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NARODOWA STRATEGIA SPÓJNOŚCI

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BIOPHYSICS

Prezentacja multimedialna współfinansowana przez Unię Europejską w ramach Europejskiego Funduszu Społecznego w projekcie pt.

„Innowacyjna dydaktyka bez ograniczeń - zintegrowany rozwój Politechniki Łódzkiej - zarządzanie Uczelnią, nowoczesna oferta edukacyjna i wzmacniania zdolności do zatrudniania osób niepełnosprawnych”

Lecture 9

ELECTROCHEMISTRY and PROSTHESES (9)

Bogdan Walkowiak

Department of Biophysics
Institute of Materials Science and Engineering
Technical University of Lodz

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Introduction

- As we know, even the most often and the longest time practiced dental procedures of implantation still bring complications.

- Metal alloys, commonly used for dental fillings and restorations, are a reason of creation of galvanic cells possessing a low energetic capacity but a high regeneration ability, with voltage reaching 1V.

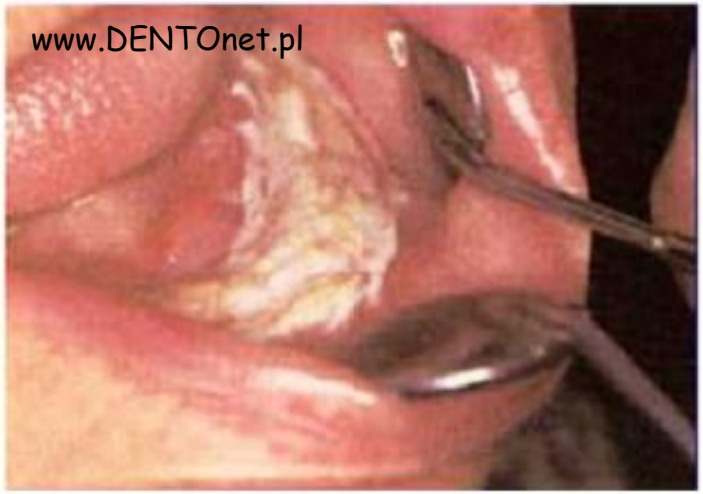
Dzieniakowski T., Jatczak J., Jędrzejewski T., **Walkowiak B.** Measurements of the power of electric current generated on a resistor containing an electric pile developed in patients with amalgam fillings. Czas Stomat. 1980; 33: 905-12.

- There are several indications, that the presence of galvanic elements can affect our body both, globally and systemically.

Bergman M. Corrosion in the oral cavity – potential local and systemic effects. Int Dent J. 1986; 36: 41-4.

Risk Associated with the Use of Metallic Dental Devices

Electrochemical phenomena taking place in the oral cavity are often a reason of pathological changes, most often leukoplakia, which usually subside with metal remove, but sometimes can also cause malignant changes.



bottom oral cavity leucoplakia

tongue leucoplakia

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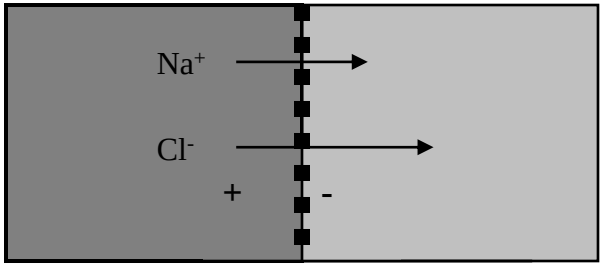
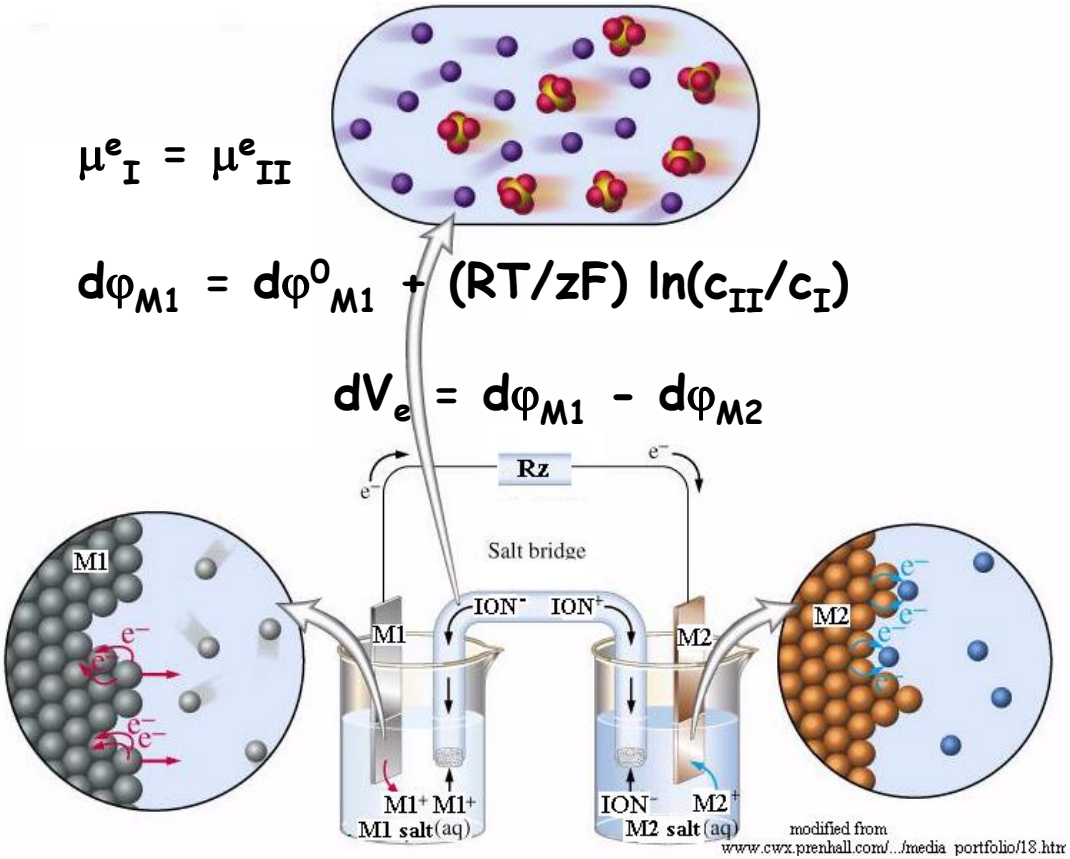
Concentration Cells Generated by Metallic Dental Devices



