臺北醫學大學

Biomedical Imaging

生物醫學影像學

楊自森 助理教授

牙體技術學系

2013/02/18

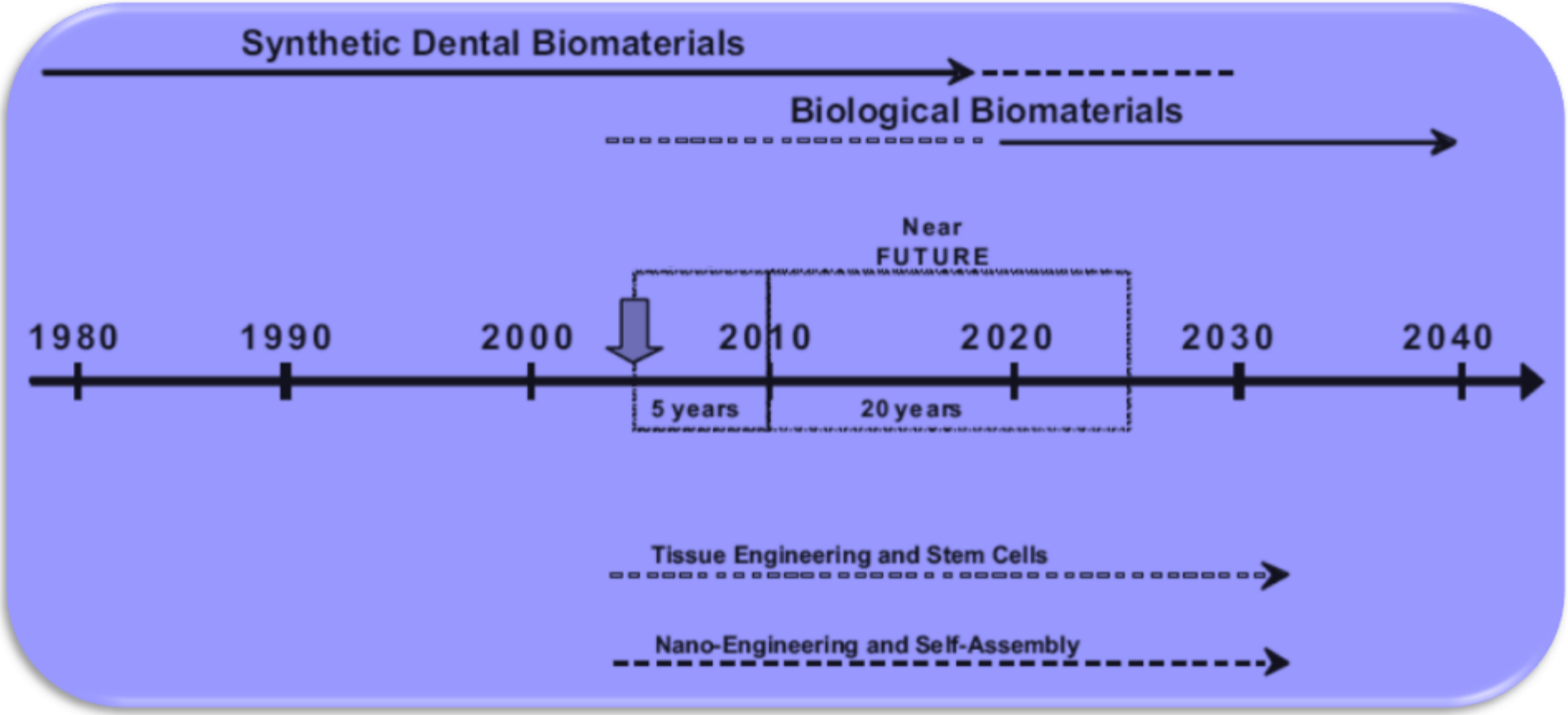
tsyang@tmu.edu.tw

Course Outline

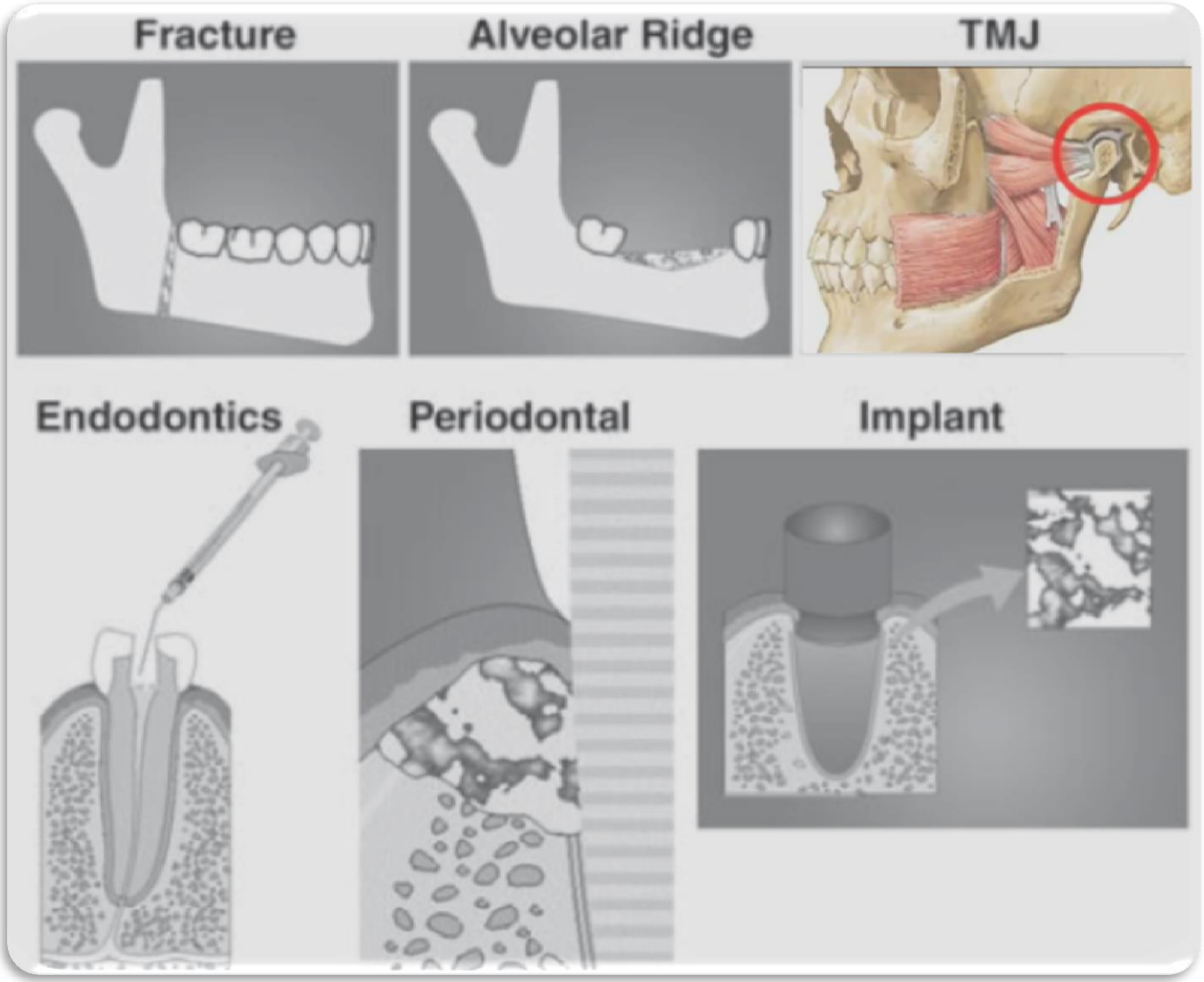
1. Course Introduction
2. Basic Optics and Light Microscopes
3. Fluorescence/Confocal/TIRF Microscopes
4. FRET Techniques and Photo-Spectroscopic Imaging
5. Single Molecule Detection
6. Cell Imaging
7. Atomic Force Microscopy (AFM)
8. Scanning Electron Microscope (SEM)
9. Transmission Electron Microscopy (TEM)
10. Digital Image Processing Using MATLAB

