University of Genova
DIBRIS – Department of Informatics, Bioengineering, Robotics, and System Engineering

Master Degree in:
BIOENGINEERING

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Coordinator
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Bridging gaps

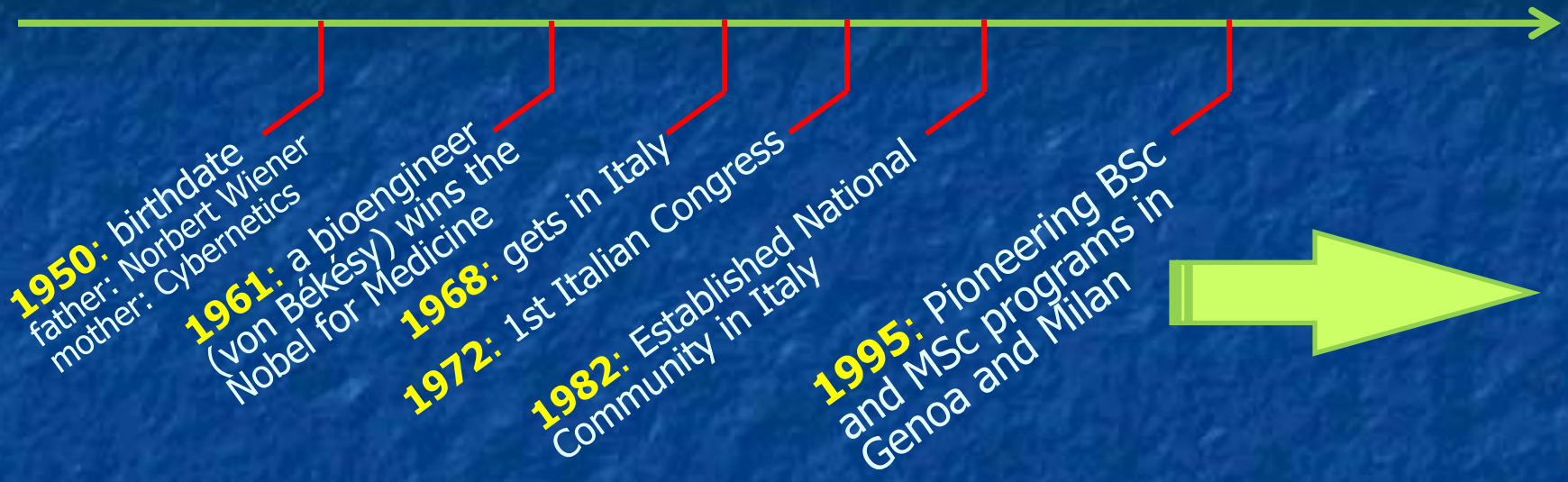
ICT and Material Engineering

Medicine and Biology

Educates an attitude ...

- Intersectorial, Multidisciplinary, and oriented toward innovation

A young discipline …



… consolidated assets:

Academic year	Students *(avg School)*	% Satisfaction *(national avg)*
2009-10	44 *(25)*	n.a.
2010-11	39 *(27)*	80.4 *(86.3)*
2011-12	44 *(33)*	91.5 *(83.8)*
2012-13	53 *(34)*	95.7 *(83.1)*
2013-14	61 *(38)*	n.a.

A promising field

- 18000 firms in Europe
  - 80% SMEs
  - 95 Billion Euro turnover
- More than 500,000 employees
- 8% of turnover reinvested in Research and Development
- 10412 patents granted before 2012

[source: European Commission Health Directorate DG Research & Innovation, 2012]

MSc specifications

- National regulations (D.M. 16 March 2007, issued G.U. 9 July 2007 n. 155)
  - require specification of **Featuring**, **Affine**, and **Other** activities
  - constraint (i) credit units per specific activity, (ii) max number of exams [12]
  - 1 credit unit (CFU) = 25 student-hours (avg effort)

ATTIVITÀ FORMATIVE INDISPENSABILI				
Attività formative:	Ambiti disciplinari	Settori scientifico-disciplinari	CFU	Tot. CFU
Caratterizzanti	Ingegneria biomedica	ING-IND/34 - Bioingegneria industriale ING-INF/06 - Bioingegneria elettronica e informatica		45

UniGe Master in Bioengineering – Regulations –

Master in Bioengineering - Classe LM-21 – Ingegneria Biomedica

Featuring activities

Ambito disciplinare	settore	CFU min	CFU max	minimo da D.M. per l'ambito
Ingegneria biomedica	ING-IND/34 - Bioingegneria industriale ING-INF/06 - Bioingegneria elettronica e informatica	45	72	n.a.
	Minimo di crediti riservati dall'Ateneo minimo da D.M. 45	45		
Totale Attivita' Caratterizzanti		45	72	

Affine activities

Ambito disciplinare	settore	CFU min	CFU max	minimo da D.M.
	BIO/09 - Fisiologia			
	BIO/10 - Biochimica			
	CHIM/07 - Fondamenti chimici delle tecnologie			
	ICAR/01 - Idraulica			
	ICAR/03 - Ingegneria sanitaria - ambientale			
	ICAR/08 - Scienza delle costruzioni			
	INF/01 - Informatica			
	ING-IND/10 - Fisica tecnica industriale			
Attivita' formative affini o integrative	ING-IND/22 - Scienza e tecnologia dei materiali	18	42	12
	ING-IND/27 - Chimica industriale e tecnologica			
	ING-IND/31 - Elettrotecnica			
	ING-IND/33 - Sistemi elettrici per l'energia			
	ING-IND/35 - Ingegneria economico-gestionale			
	ING-INF/01 - Elettronica			
	ING-INF/02 - Campi elettromagnetici			
	ING-INF/03 - Telecomunicazioni			
	ING-INF/04 - Automatica			
	ING-INF/05 - Sistemi di elaborazione delle informazioni			
	MAT/07 - Fisica matematica			
	MAT/09 - Ricerca operativa			
	MED/26 - Neurologia			
	MED/37 - Neuroradiologia			
	MED/42 - Igiene generale e applicata			
	SECS-P/02 - Politica economica			
Totale Attivita' Affini		18	42	

Other activities

Ambito disciplinare		CFU min	CFU max
A scelta dello studente		8	12
Per la prova finale		18	30
Ulteriori attivita' formative (art. 10, comma 5, lettera d)	Ulteriori conoscenze linguistiche	0	6
	Abilita' informatiche e telematiche	n.a.	n.a.
	Tirocini formativi e di orientamento	0	6
	Altre conoscenze utili per l'inserimento nel mondo del lavoro	0	6
Minimo di crediti riservati dall'Ateneo alle Attivita' art. 10, comma 5 lett. D		1	
Per stages e tirocini presso imprese, enti pubblici o privati, ordini professionali		n.a.	n.a.
Totale Altre Attivita'		27	60

Riepilogo CFU

CFU totali per il conseguimento del titolo	120	
Range CFU totali del corso	90	174

Overall structure

A common root and three curricula:

- **Rehabilitation engineering and biomaterials**
- **Biomedical technologies and engineering for health**
- **Neuroengineering and bio-ICT**

B.Sc. degree
(180 CFU)

Common courses
(I year)

45 CFU

Curriculum "REHABILITATION ENGINEERING & BIOMATERIALS"

(I year)

12 CFU

+ 6 CFU selected:

(among the 3 curricula)

(II year)

18 CFU

Free choice	12
Research methodology	2
Master thesis	25

Curriculum "BIOMEDICAL TECH. & ENGINEERING FOR HEALTH"

(I year)

12 CFU

+ 6 CFU selected:

(among the 3 curricula)

(II year)

18 CFU

Free choice	12
Research methodology	2
Master thesis	25

Curriculum "NEUROENGINEERING AND BIO-ICT"

(I year)

12 CFU

+ 6 CFU selected:

(among the 3 curricula)

(II year)

