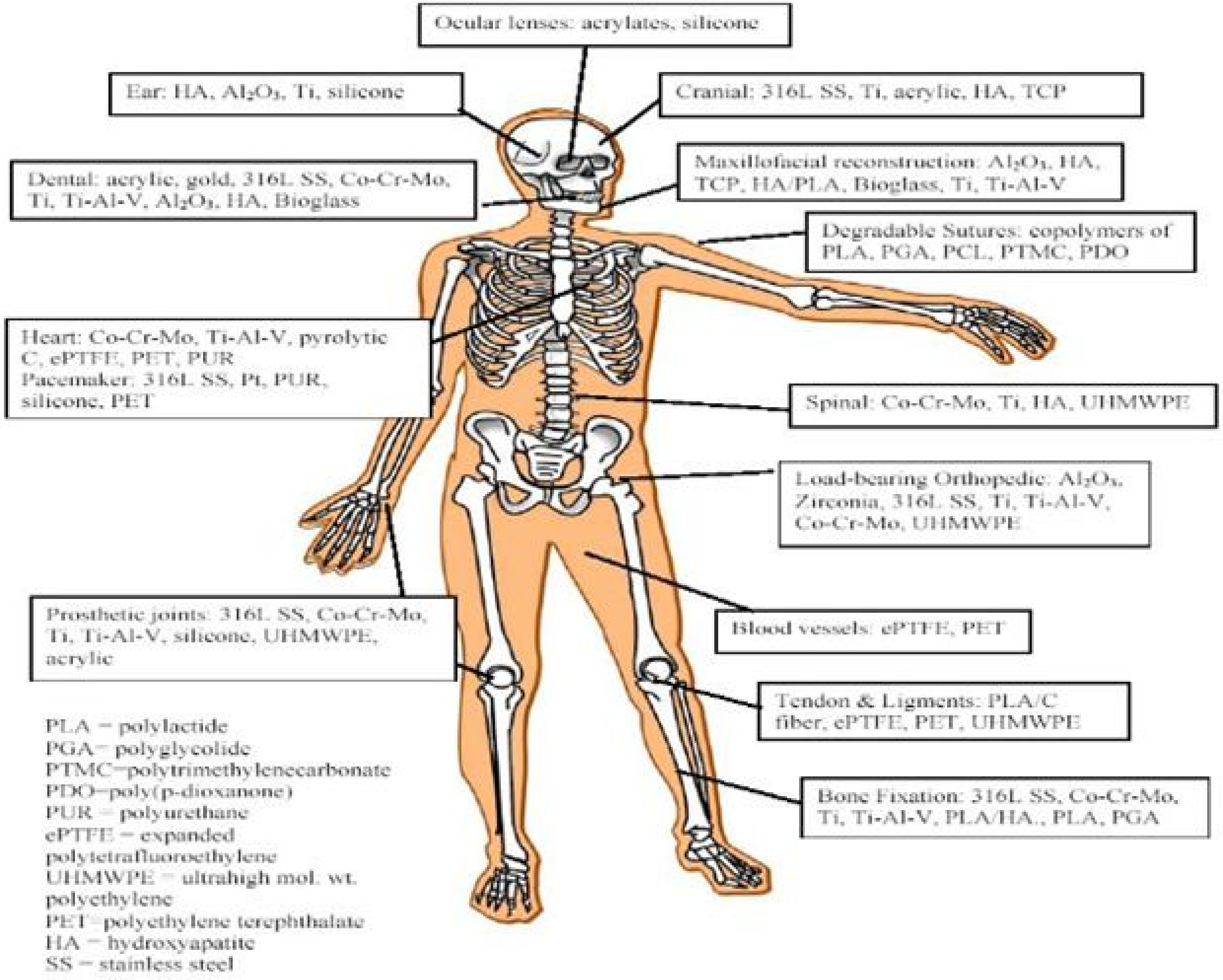
XXth Century: Development of the most relevant materials for medical applications