Nanotechnology in Dental Sciences

Timeline of the recent past, near future, and far future for the use of synthetic dental biomaterials versus truly biological materials.



Potential applications include fracture replacement, alveolar ridge augmentation, TMJ reconstruction, dentin replacement, and pre-osseointegration (骨整合) of dental implants



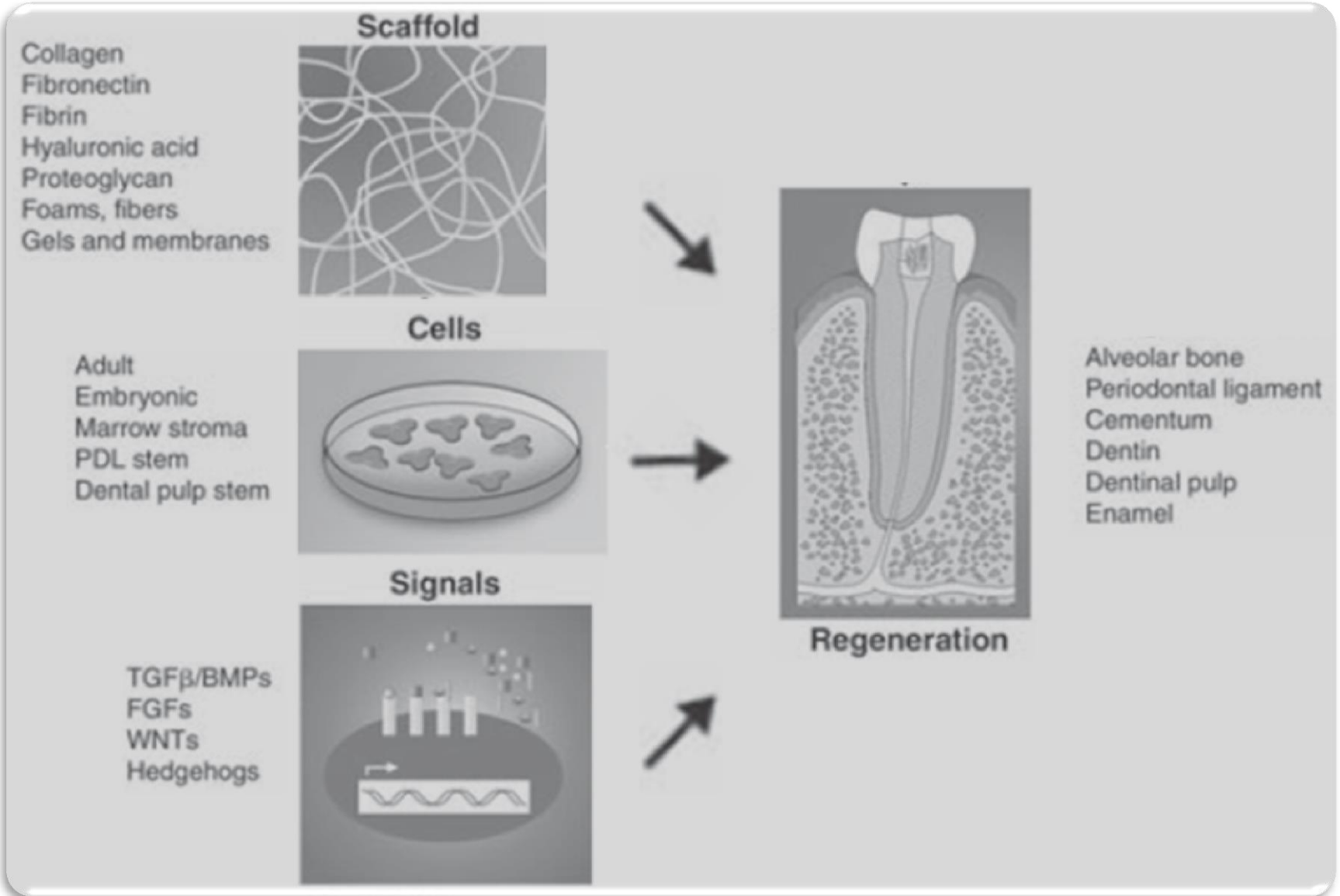
http://www.youtube.com/watch?v=gbZDcsY7hoU
http://www.burtchiropractic.com/2010/10/01/temporomandibular-joint-tmj-dysfunction-physiology-and-causes/