18 CFU

Free choice	12
Research methodology	2
Master thesis	25

Manifesto 2014-15

	Insegnamenti comuni	cfu	semestre
	Mathematical methods for engineers	9	annuale
	Biomedical instrumentation and bioimaging	12	annuale
	Analysis of biomedical data and signals	9	I semestre
	Perceptual systems and interactive technologies	6	I semestre
	Chemistry and biochemistry	9	annuale
	modulo 1 (5 CFU)		
	modulo 2 (4 CFU)		
	Curriculum "REHABILITATION ENGINEERING AND BIOMATERIALS"		
	Continuum mechanics	6	I semestre
	Motor control and human performance assessment	6	II semestre
	Un modulo a scelta fra:	6	
	Molecular, cellular and tissue engineering		II semestre
	Bionanotechnology		II semestre
	Biomedical informatics		II semestre
	TOTALE CFU	63	
I anno	**Curriculum "BIOMEDICAL TECHNOLOGIES AND ENGINEERING FOR HEALTH"**		
	Biomedical informatics	6	II semestre
	Hospital energy systems	6	I semestre
	Un modulo a scelta fra:	6	
	Bionanotechnology		II semestre
	Motor control and human performance assessment		II semestre
	Molecular, cellular and tissue engineering		II semestre
	TOTALE CFU	63	

	Curriculum "NEUROENGINEERING AND BIO-ICT"		
	Neuroengineering and Neurotechnologies	6	II semestre
	Molecular, cellular and tissue engineering	6	II semestre
	Un modulo a scelta fra:	6	
	Bionanotechnology		II semestre
	Biomedical informatics		II semestre
	Motor control and human performance assessment		II semestre
	TOTALE CFU	63	
	a scelta	12	I semestre
	Research methodology	2	II semestre
	Master thesis	25	II semestre
	Curriculum "REHABILITATION ENGINEERING AND BIOMATERIALS"		
	Biofluidodynamics	6	I semestre
	Biomedical robotics & rehabilitation engineering	6	I semestre
	Composite materials for bioapplications	6	I semestre
	TOTALE CFU	120	
II anno	**Curriculum "BIOMEDICAL TECHNOLOGIES AND ENGINEERING FOR HEALTH"**		
	Health Information Systems	6	I semestre
	Biomedical image processing	6	I semestre
	Applied hygiene	6	I semestre
	TOTALE CFU	120	
	Curriculum "NEUROENGINEERING AND BIO-ICT"		
	Computational neuroscience	6	I semestre
	Neuromorphic computing & integrative cog. sys.	6	I semestre
	Biomedical robotics & rehabilitation engineering	6	I semestre
	TOTALE CFU	120	

Rehabilitation engineering and biomaterials

- Biomechanical design (prosthetics, orthotics)
- New materials and biomorphic material applications
- Technologies and tools for restoration and/or substitution of sensorial, motor, and cognitive functionalities.
- Focus on:
  - Nanobiotechnology
  - Biomechanics and biomaterials
  - Sensorimotor assessment and control

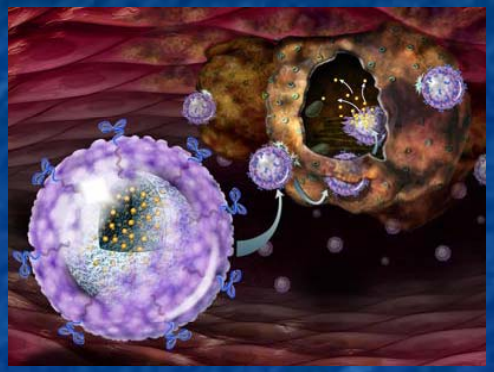
Biomedical technologies and engineering for health

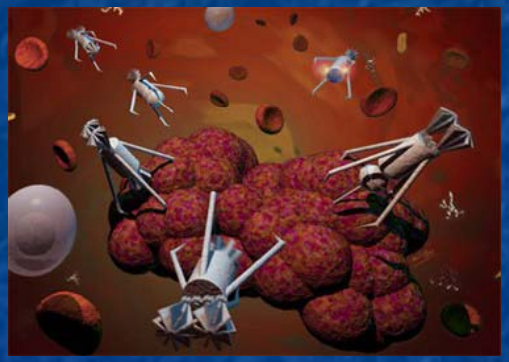
- ICT systems for health care services and management
- Automatic processing/management of biomedical data
- Clinical engineering
- Focus on:
  - Biomedical informatics
  - Bioimaging
  - Telemedicine
  - Biomedical robotics

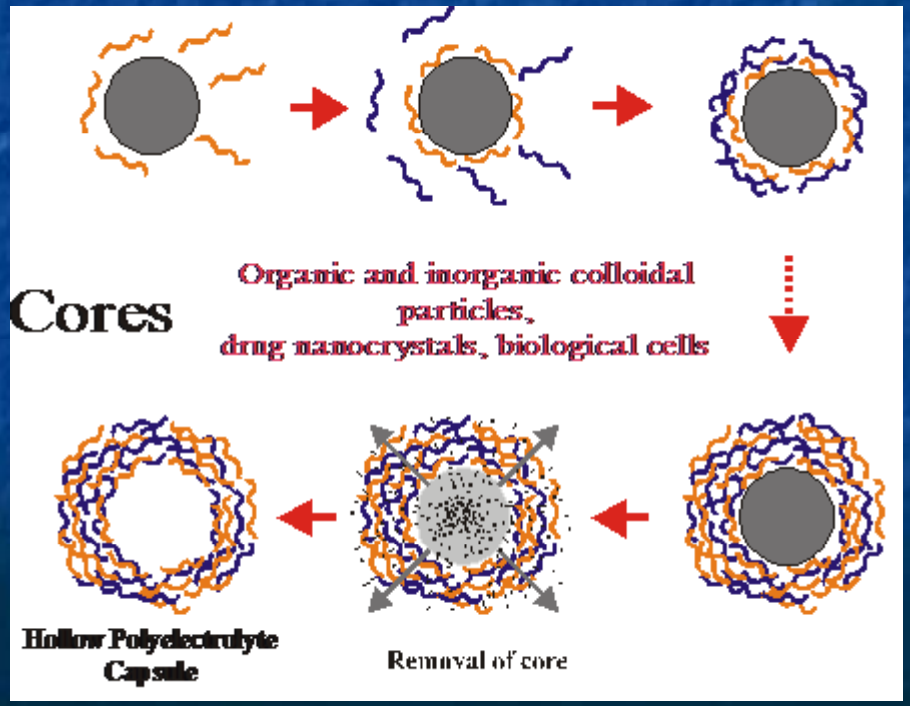
Neuroengineering and bio-ICT

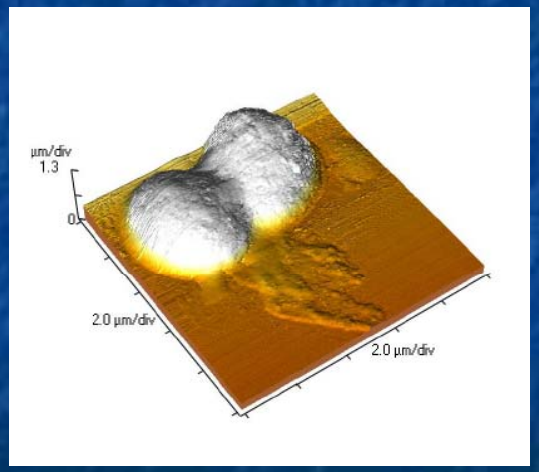
- Neuro-electronic interfaces
- Systems and technologies for neurorehabilitation
- Natural and artificial intelligent systems
- Focus on:
  - Biosensors and microtrasductors
  - Neuroscience
  - Neuromorphic systems and biomimetics
  - Humanoid robotics and brain-machine-interface