$$\mu^e_I = \mu^e_{II}$$

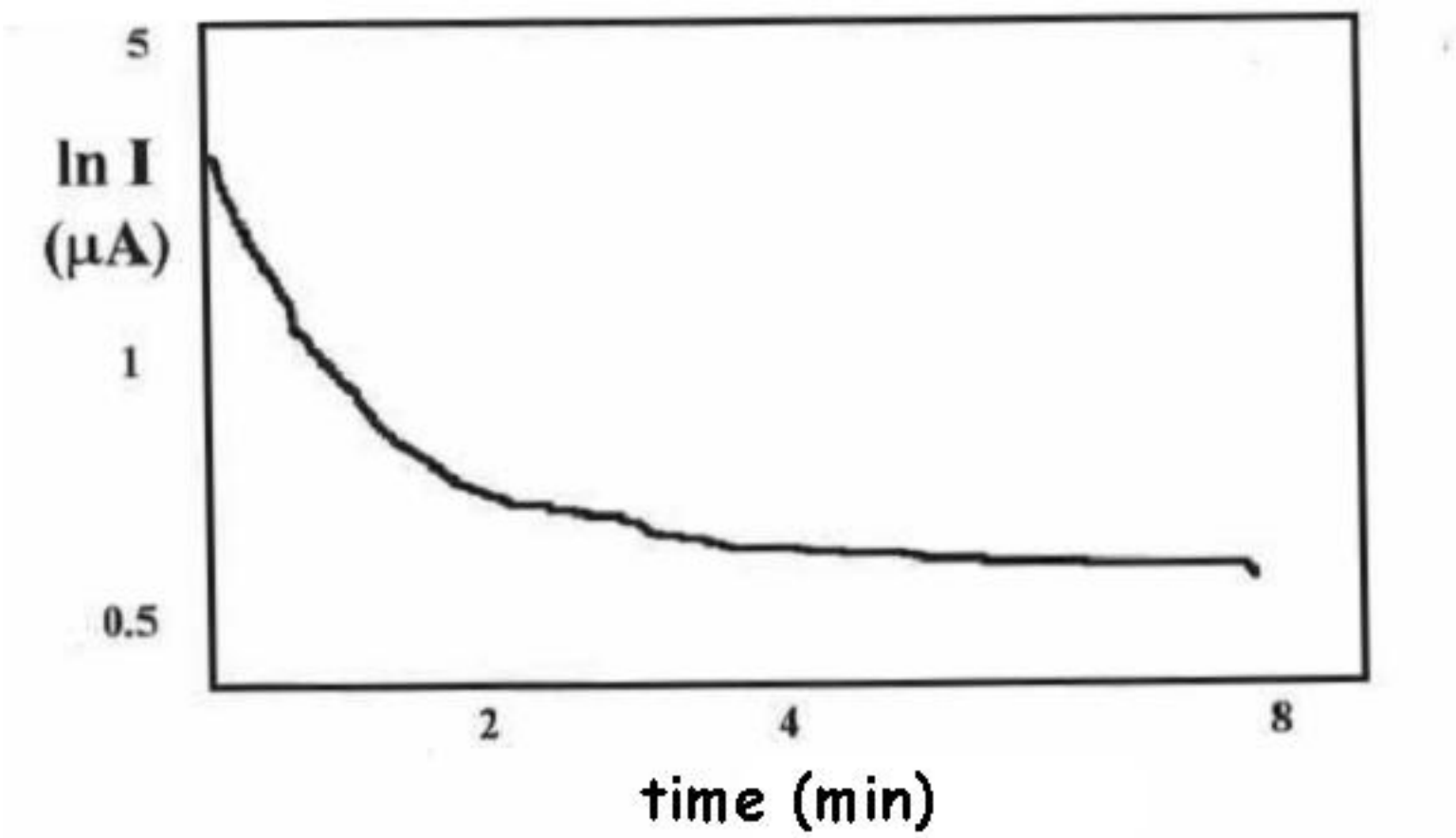
$$d\varphi_{M1} = d\varphi^0_{M1} + (RT/zF)\ \ln(c_{II}/c_I)$$

$$dV_e = d\varphi_{M1} - d\varphi_{M2}$$



$$dV_d = ((u^+ - u^-)/(u^+ + u^-))\ \ln\ (c_2/c_1)$$

Time Dependent Current Flowing Through an External Resistor



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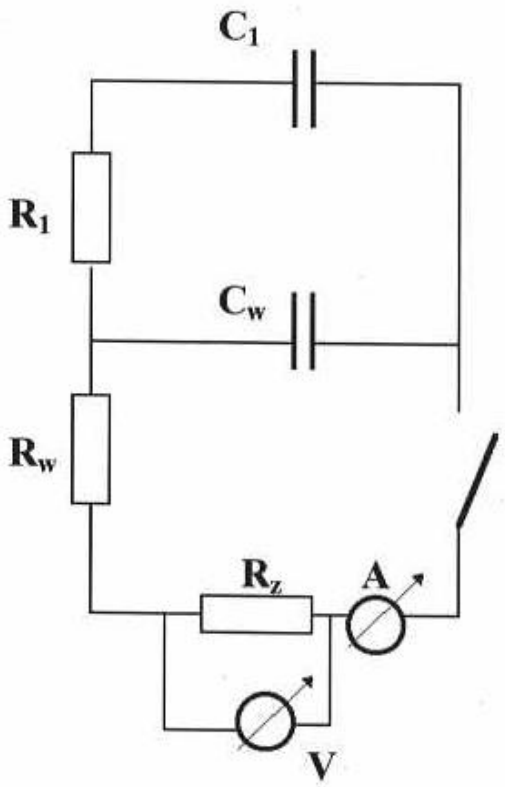
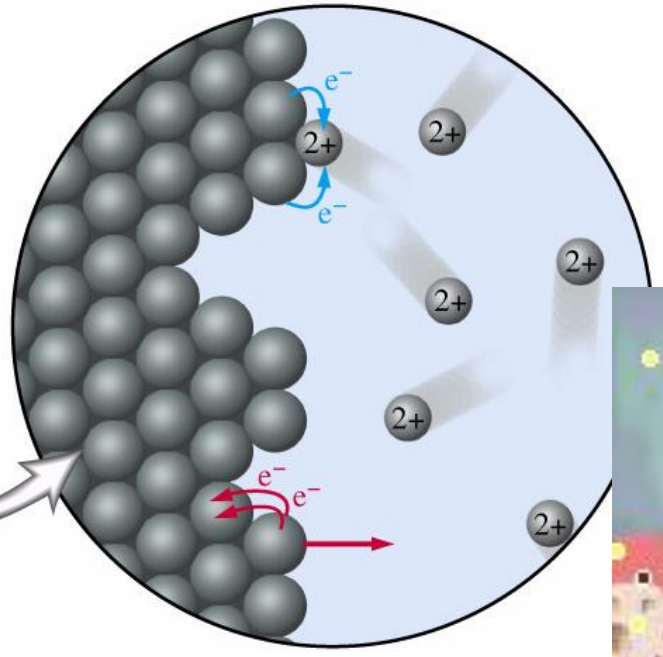
Electric Model of the Concentration Cell



$C_1 >> C_w$; $R_1 >> R_w$; $I = I_1 \exp(f_1 t) + I_2 \exp(f_2 t)$

Jatczak J. Walkowiak B. Modelowanie czasowych charakterystyk źródeł prądu elektrycznego w jamie ustnej. Postępy Fizyki Medycznej 1980, t 15, 141-145.

Diffusion of Free Metallic Ions



Diffusion stream depends on concentration of ions:

$$J = -D\, dc/dx$$

Sources of Risk

- Metal corrosion can be limited by surface modification, but modified surface exhibits new molecular structures which can introduce new interactions with surrounding tissue and potentially are able to release molecules with unknown properties.
- It is essential that the newly produced surface should durably stick to a substrate material and any surface defects or local surface delamination entirely disqualify the new product.
- Other materials, including ceramics, glasses, polymers, composites or natural biomaterials, also undergo a gradual degradation, in contact with body fluids, releasing substances capable to relatively freely migrate in a whole body causing variety of biological effects.