Metals and alloys:	Stainless steels Cobalt-chrome alloys Titanium and titanium alloys Other: magnesium, tantalum, niobium
Ceramics:	Technological ceramics (alumina and zirconia) Calcium phosphates
Polymers:	Synthetic origin, derived from mineral oil

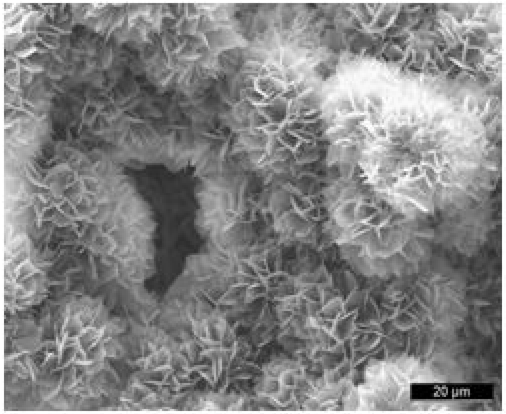
Advances in processing and manufacturing technologies

New composites

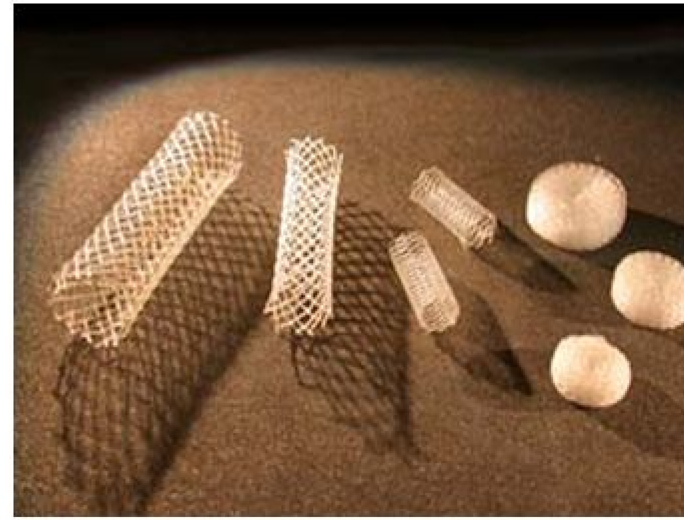
Most of XXth Century: Biomaterials were selected among existing materials for other industrial applications exhibiting the specific properties of being as inert as possible in order to be as harmless as possible upon implantation



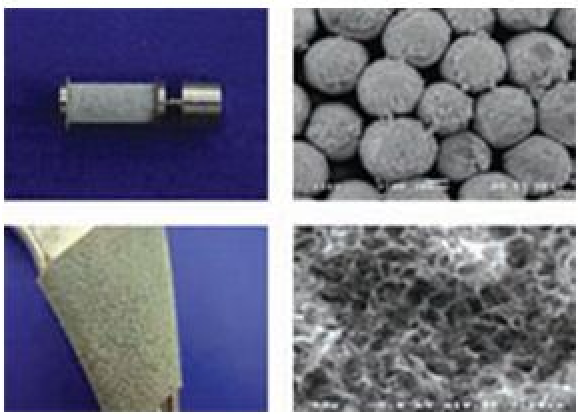
Biomaterials were mainly oriented to permanent implants, and consisted in inert biomaterials that at present are considered as first generation biomaterials