Drug delivery and docking



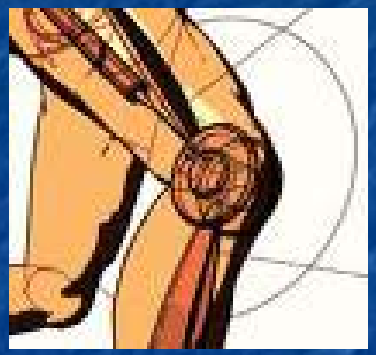


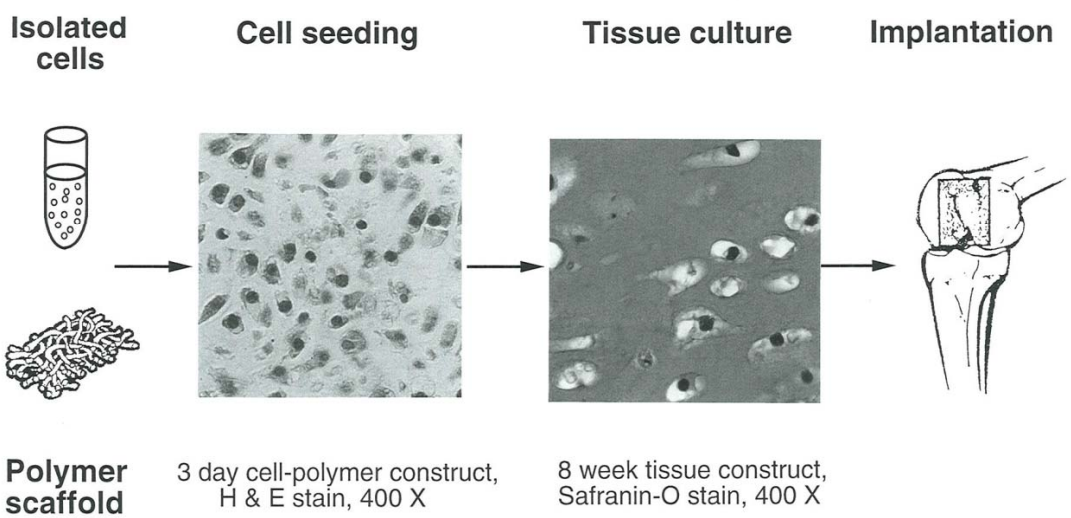


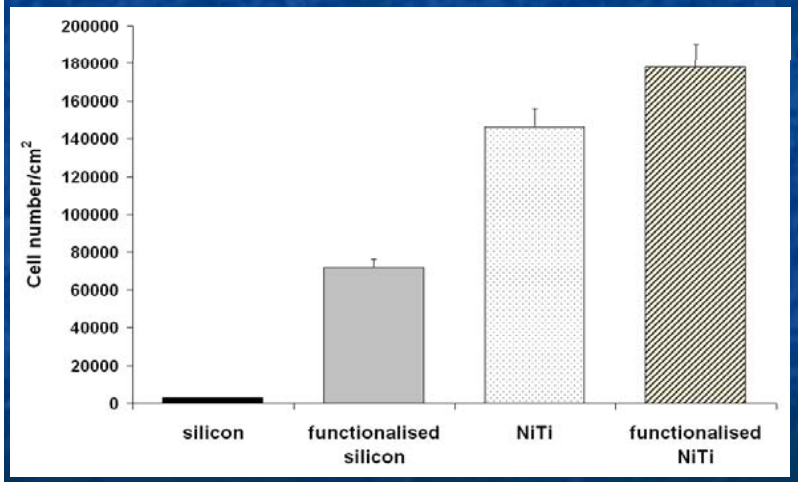


AFM image of the paclitaxel-containing nanoengineered polymeric capsules on the surface of silicon

Tissue engineering

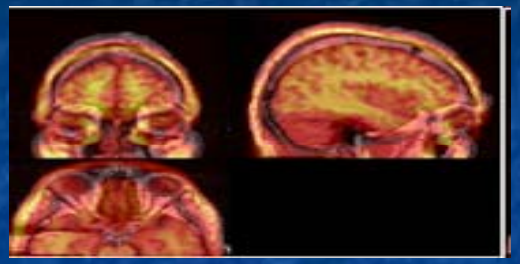
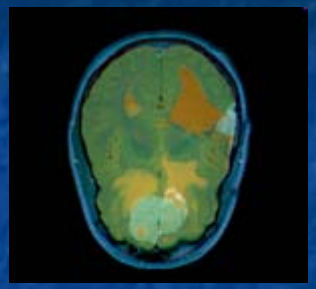
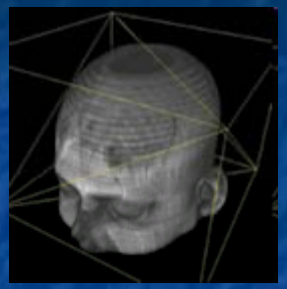




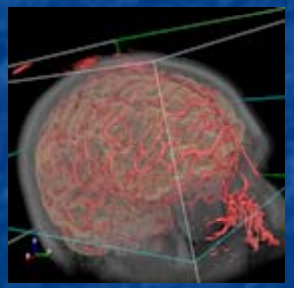
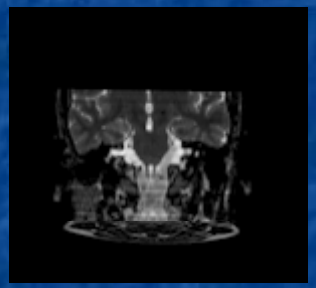
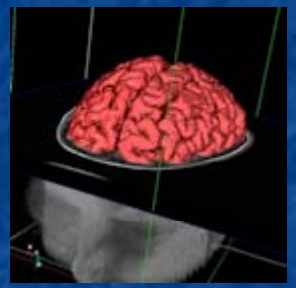


Biomimetic coatings containing fibronectin have been assembled by means of the LBL technique, and tested for the growth osteoblast cells.

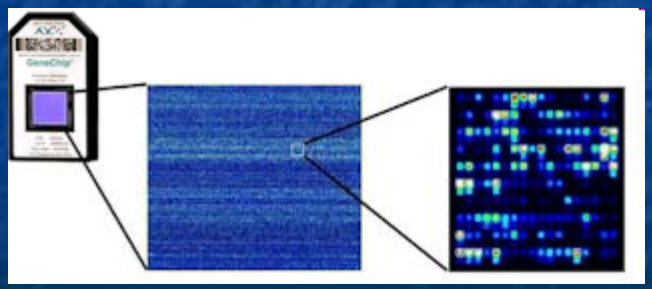
Bioimaging

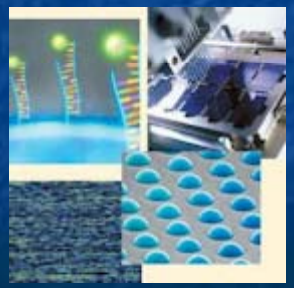





Neuroinformatics

Bioinformatics

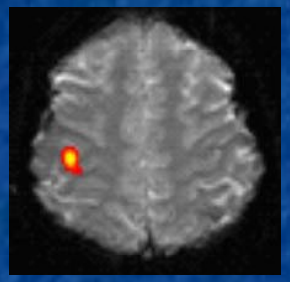


Advanced bioimaging technologies

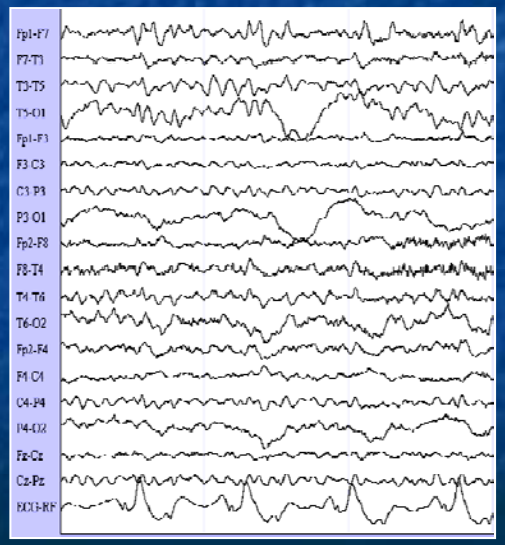
integration of heterogeneous signals: brain imaging + electrical activity