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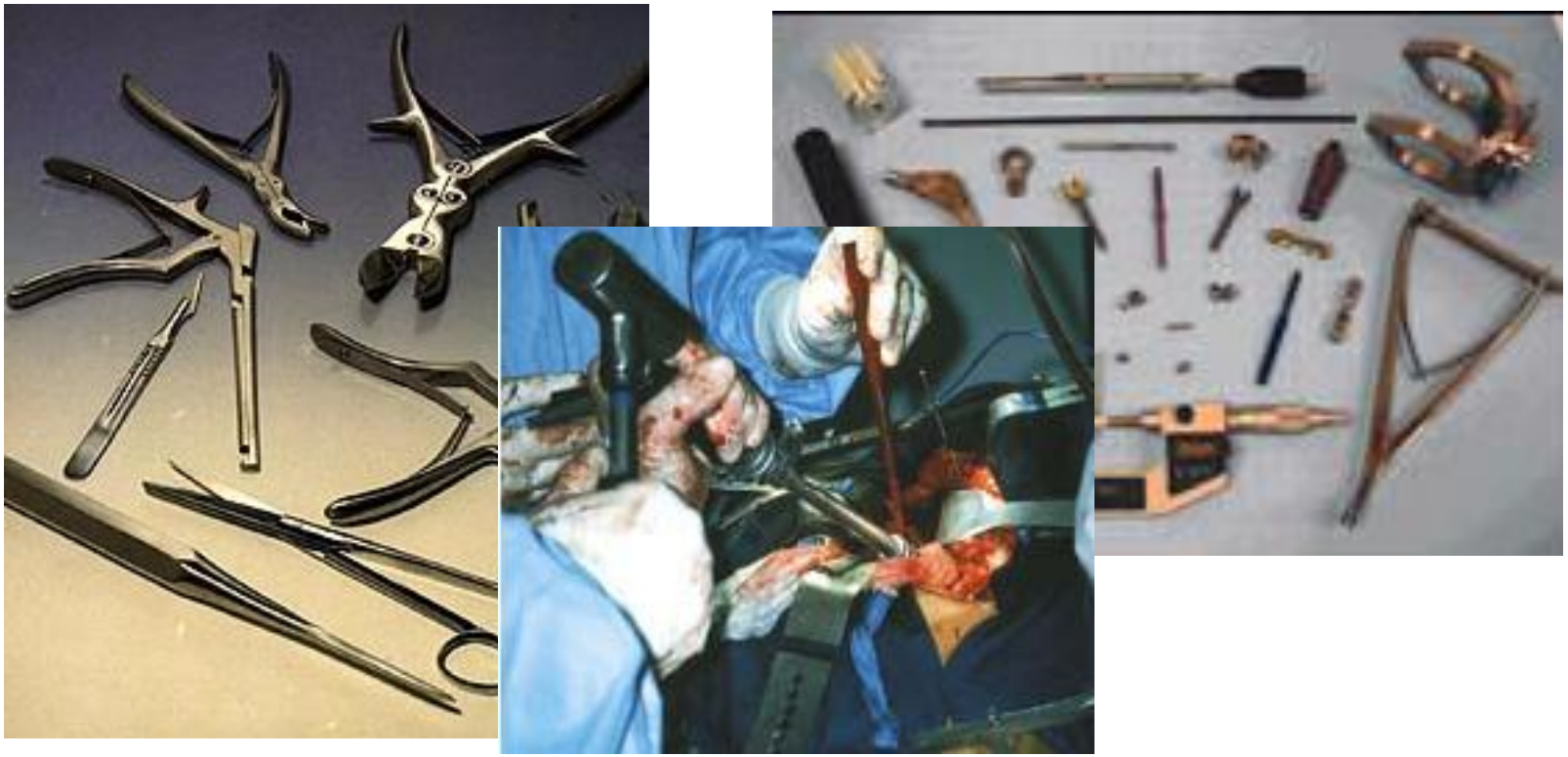
Sources of Risk



Microscopic size remains of surgical devices, created as a result of mechanical interaction of the device with tissue and with implant, and also particles produced by an implant wear, are often underestimated source of risk

Source: INTERNET

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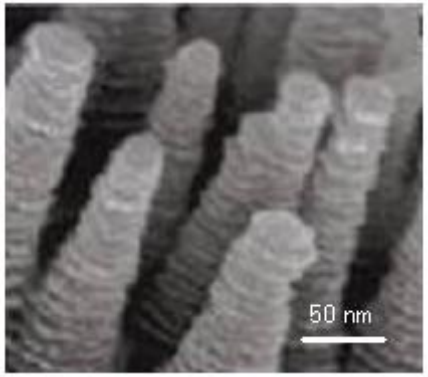
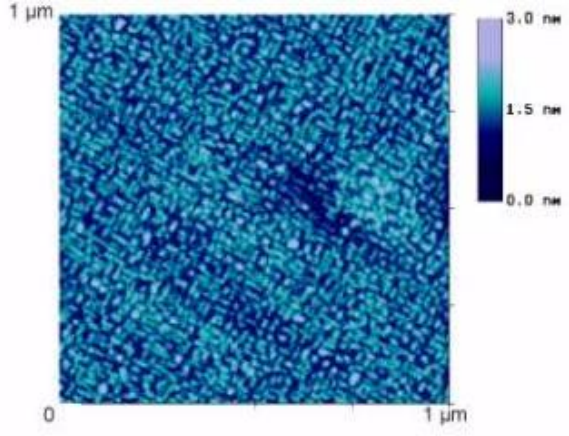
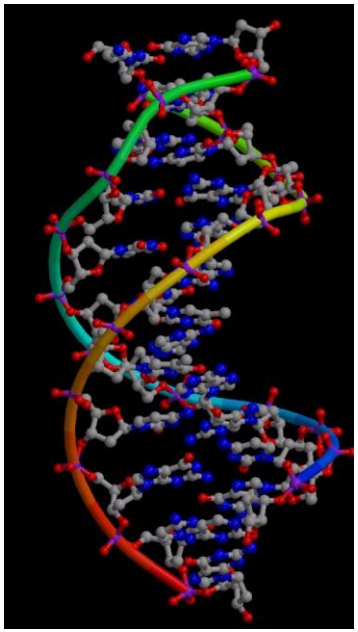
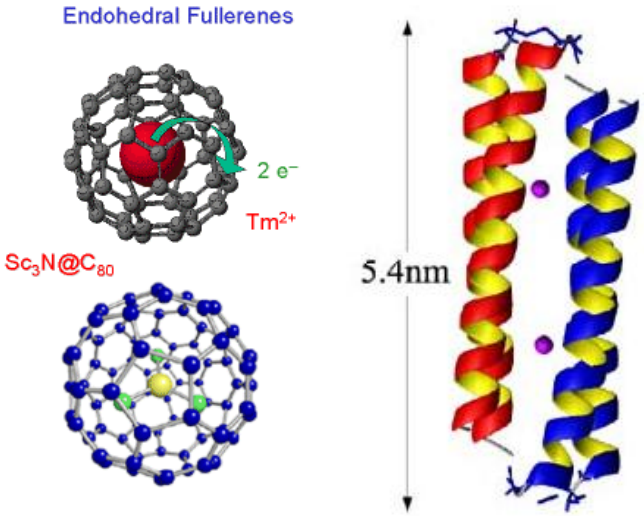
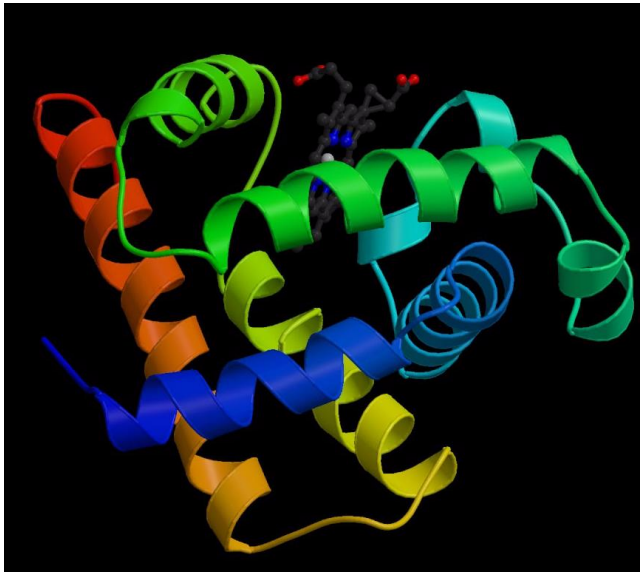
Nanostructures