Osseointegration (骨整合) of Dental Implants

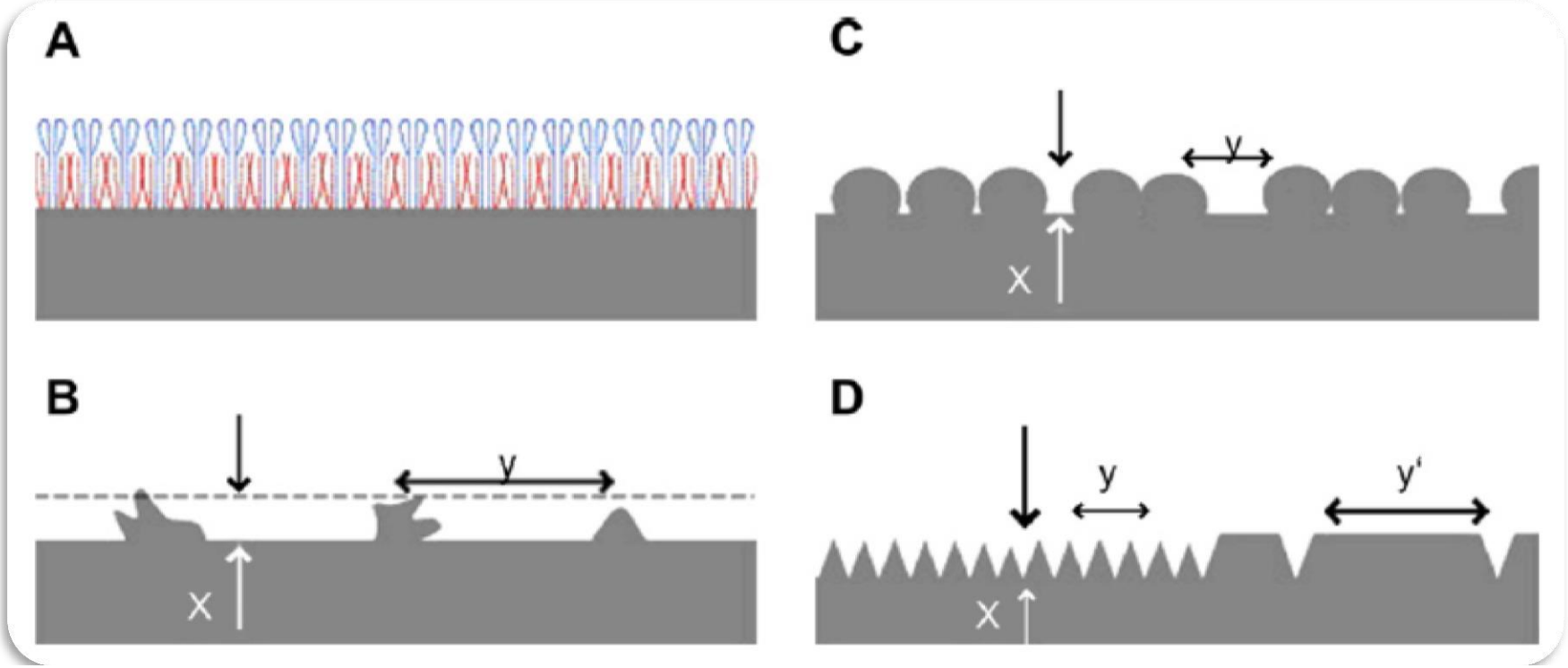
Cell-To-Cell Communication:

http://www.youtube.com/watch?v=yn5g2oxvN34

Summary of the opportunities for tissue engineering to develop scaffolds, cells, and signals to create substitute or replacement dental tissues in the future.