fMRI



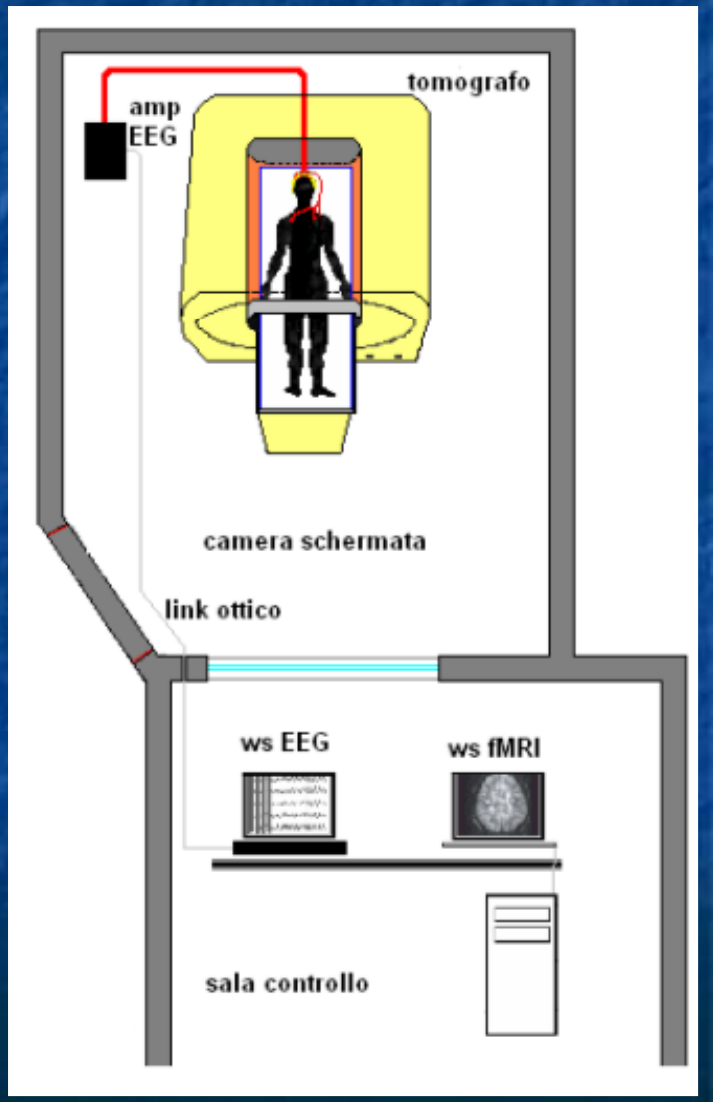
High spatial resolution – poor temporal resolution

EEG/EP

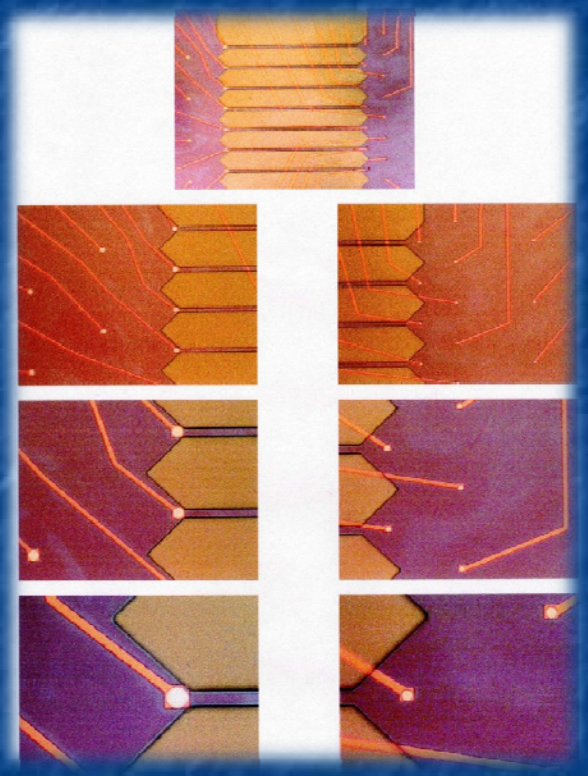


High temporal resolution – poor spatial resolution

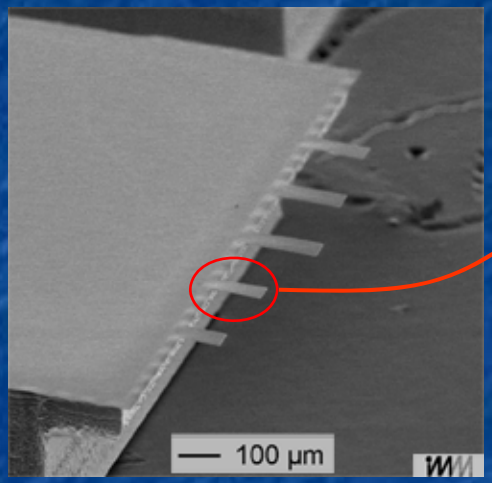
EBNeuro SpA

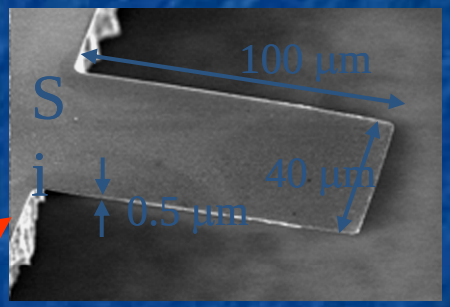


Biosensors

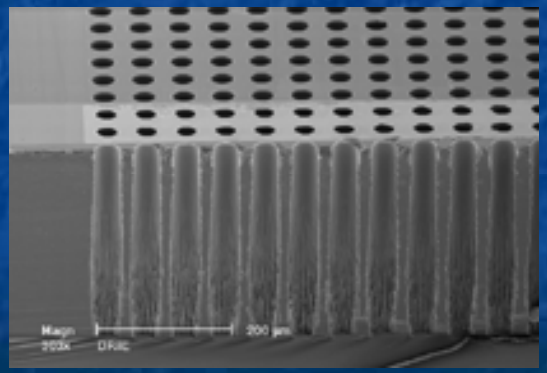


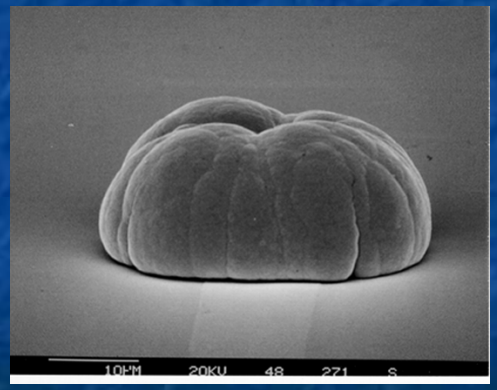
Matrice di microelettrodi microlavorata





Micro-biosensori

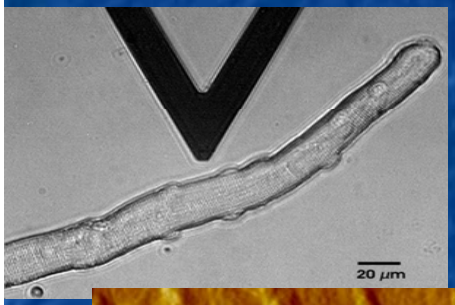


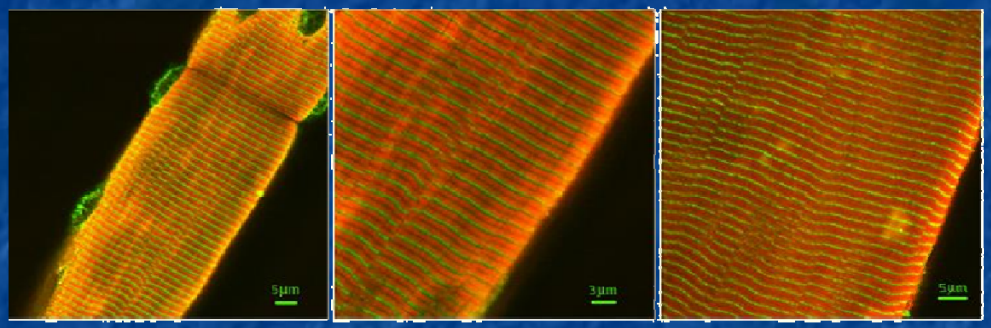


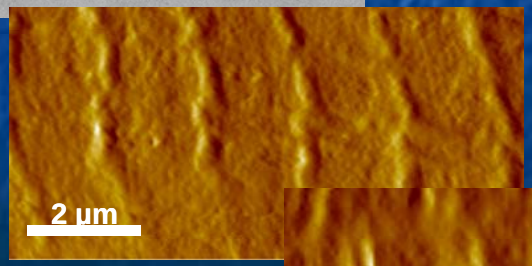
Substrato microforato ed elettrodo di Platino

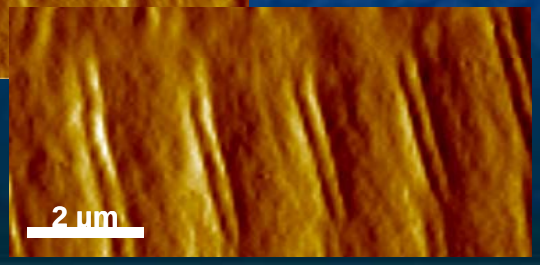
AFM on biological samples

- Tissue elasticity (cartilage)
- Muscle cell structure (healthy and dystrophic)
- Membrane protein interactions and mapping