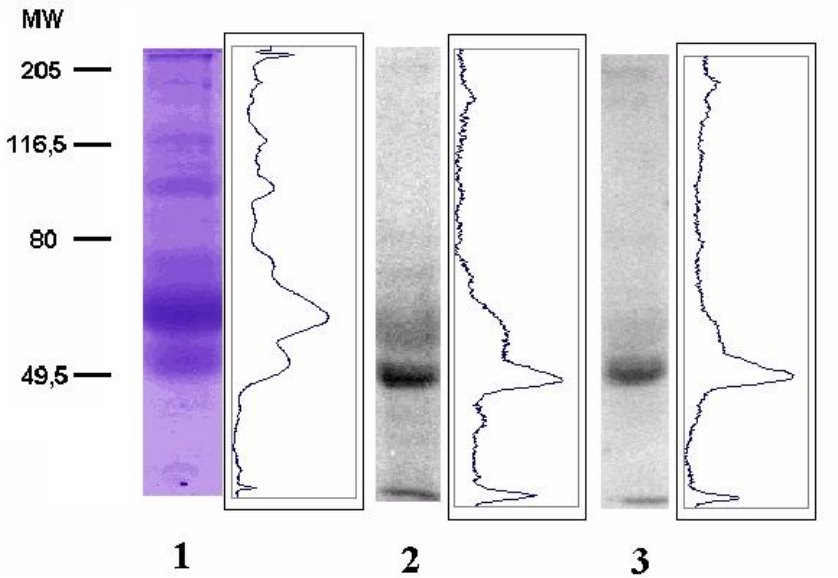




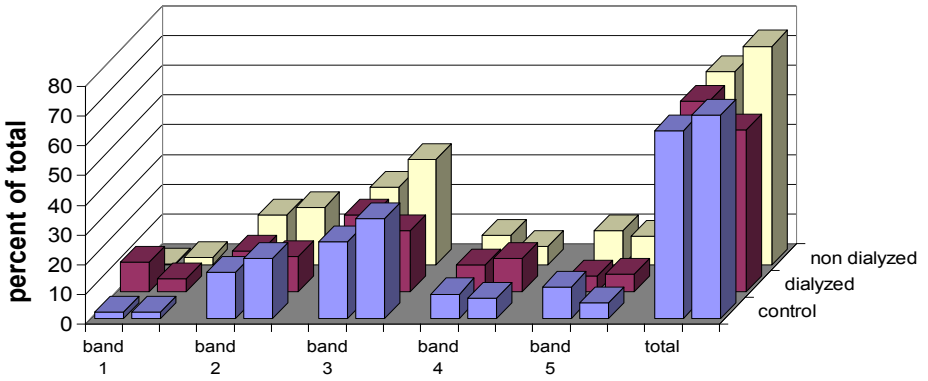


Source: INTERNET

Level of Phosphorylated Platelet Proteins in Uremic Patients



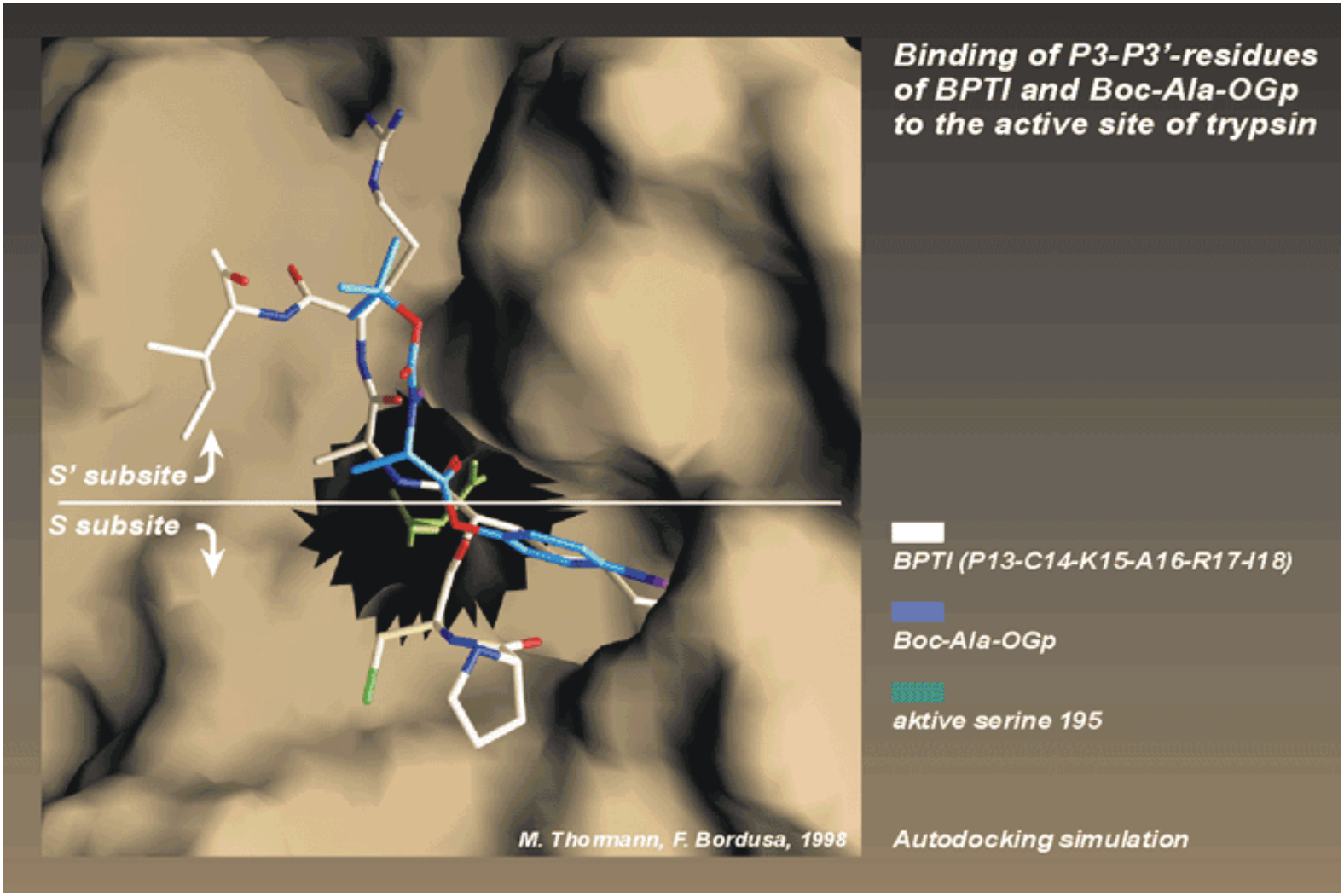
Electrophoretical separation of platelet proteins and detection of tyrosine phosphorylated proteins :
1- coomassie stained proteins,
2-phosphorylated proteins before activation,
3-phosphorylated proteins after activation.