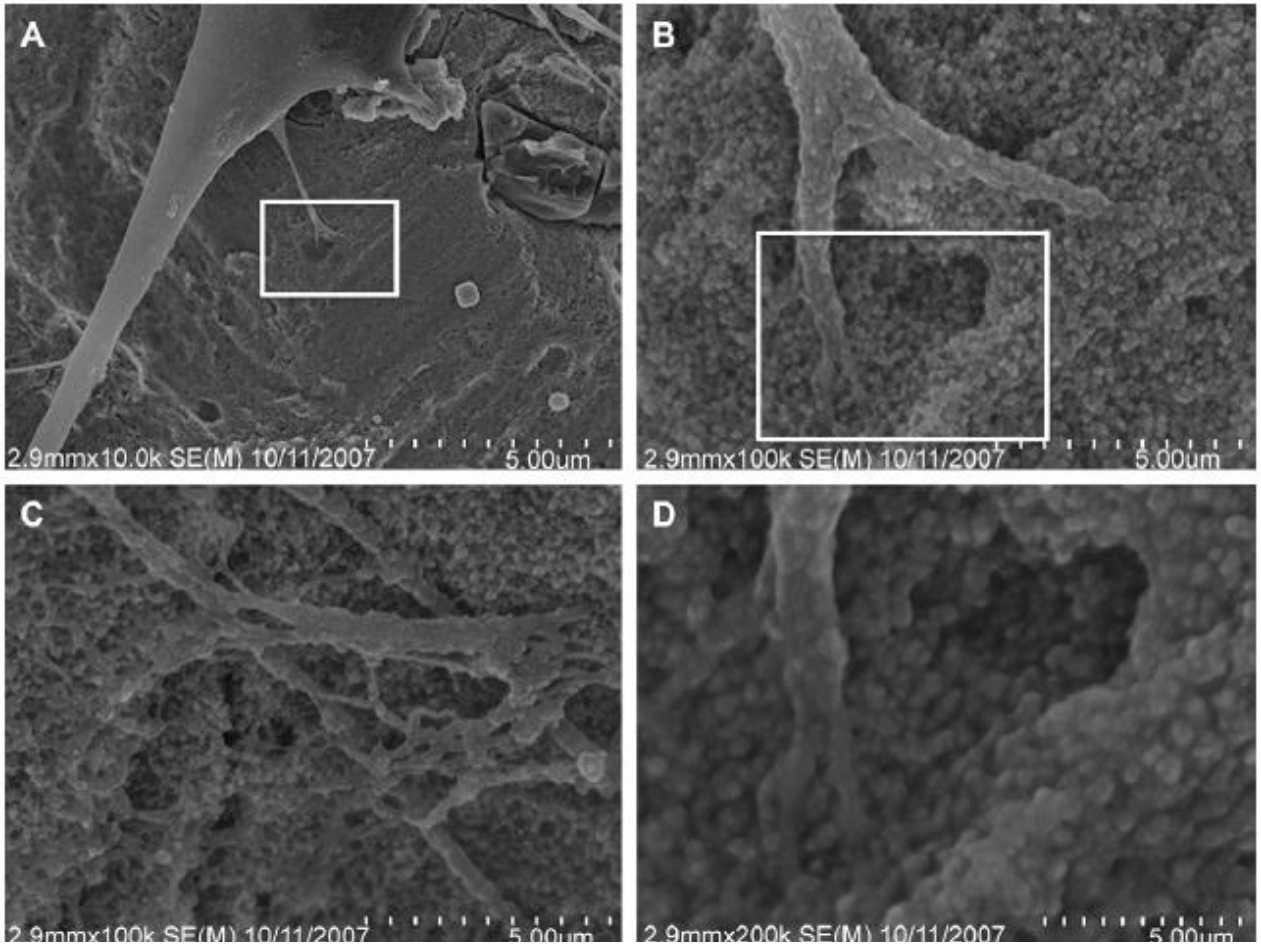


Some Nanosurfaces Mimic Natural Cell Environments



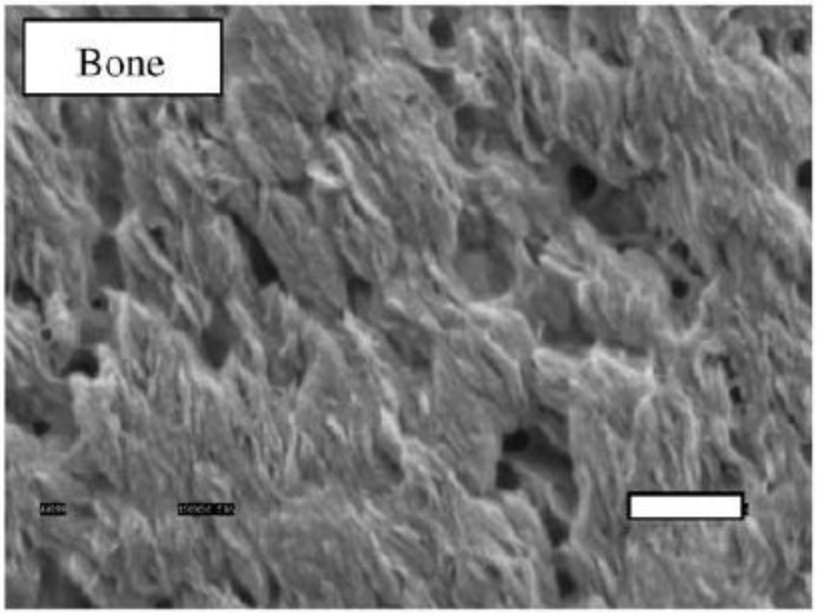
Nanoscale surface modification. (A) Self-assembled monolayers (SAMs) can change the topography and chemistry of a surface to impart novel physical and/or biochemical properties. (B) Deposition (沉積) or chemical modification techniques can apply nanoscale features (x≤100 nm) in a manner that are distributed in micron-scale (y > 100 nm). (C) Other deposition or compaction methods can place nanoscale features in nanoscale distribution. The cell response to surfaces represented by (B) or (C) may be different. (D) Isotropic surfaces can be created in the nanoscale (x ≤ 100 nm) by subtractive or additive methods. The distribution can be in either the nano- (y) or micron-scale (y').

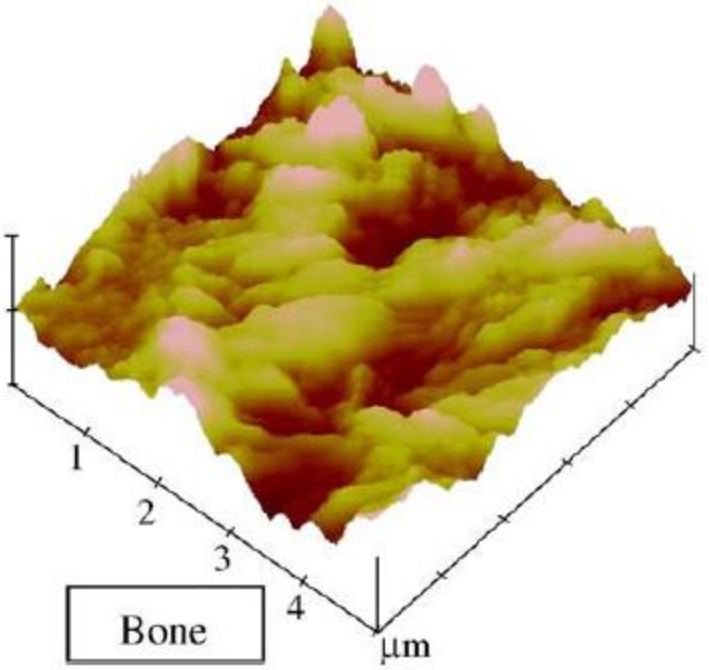
Nanoscale Topography-Cell Interactions



There is apparent affinity of cells for nanoscale features. Here, 20–40 nm features produced by H_2O_2/H_2SO_4 treatment are interactive points for lamellipodia of spreading cells. The cause and effect relationship is a current point of investigation. (A) 10,000 image of adherent cell, (B) and (C) represent 100,000 images of the same adherent cell and (D) 200,000 magnification of the cell with nanofeatures. (B) higher magnification of the rectangle in (A). (D) higher magnification of the rectangle in (B).

SEM and AFM Scan of Porcine Femur Bone Demonstrating a High Degree of Nanometer Roughness