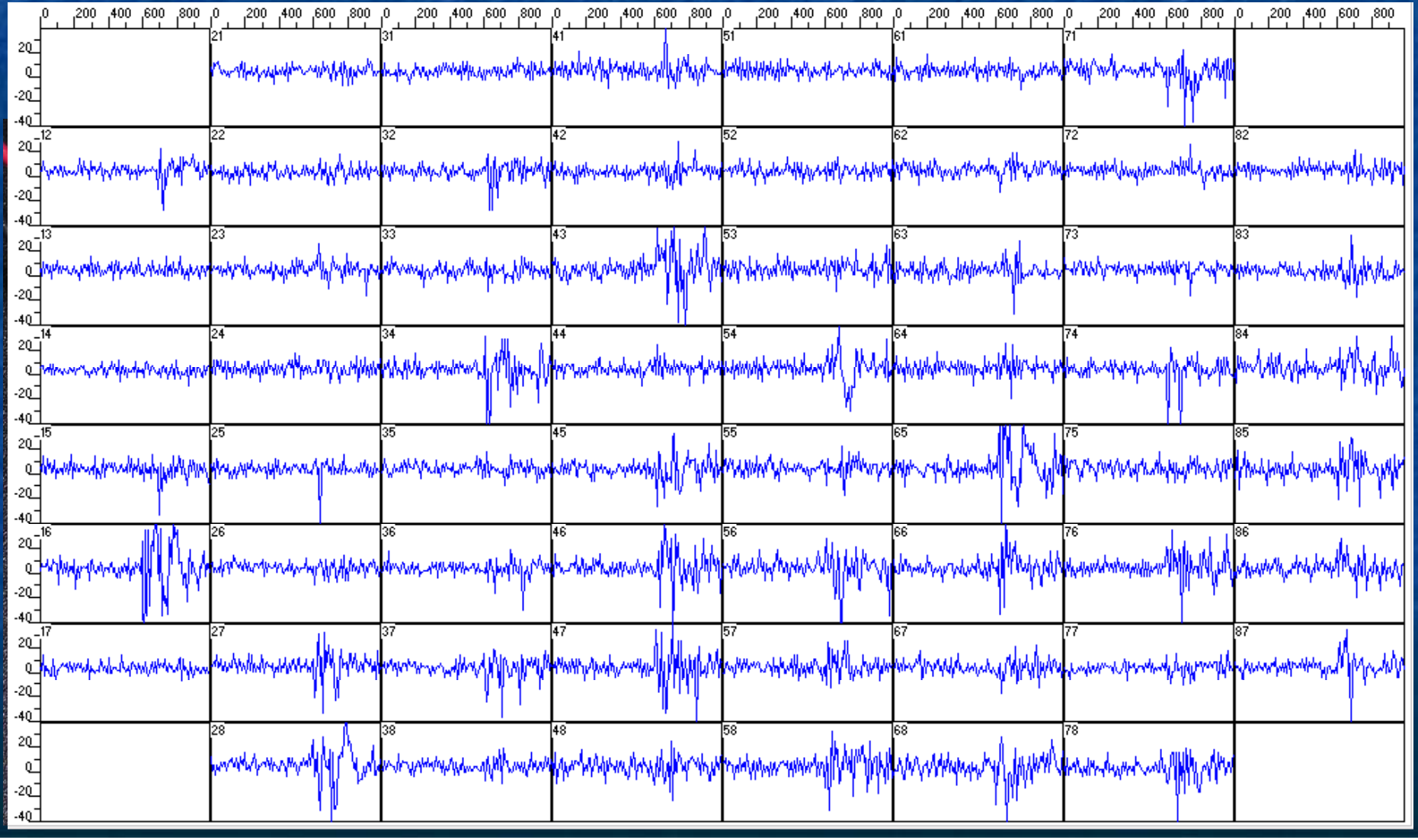








Neuro-electronic interfaces

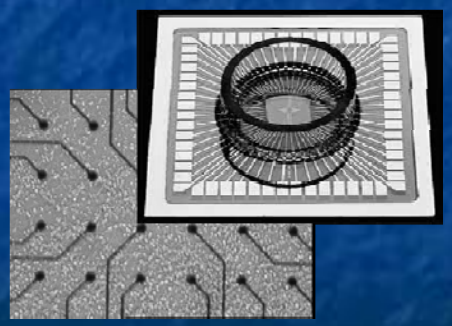


Neuro-robotic systems

A bioartificial system with an artificial body: training cultured neurons to drive purposive behavior of an artificial body

Living bioartificial system

Real environment



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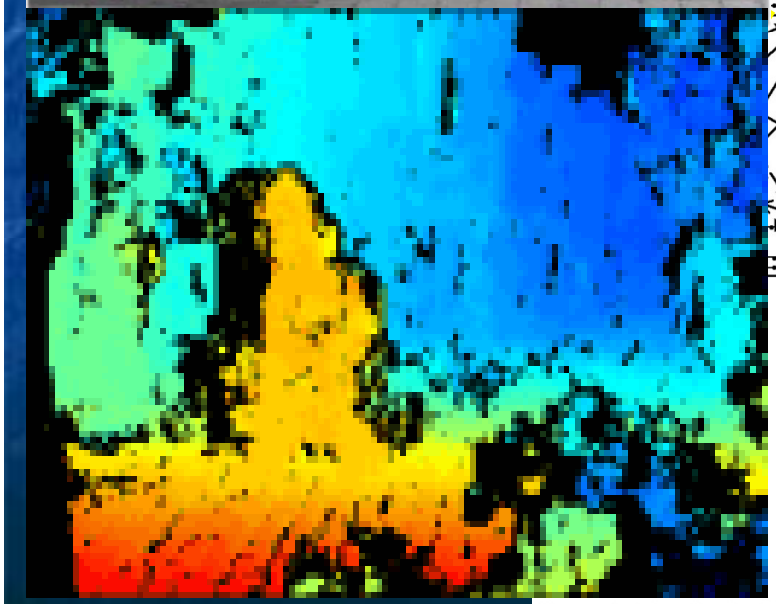
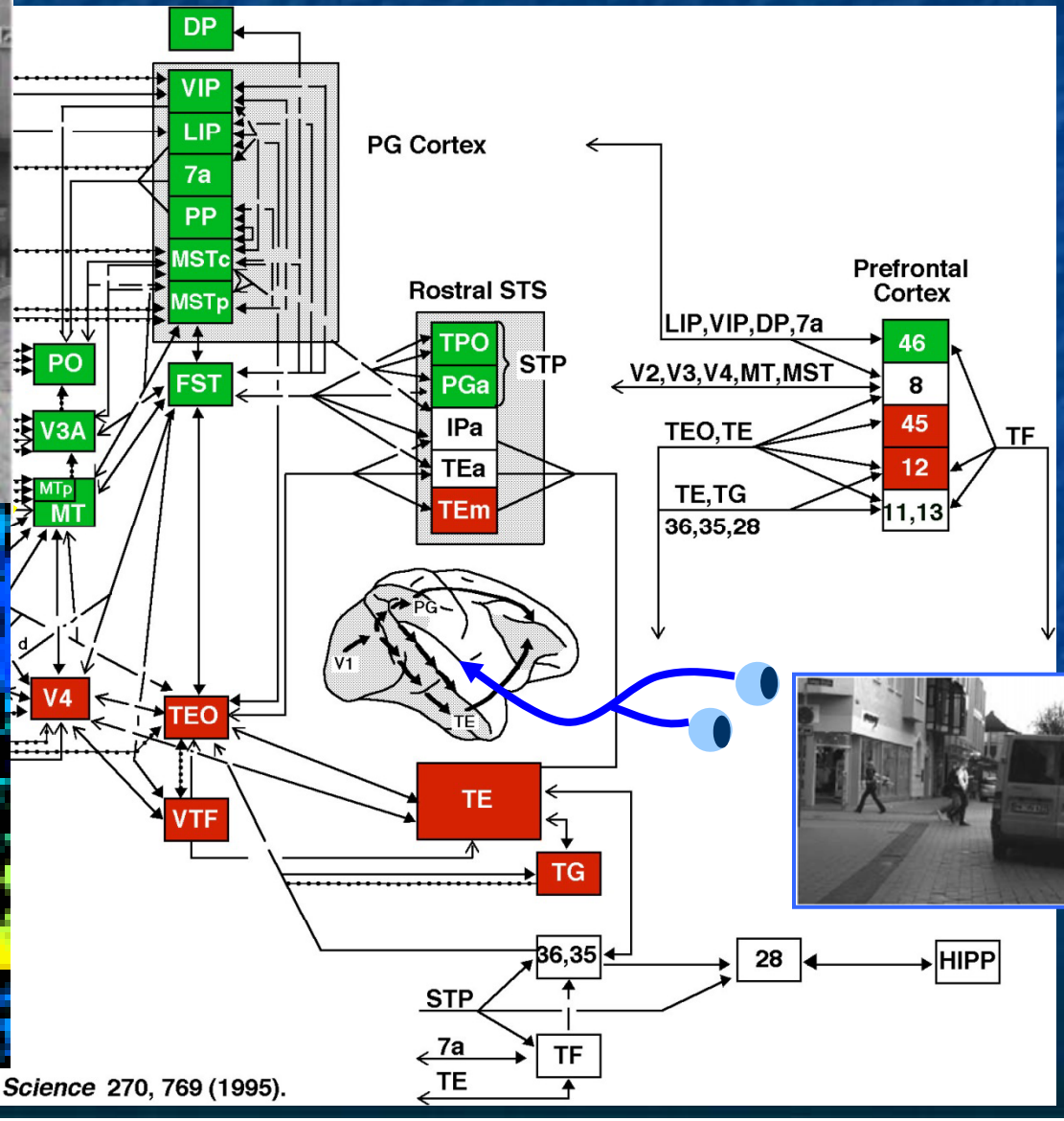
Adaptive neural controller