Amount of phosphorylated blood platelet proteins in control, dialyzed and non-dialyzed patients.

Walkowiak B., Tanski W., Koziołkiewicz W.
Phosphorylation of platelet protein in hemodialyzed patients is different than in control donors.
XIX Congress on Thrombosis and Haemostasis, Birmingham, UK. July 2003, abstract No. P1315.

Binding of Synthetic Molecule to the Active Site of Trypsin



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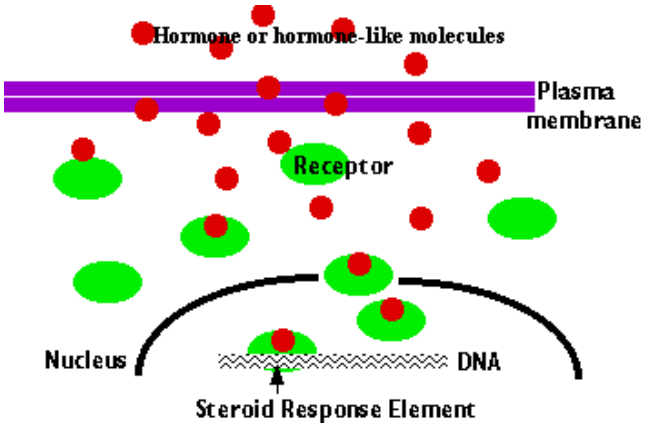
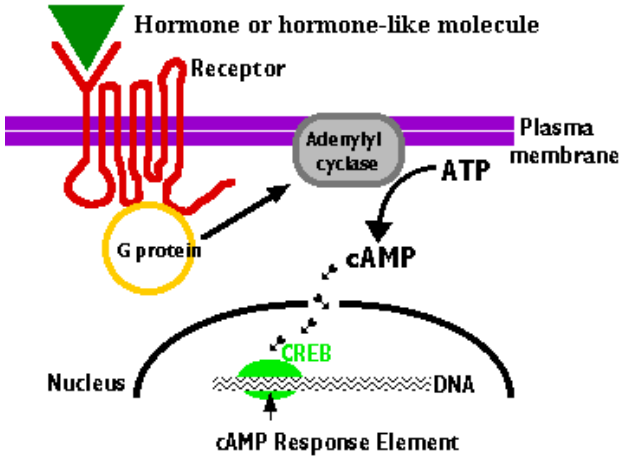
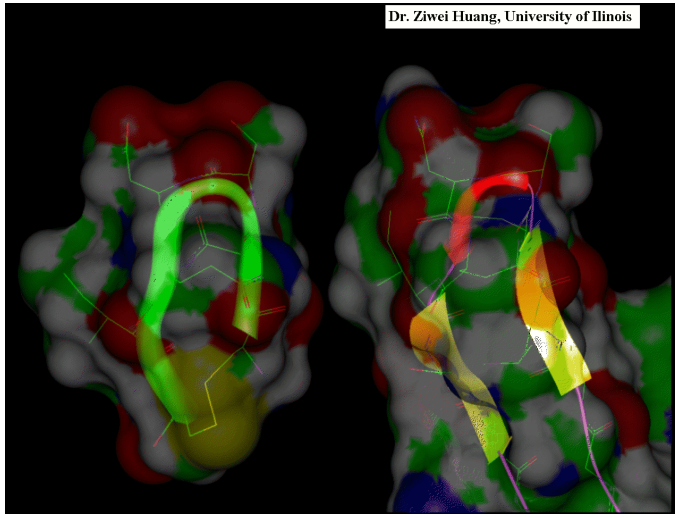
Possible Action of Hormone-like Mimetics