Bohner, M., Mater. Today 2010, 13; 24-30

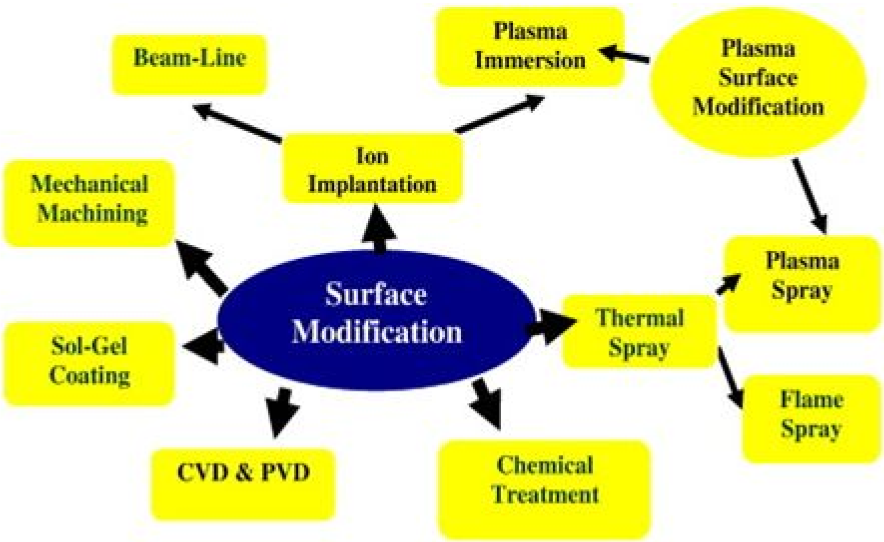


HighTech Filand. Tampere University of Technology. www.tut.fi

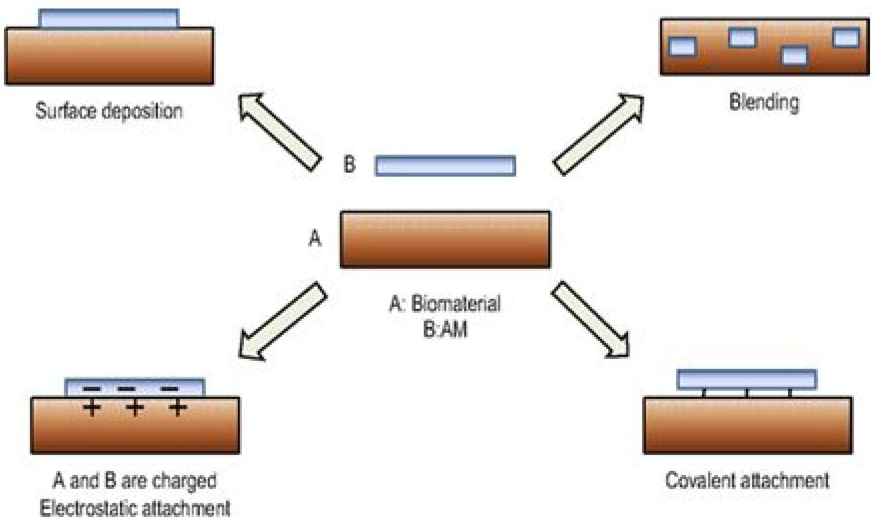


National research council of Canada. www.nrc-cnrc.gc.ca

In the late 80's and early 90's hydroxyapatite and in general calcium phosphates (including glasses) in bulk, granules or coatings, as well as biodegradable polymers, were central in biomaterials research. Bioactive and biodegradable biomaterials constitute the second generation according to L. Hench