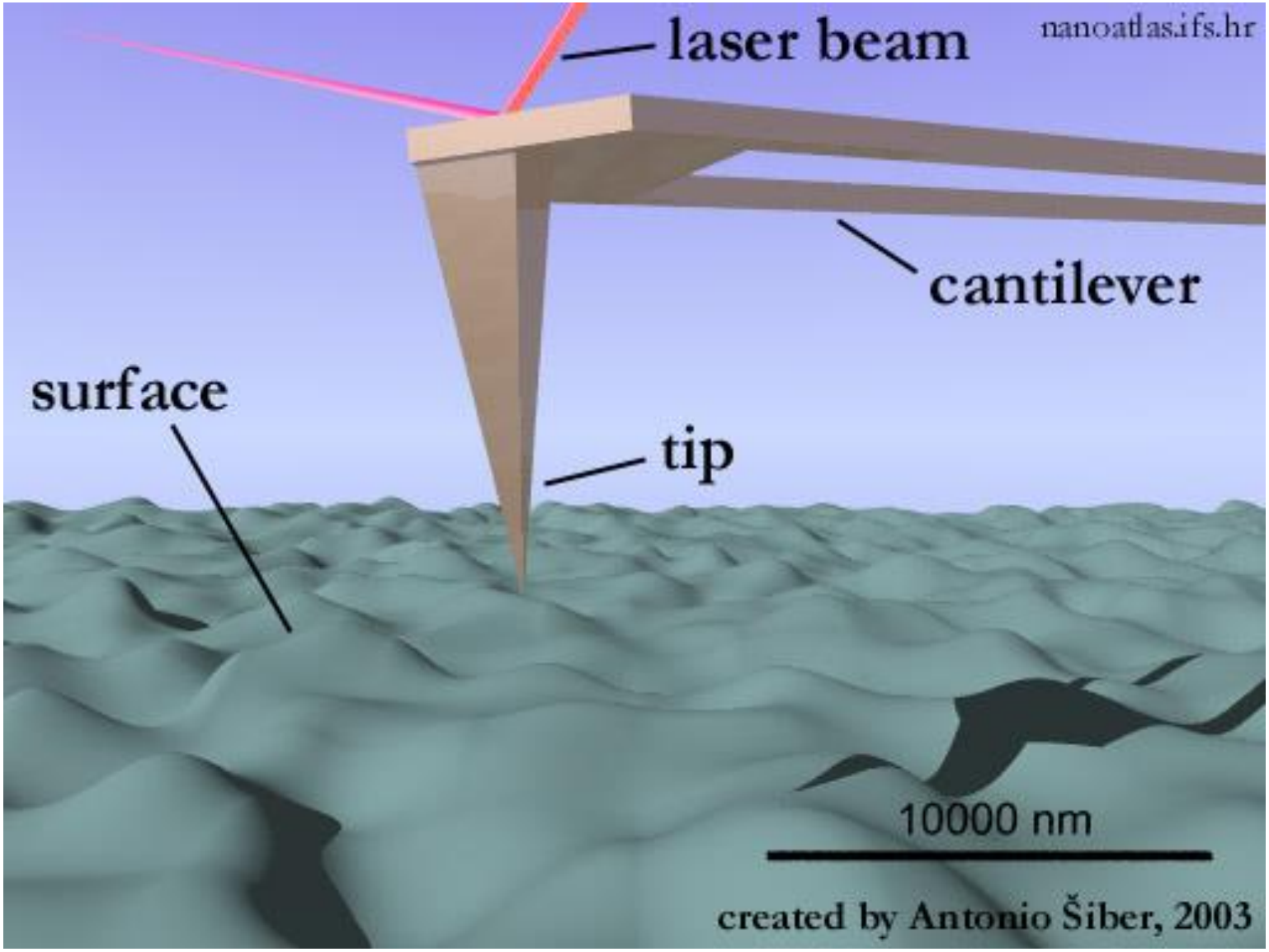




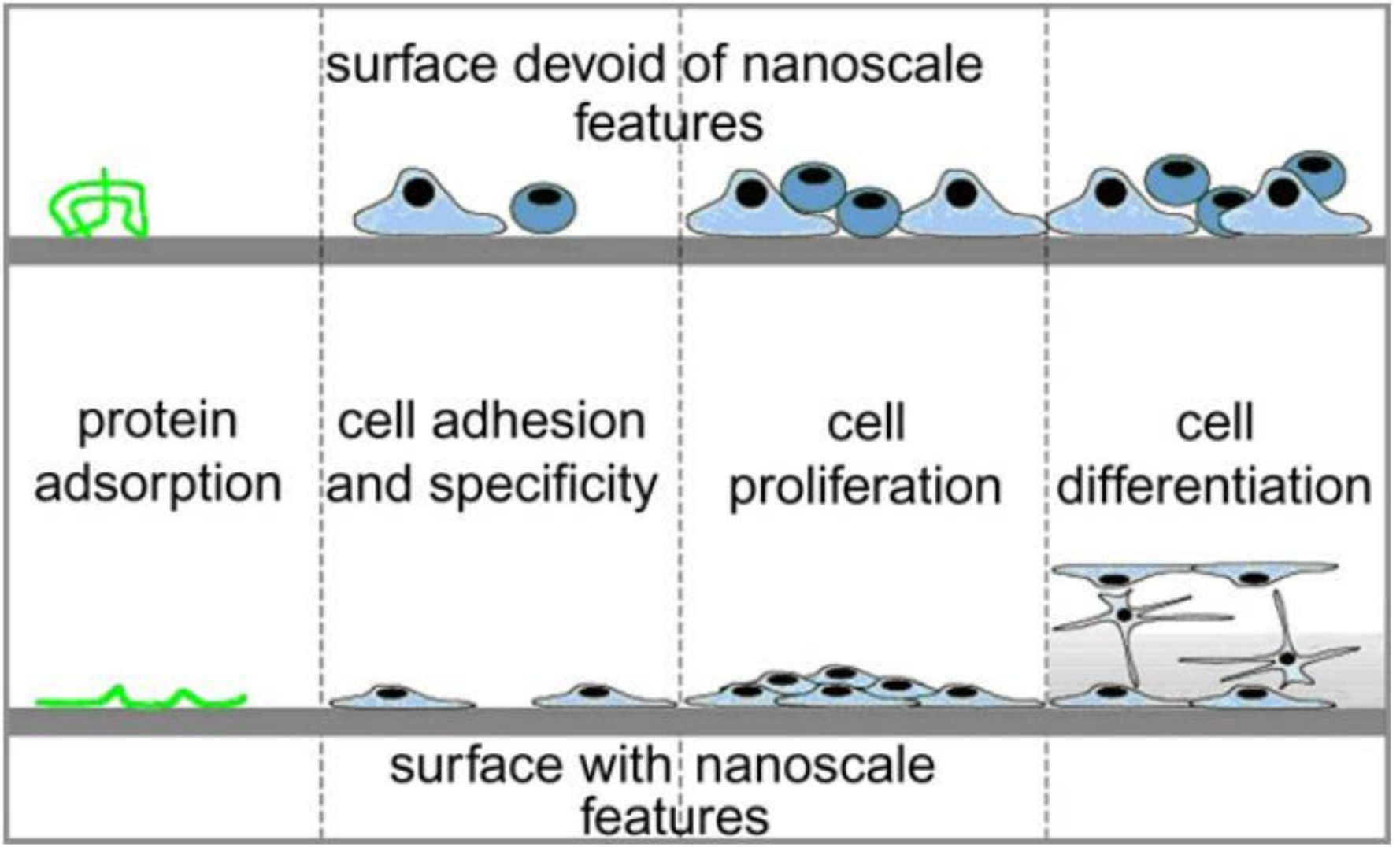
1) Original SEM magnification is 15 kX and magnification bar is 1 mm.

2) Original AFM scan size is 5 mm×5 mm and data Z-scale is 300nm.

Atomic Force Microscopy (AFM)