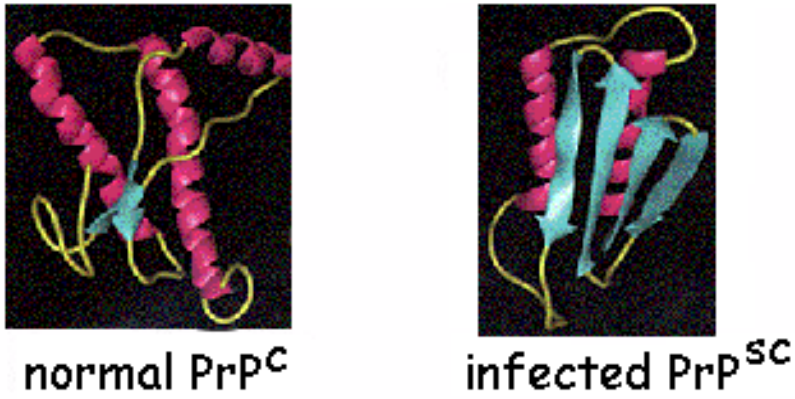


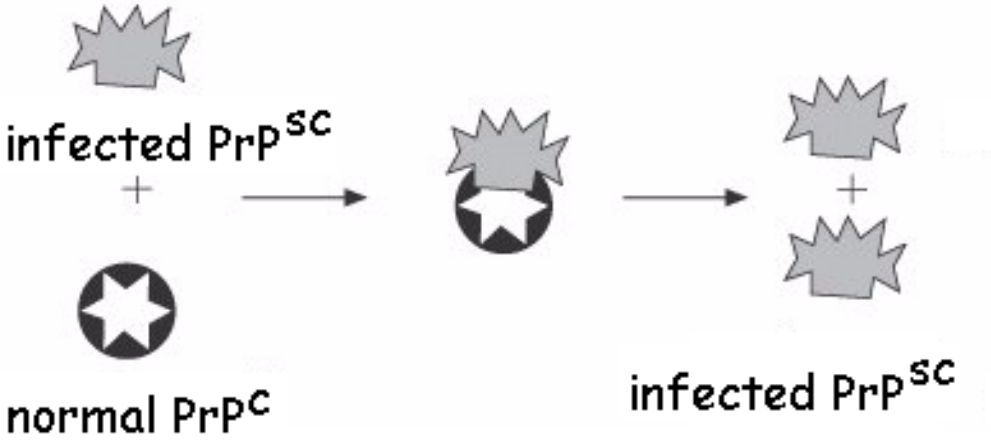




Source: INTERNET

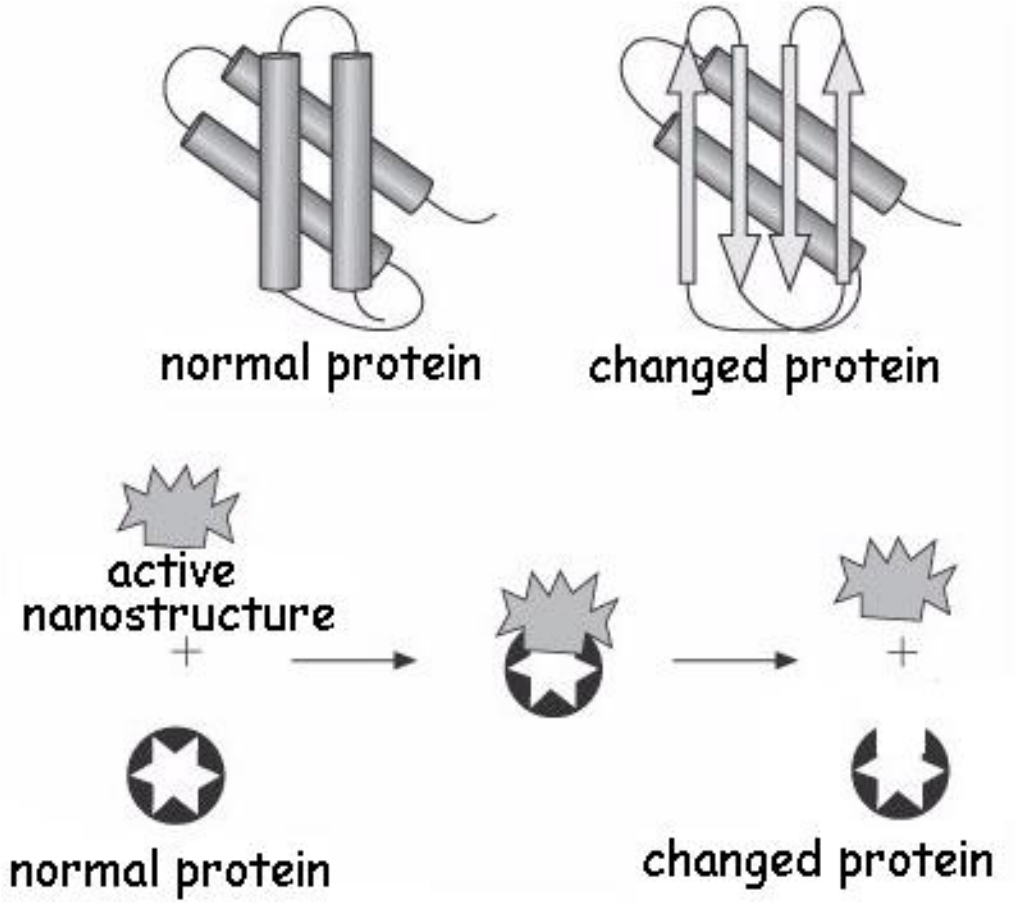
Possible Changes Induced in a Protein Structure by a Contact with Nanostructure





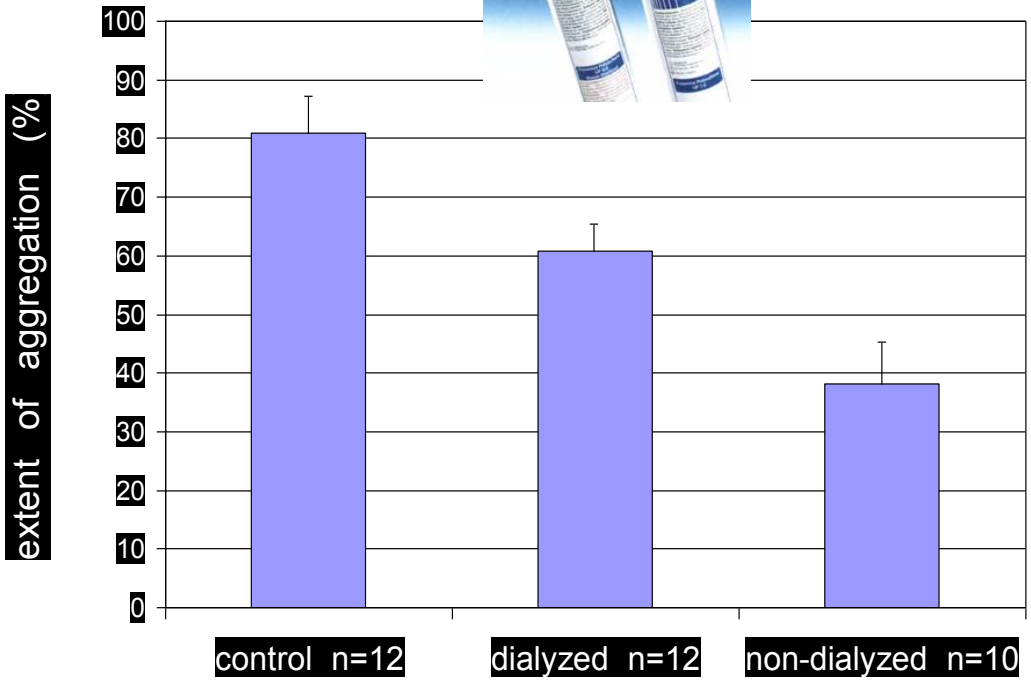
Source: INTERNET

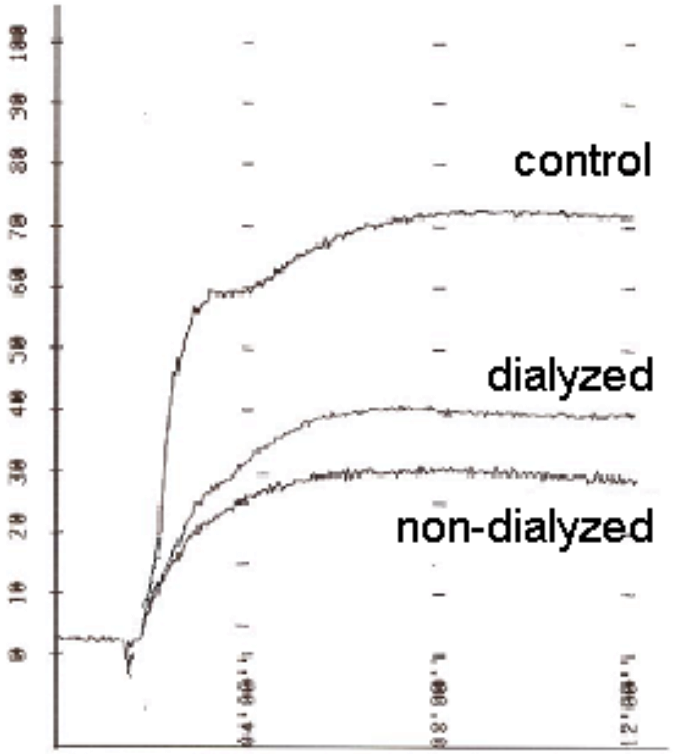
Possible Changes Induced in a Protein Structure by a Contact with Nanostructure