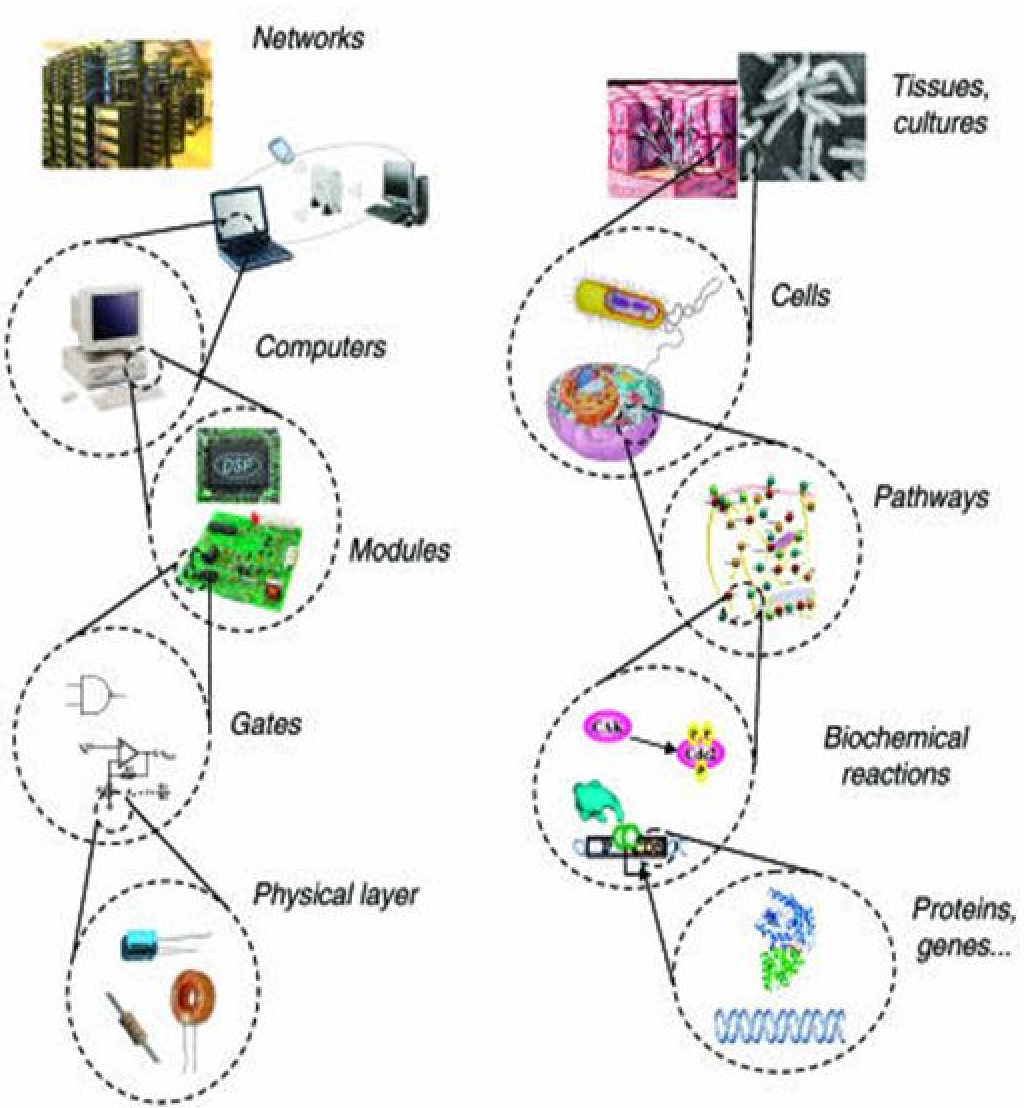


Chu, P.K., Surf. and Coat. Tech., 2007



The focus on surfaces becomes progressively more relevant and this leads the way towards what is commonly understood as third generation biomaterials.

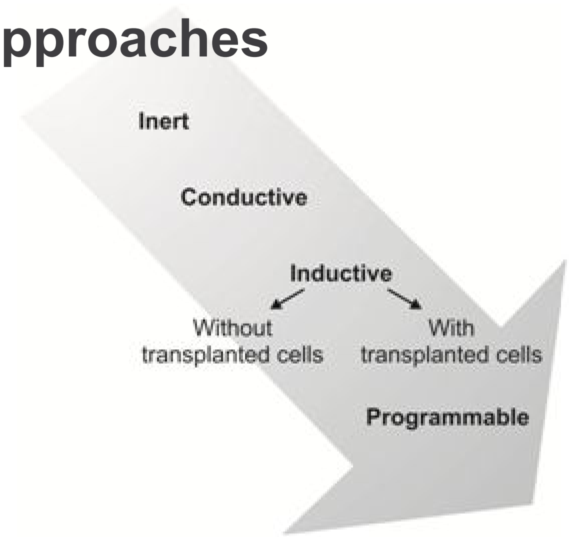
Rao, S.S. and Winter J.O., Front. Neuroeng., 2009