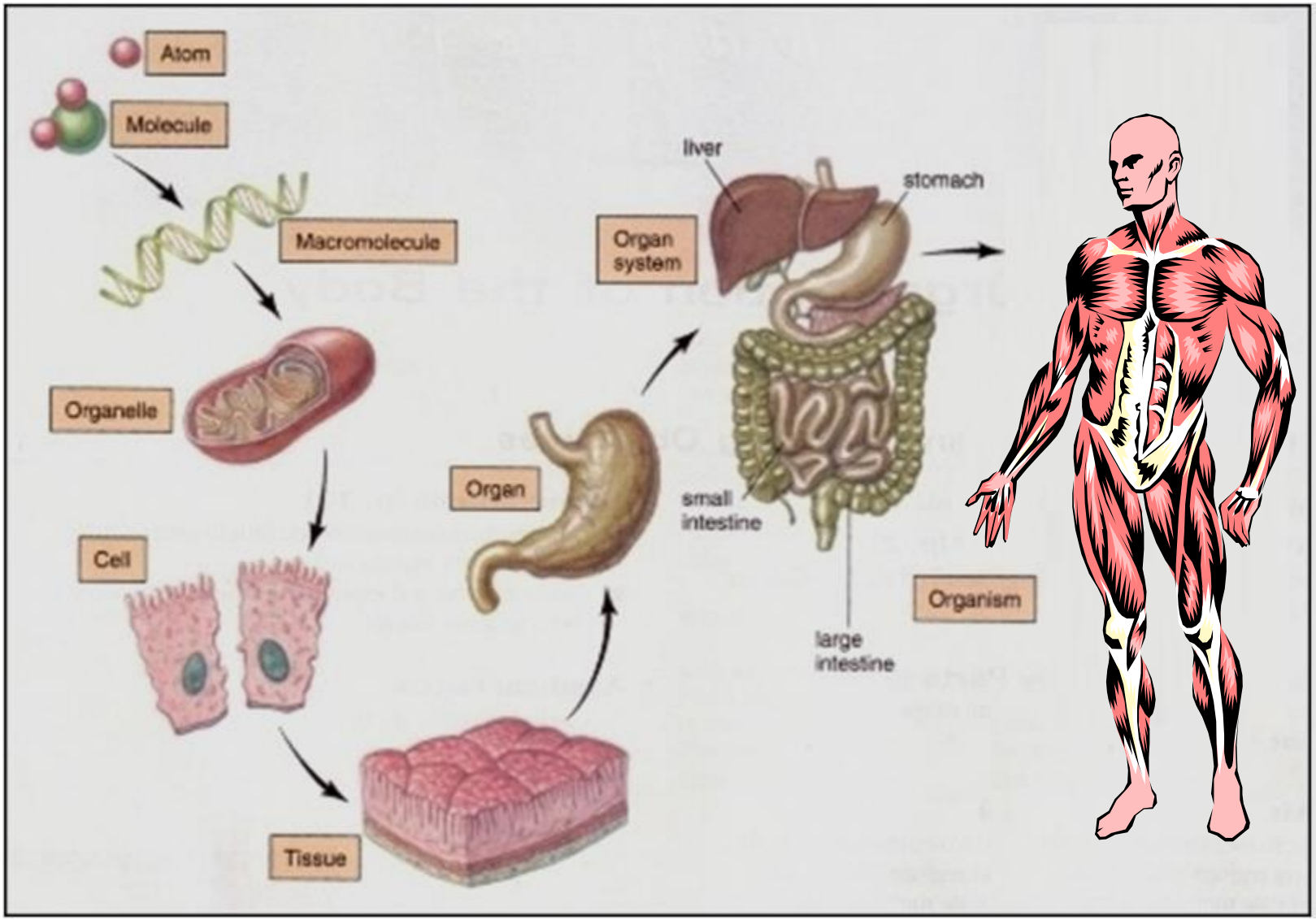


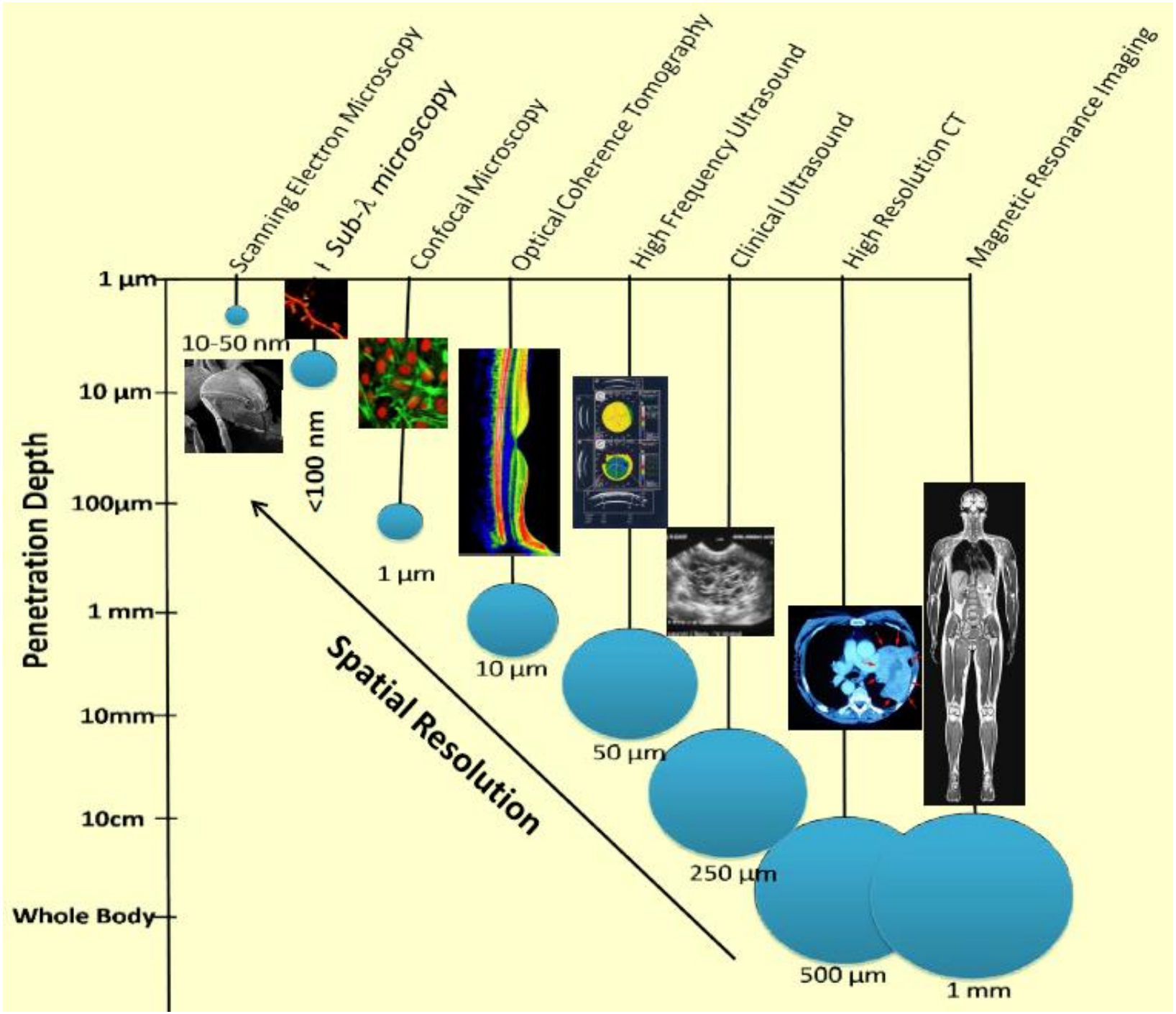
Depiction of broad range of nanoscale topography effects observed in cellular protein adsorption is altered by nanoscale modification of bulk material