Source: INTERNET

Bleeding Tendency Associated with Renal Failure





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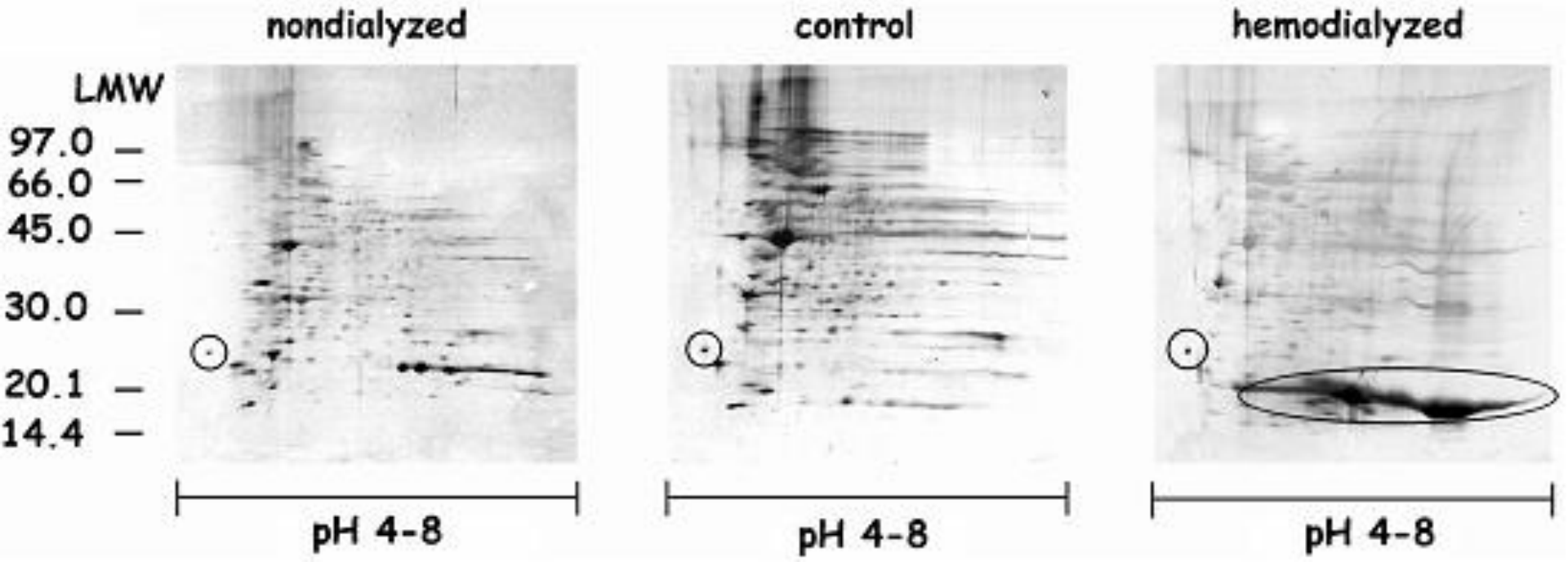
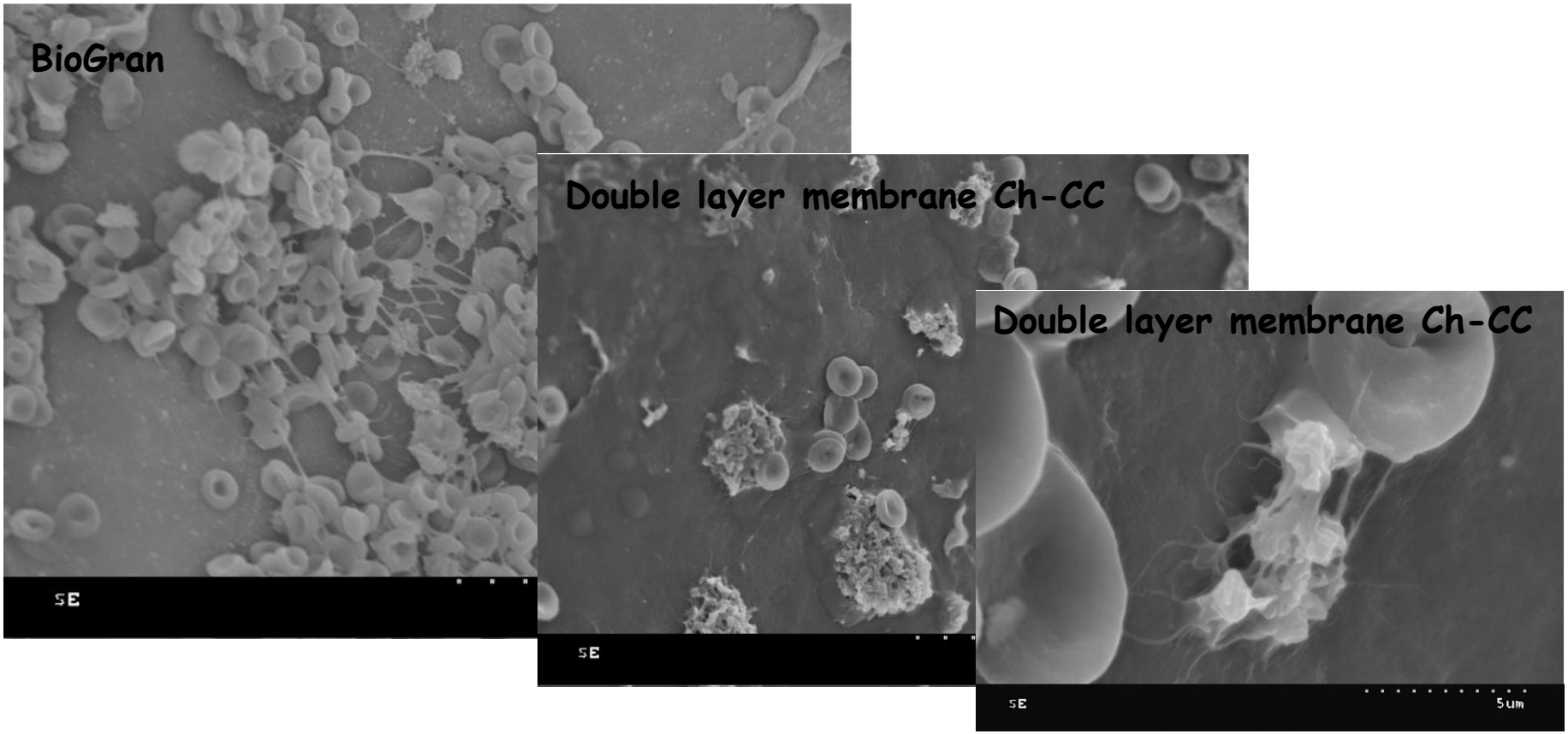
Changes in Proteome Profile in Hemodialyzed Patients



Selected gels representing nondialyzed, control and hemodialyzed groups. The circled spots represent protein with the same expression level in all groups, whereas the area marked with an ellipse contains low molecular peptides with a wide range of pI values.

Walkowiak B, **Kanińska M**, **Okrój W**, Tański W, Sobol A, Zbrog Z, **Przybyszewska-Doros I**
The blood platelet proteome is changed in UREMIC patients.
Platelets 2007, 18, 386-8

Bone Substitute Material Interaction with Blood Platelets



Kozakiewicz M., Okrój W., Klimek L., Lobos M., Walkowiak B.
Bone substitute material and barrier membrane interaction with human blood platelets.
10th Erfurt Conference on Platelets. Erfurt, Germany, June 2004. Abstract book, page 71.