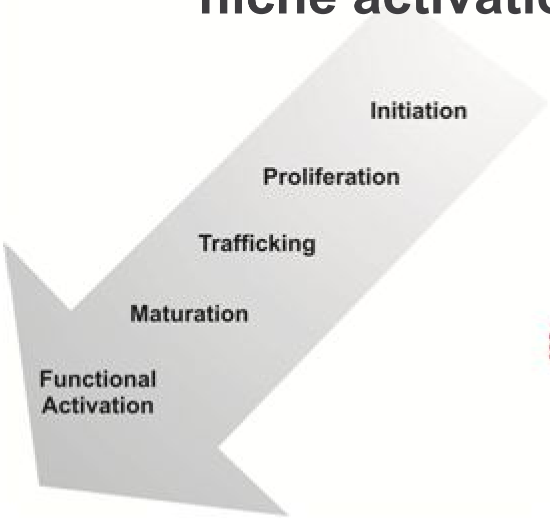
New knowledge on biochemical and physical signaling and nanotechnology have become two major players in the field

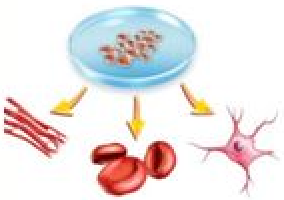
Regenerative medicine: Biomaterials and Biology at the interface