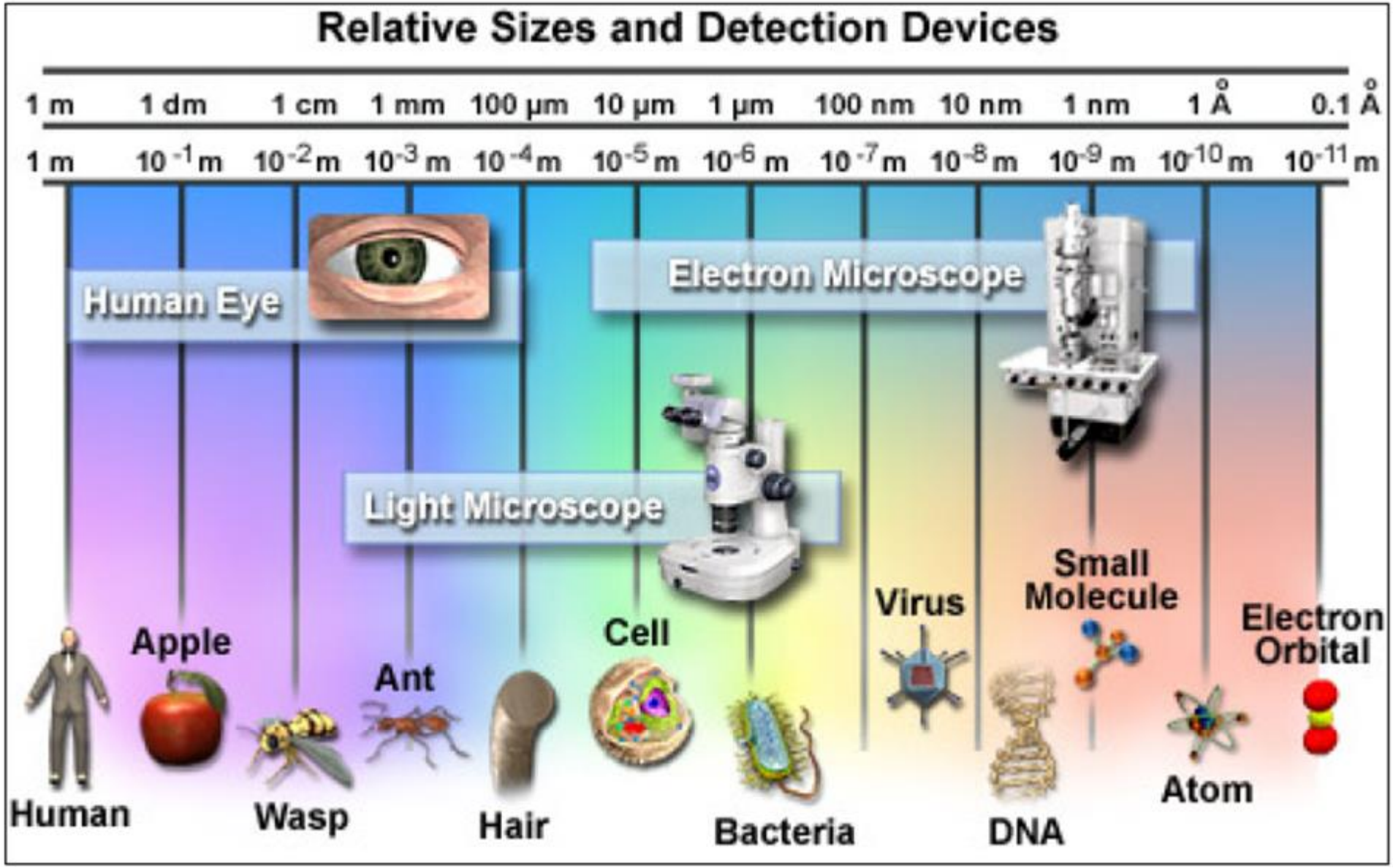
Diversity of Optical Bio-Imaging:
principles, technologies, information, applications