Autonomous robot: artificial body

Neuromorphic computing

for sensory processing and representation

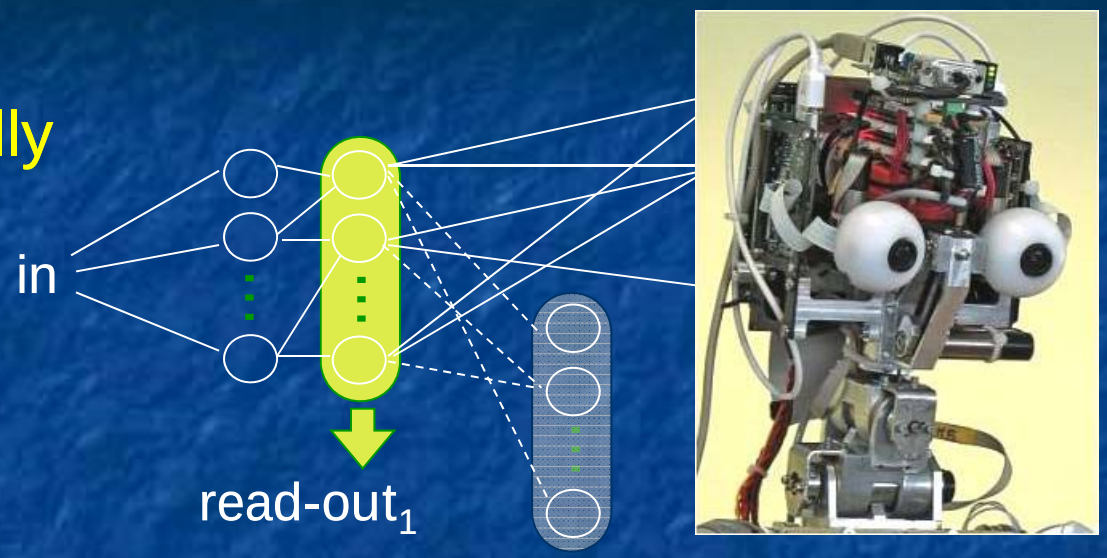




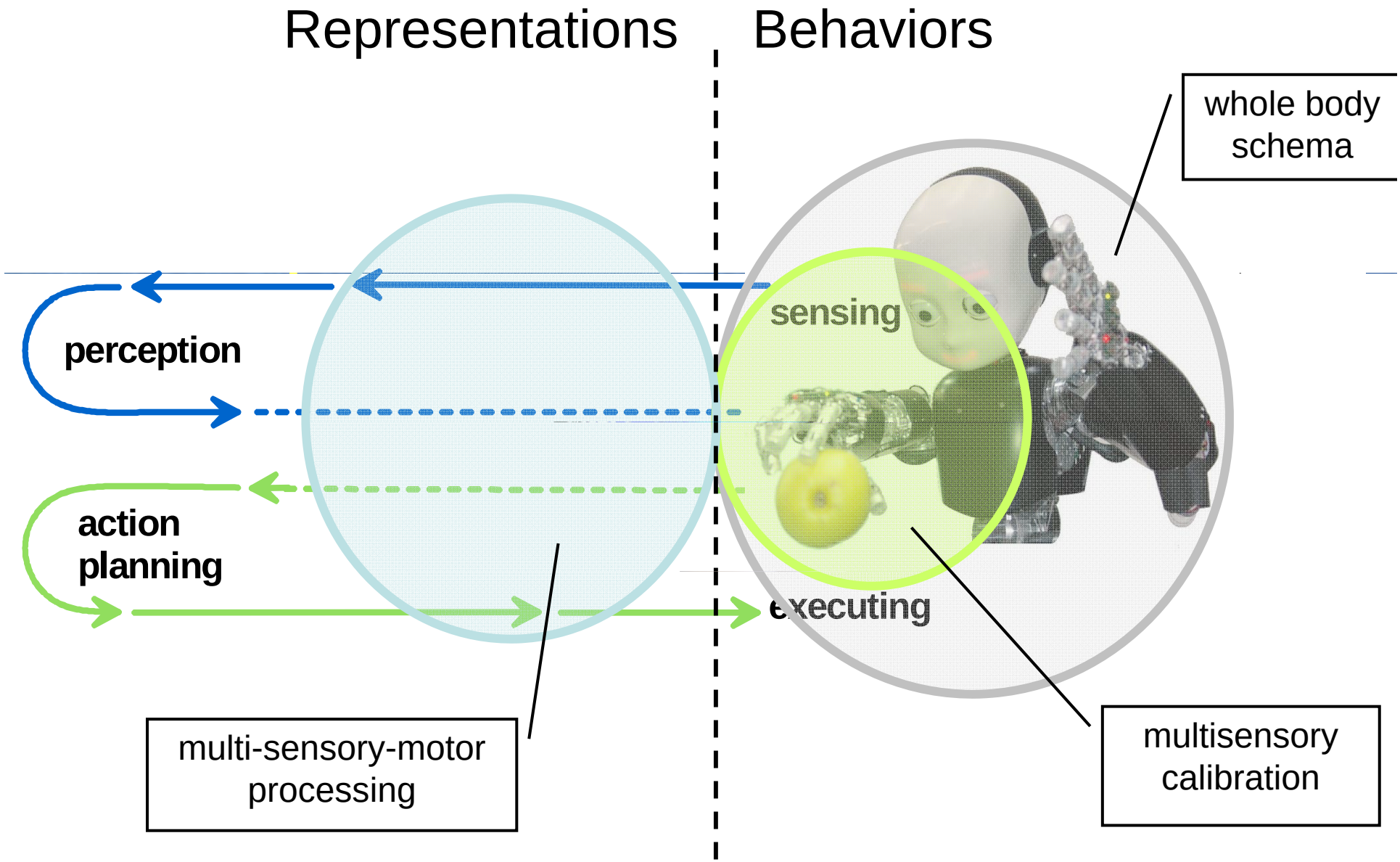
Ungerleider, L.G. *Science* 270, 769 (1995).