Evolution of biomaterials approaches



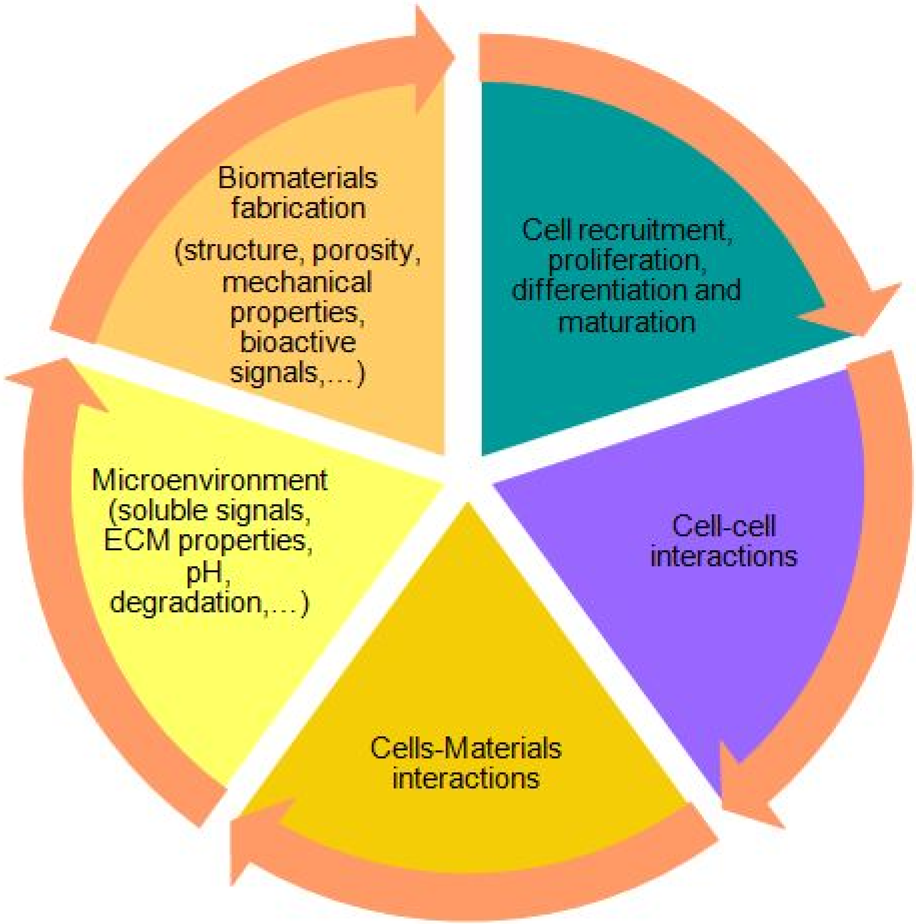
Phases of stem cell niche activation





Instructive Materials as a factor to program stem cells

Biology feedback to biomaterials fabrication



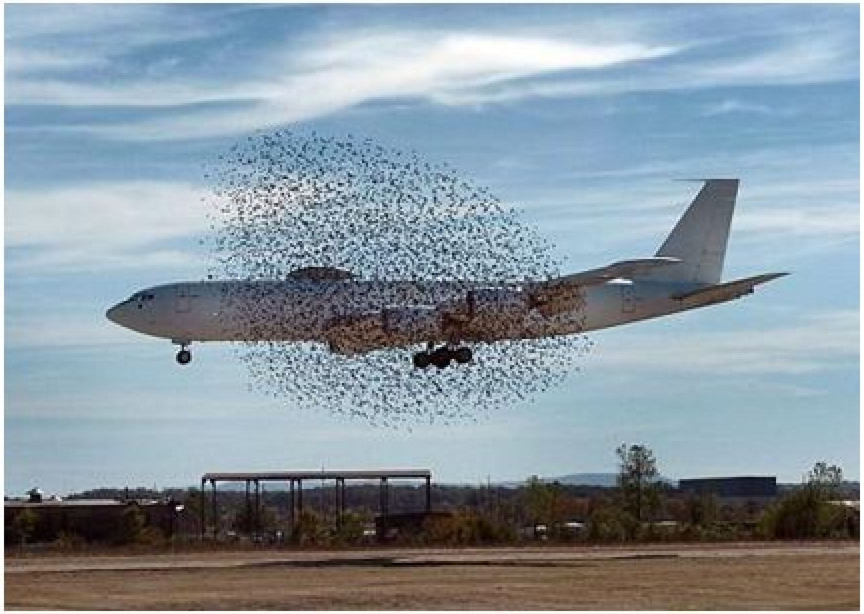
Biomaterial Science and Technology is a real interdisciplinary field

The inputs of computer modelling, macromolecular chemistry, free form fabrication methods and molecular and cellular biology produce an impressive boost to the field

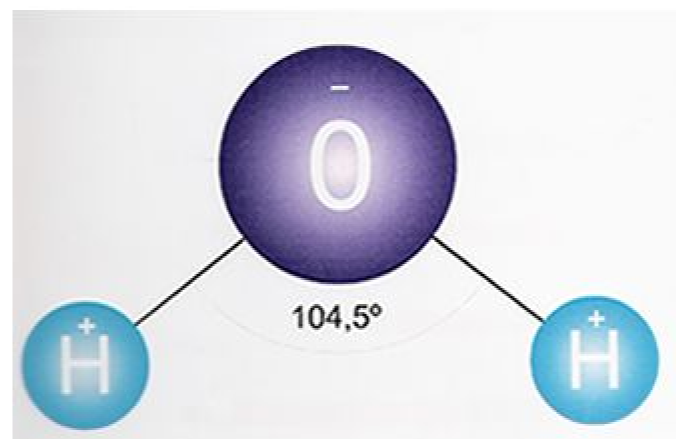
But the change of paradigm comes with the concept of Tissue Engineering and later Regenerative Medicine. The increasing knowledge and control on stem cells opens a whole new future and demands on biomaterials.

The new demands may range from those requested in drug or gene delivery to those simulating the extra cellular matrix for scaffolds in tissue engineering or regenerative medicine. (i.e. *On the nature of biomaterials*, D. F. Williams, Biomaterials, 2009).

COMPLEXITY AND EMERGENCE



COMPLEXITY AND EMERGENCE



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