Clinic/Life sciences/Biotechnology



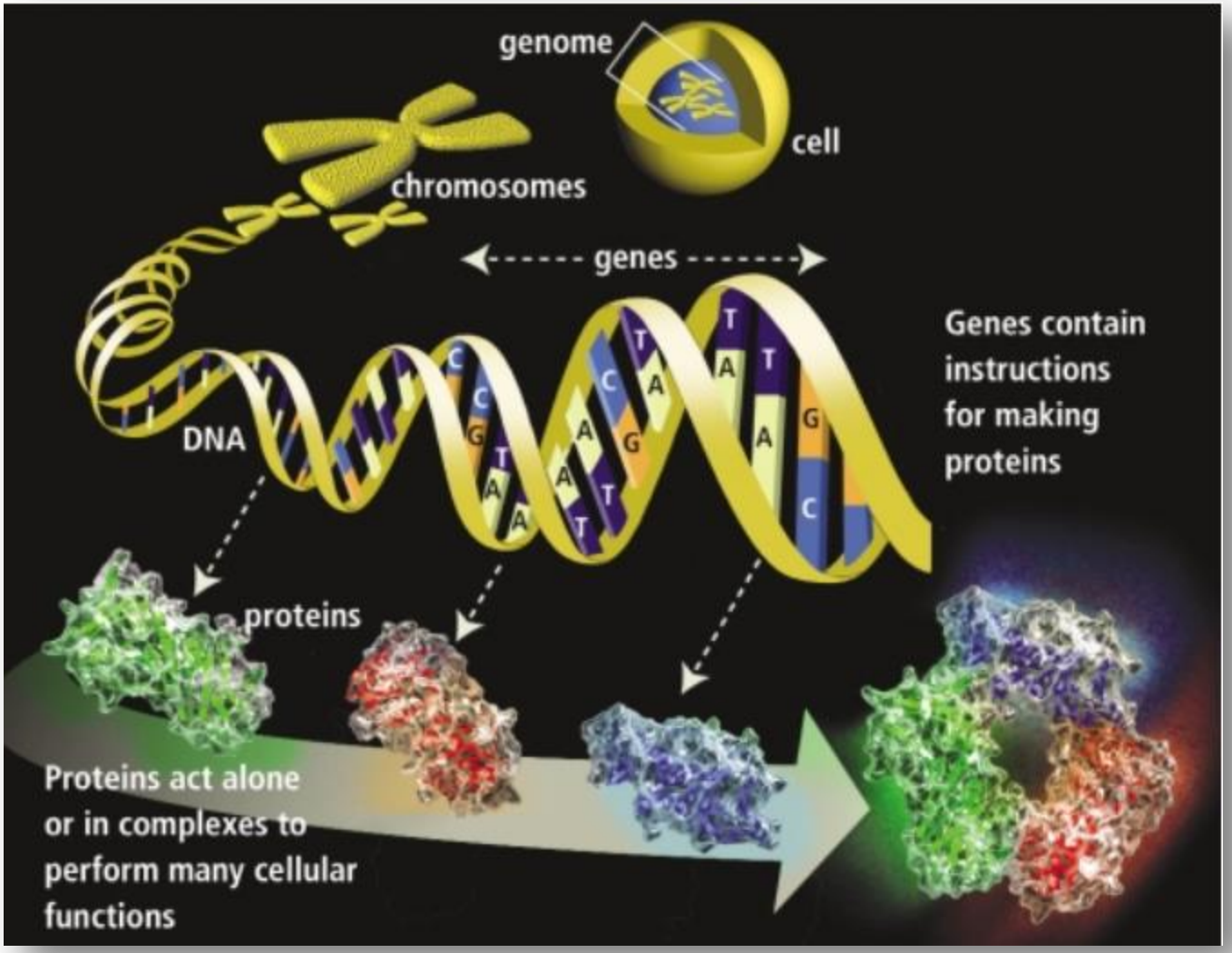

Scanning Electron Microscopy
Sub-λ microscopy
Confocal Microscopy
Optical Coherence Tomography
High Frequency Ultrasound
Clinical Ultrasound
High Resolution CT
Magnetic Resonance Imaging
Penetration Depth
1 µm
10 µm
100µm
1 mm
10mm
10cm
Whole Body
Spatial Resolution
10-50 nm
<100 nm
1 µm
10 µm
50 µm
250 µm
500 µm
1 mm

Diversity of Optical Bio-Imaging:
principles, technologies, information, applications



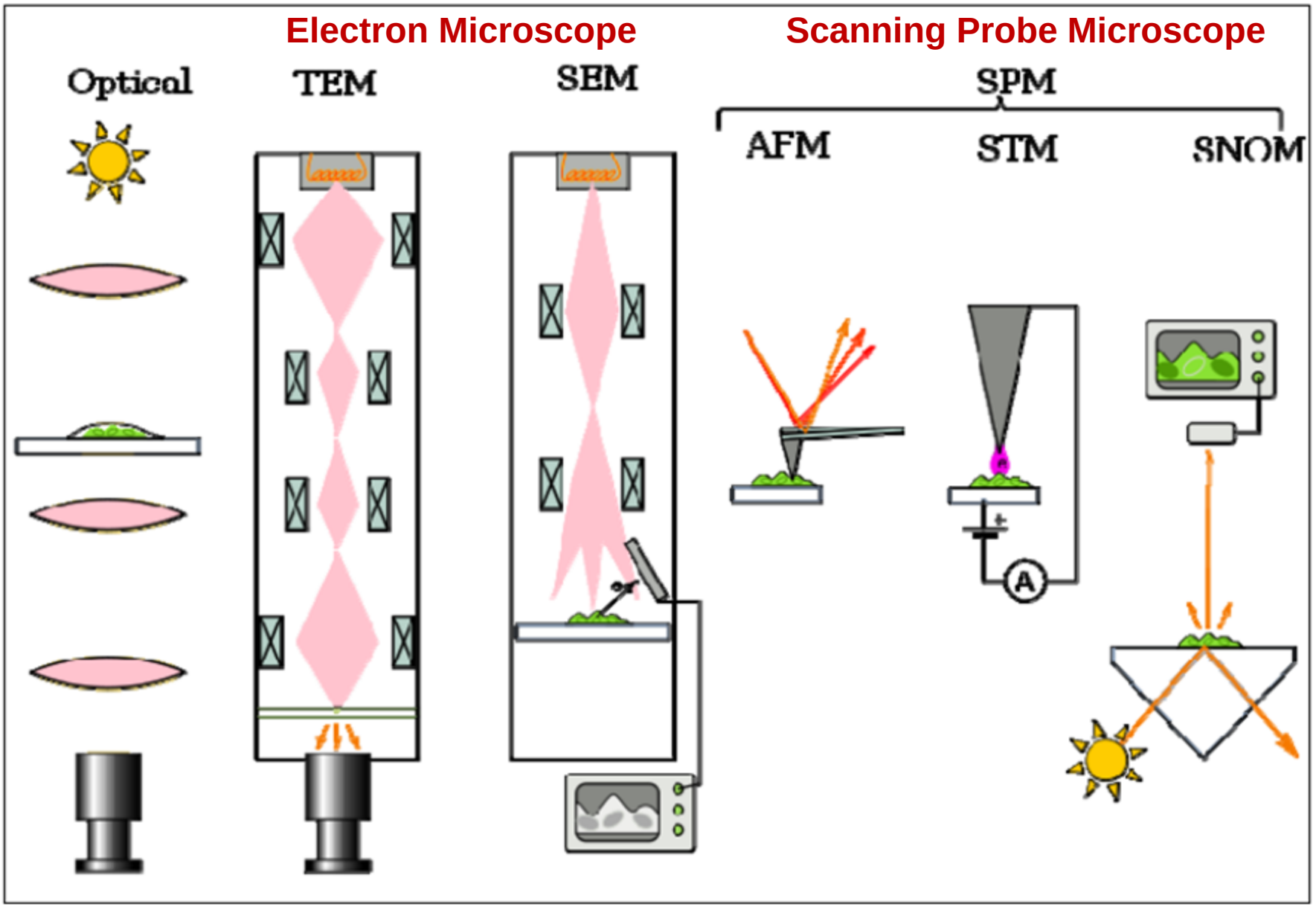
From Genomes to Proteomes

'Omics' Sciences: Proteomics (蛋白質體學)



http://www.ornl.gov/sci/techresources/Human_Genome/publicat/jmmbbag.pd

Types of Microscopes



http://www.deeringestate.com/uploads/Cell%20Biology%20Lesson%20Plan.pdf

Characteristics of Measuring Techniques for Surface Morphology

	Resolution X,Y	Resolution Z	Circumstance	Pretreatment required	Magnific-ation
Optical Microscope	0.2 μm	1 μm	air, liquid	none	10^3
Confocal Microscope	170 nm	500 nm	air, liquid	none	10^4
AFM	**0.1 nm**	**0.1 nm**	air, liquid, vacuum	**none**	**10^9**

- **AFM have high resolution and simply sample preparation.**

Digital Image Processing Using MATLAB

What Is Image Processing Toolbox?

Image Processing Toolbox is a collection of functions that extend the capability of the MATLAB numeric computing environment. The toolbox supports a wide range of image processing operations, including

- Spatial image transformations
- Morphological operations
- Neighborhood and block operations
- Linear filtering and filter design
- Transforms
- Image analysis and enhancement
- Image registration
- Deblurring
- Region of interest operations

http://www.mathworks.com/products/image/
http://www.mathworks.com/videos/medical-imaging-analysis-and-visualization-71066.html

Digital Image Processing Using MATLAB

Medical Imaging Analysis and Visualization

http://www.mathworks.com/products/image/
http://www.mathworks.com/videos/medical-imaging-analysis-and-visualization-71066.html

評分方法

1.出缺席狀況 10%

2.平時表現 10%

3. Homework 30%

4.實驗操作與分析 20%

4.期末分組書面與口頭報告 30%

Thanks For Your Attention