Visual processing and representation

- *Vision systems*
- Deep hierarchy architectures for visually guided behavior
- Biorobotics
  - Enable sensorimotor behavior in robots



Neuromorphic and biomimetic systems



Visual processing and representation

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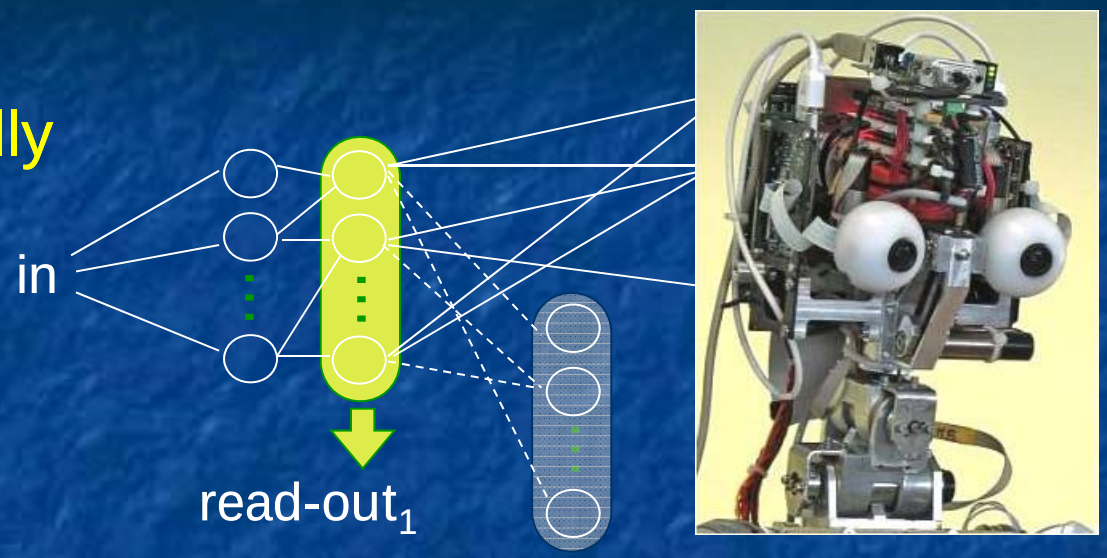

Visual processing and representation

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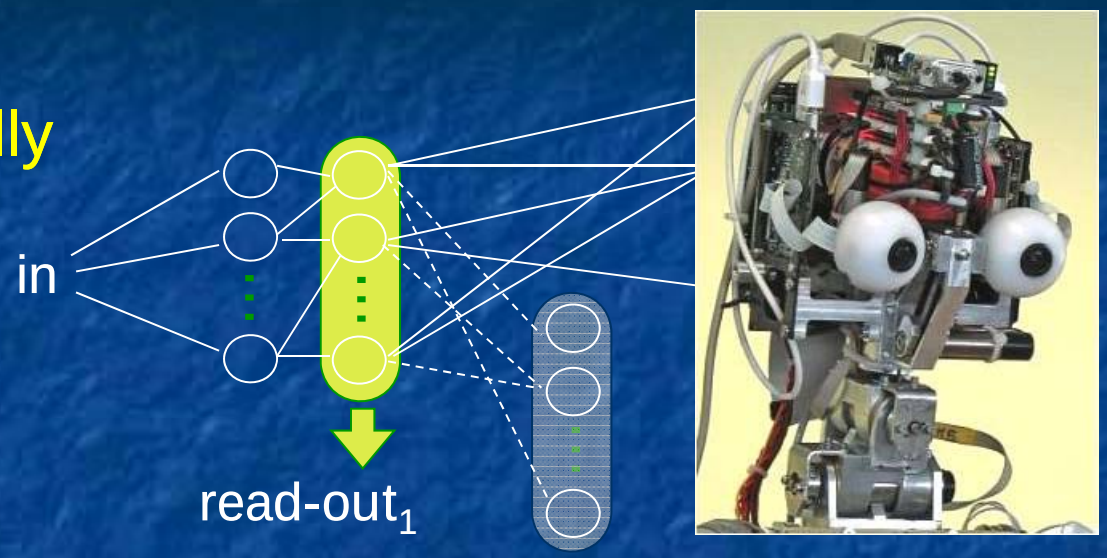
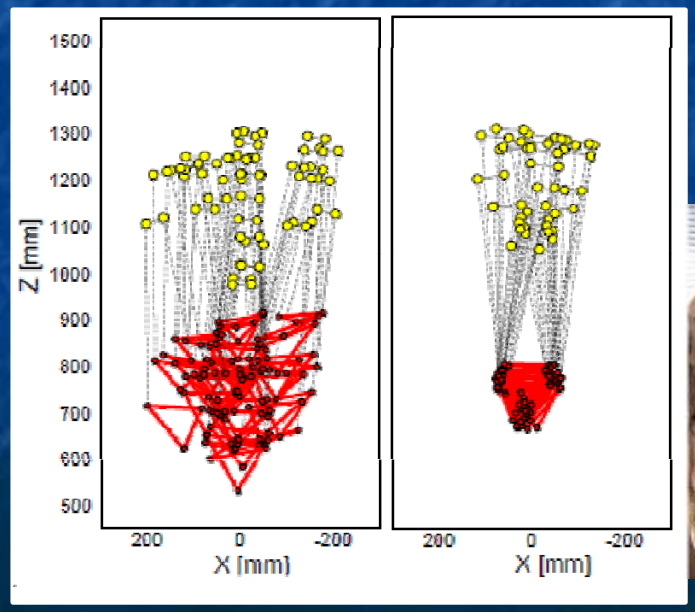
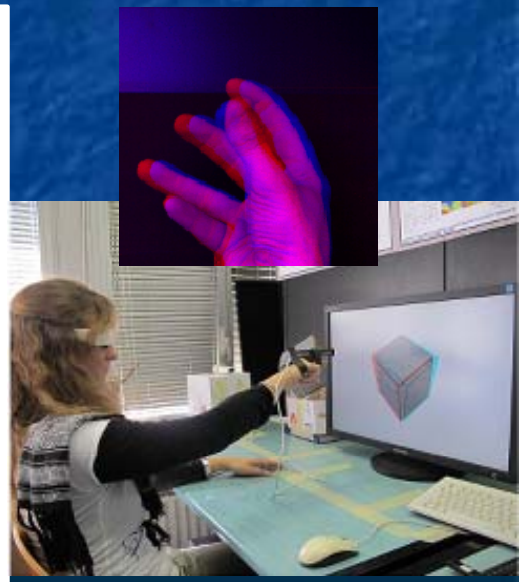


- *Vision science*
- Interactive VR/AR systems
- Sensorimotor exercise and rehabilitation
  - Analyze sensorimotor behavior in humans





Robotics for neurorehabilitation

Braccio di Ferro

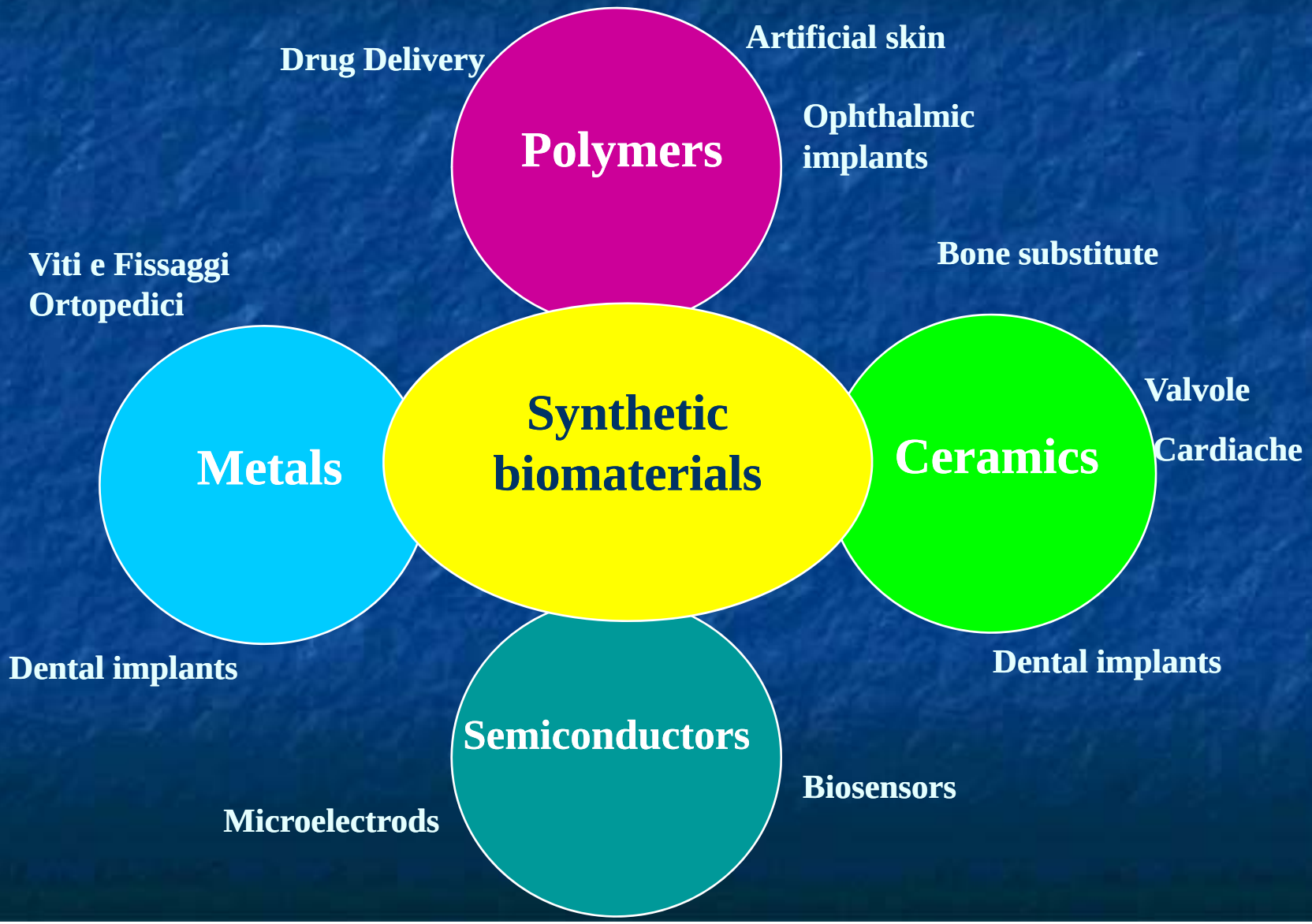
The robotic physiotherapist

Haptic perception & sensorimotor learning

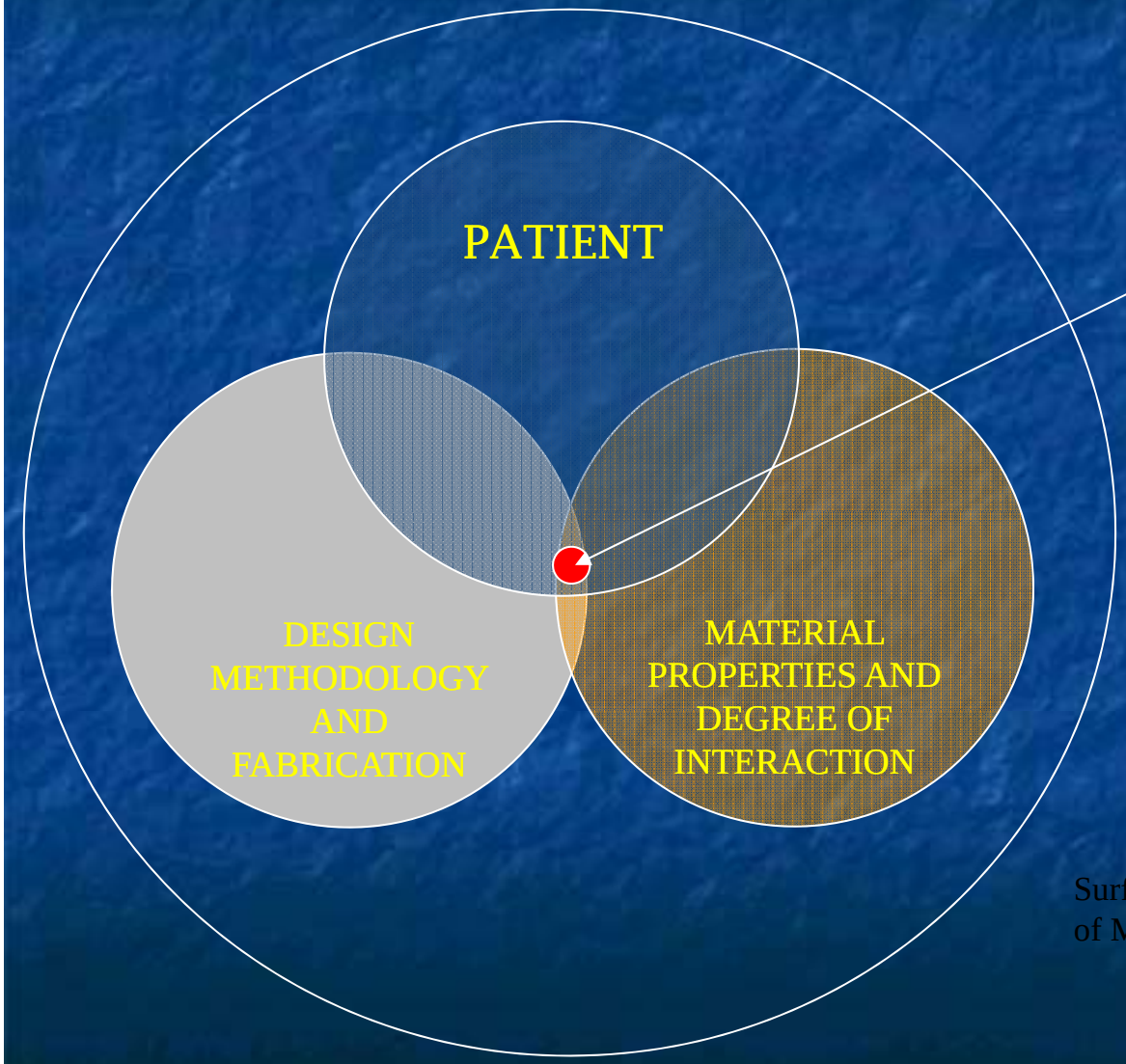
Modification of EEG patterns during adaptation to force fields

… Toward **Brain-Computer-Interfaces** through high resolution EEG signals

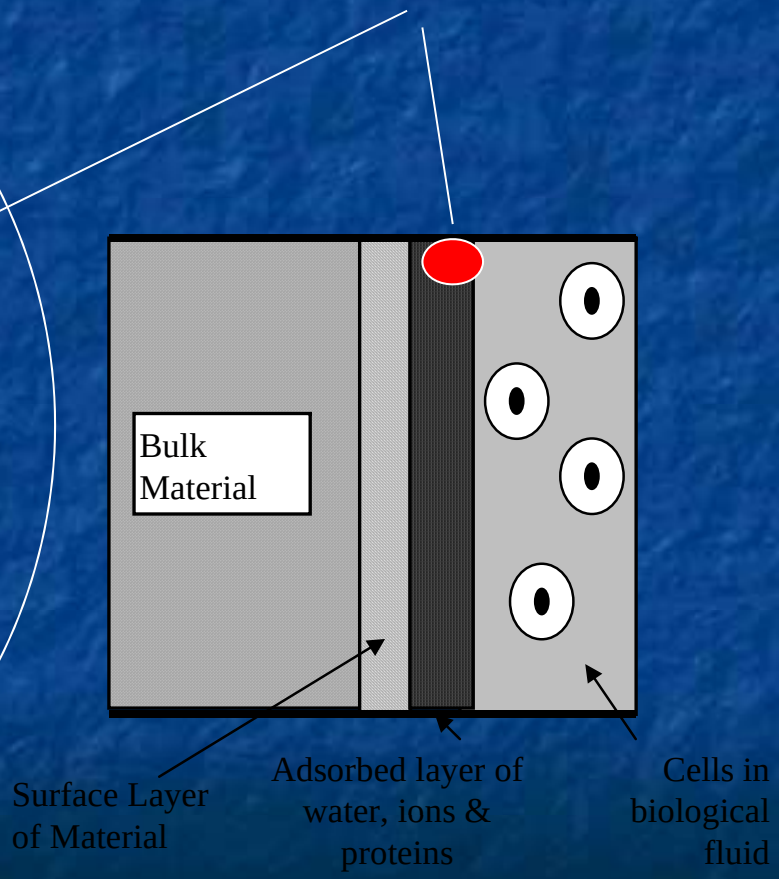
Biomechanics and biomaterials



Biomechanics and biomaterials



BIOCOMPATIBILITY



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