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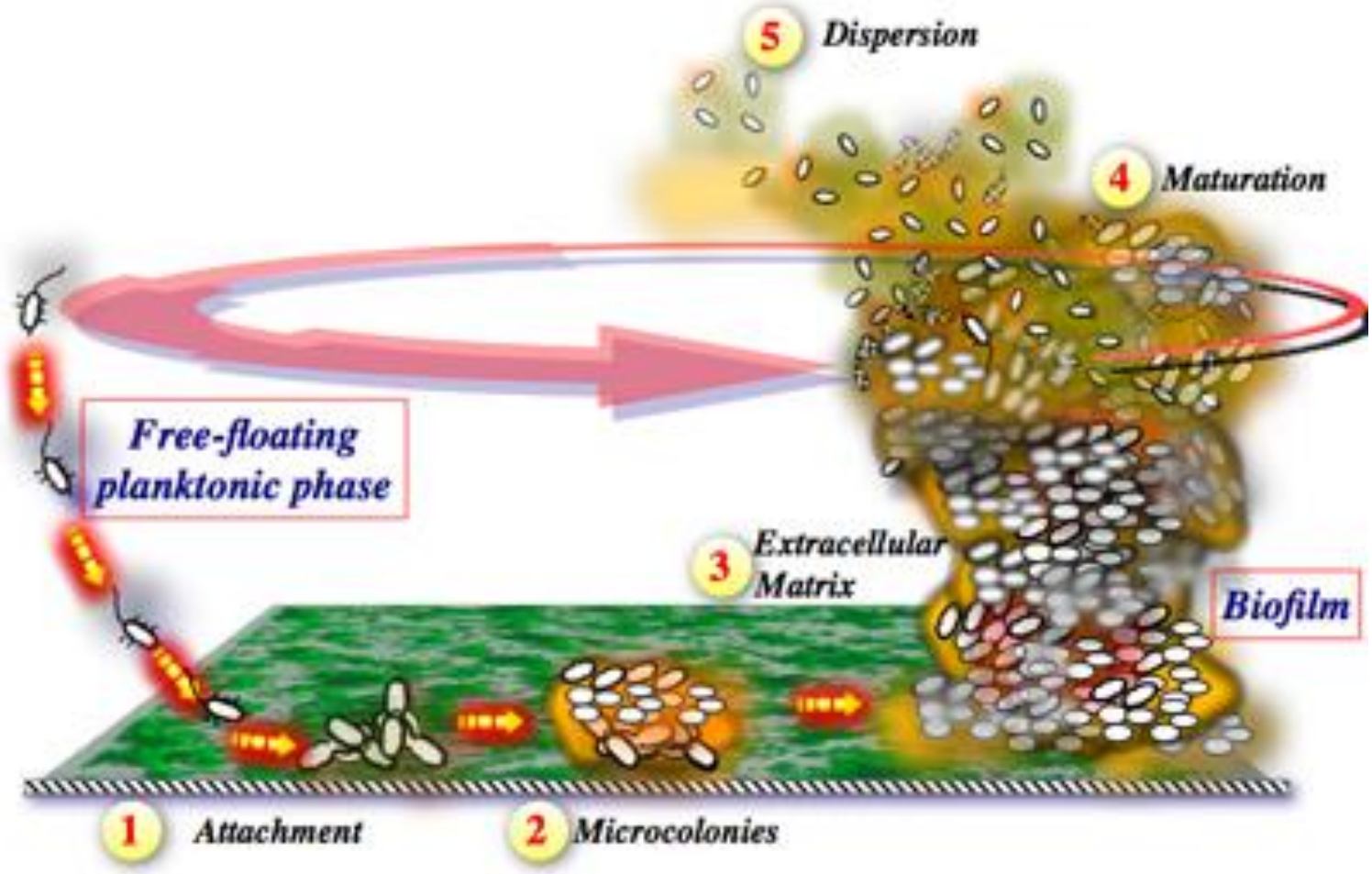
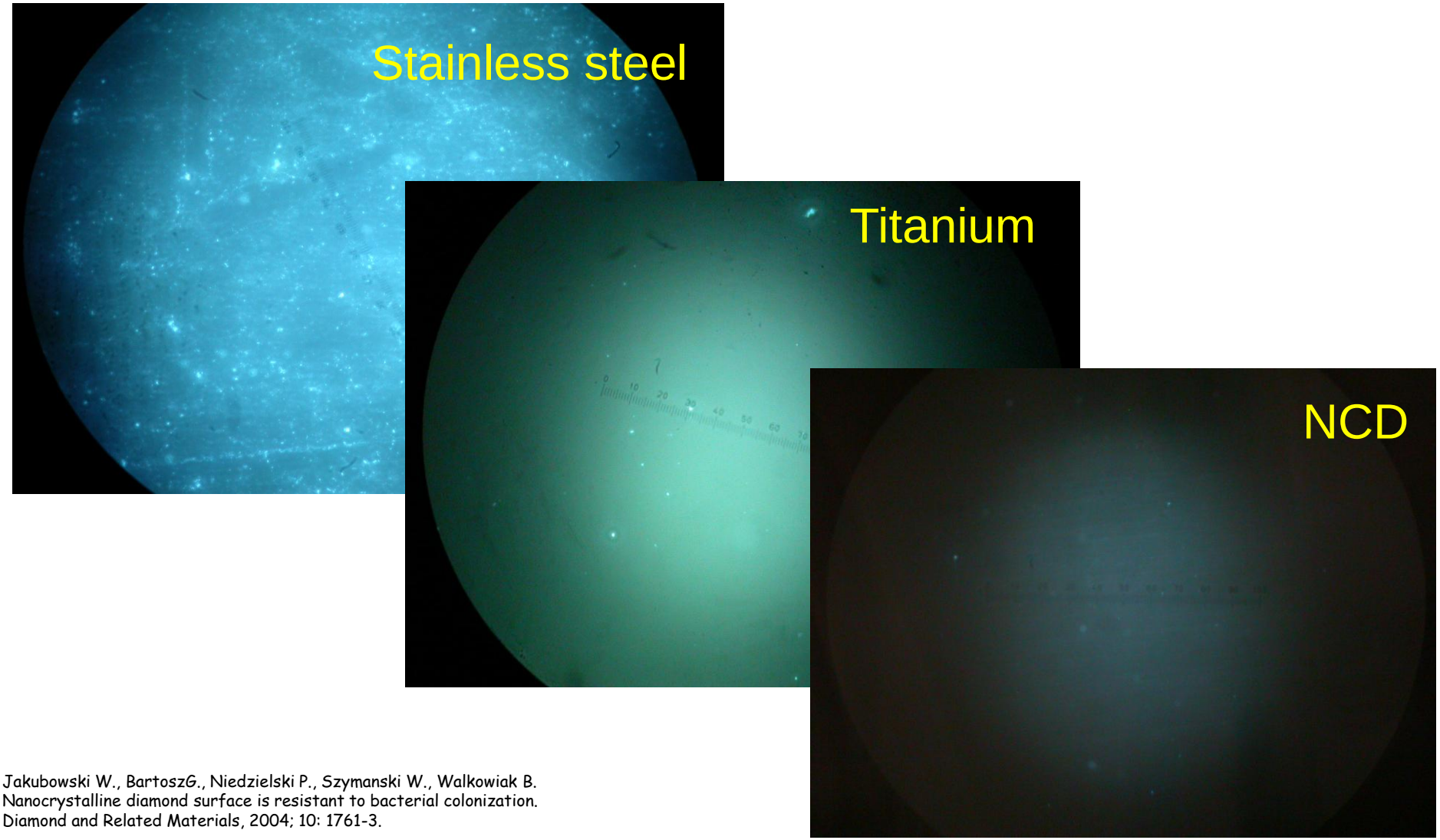
Biofilm Formation and Duration



www.pasteur.fr/recherche/RAR/RAR2006/Ggb-en.html

E.coli Cells Found at the Surfaces:



Jakubowski W., BartoszG., Niedzielski P., Szymanski W., Walkowiak B. Nanocrystalline diamond surface is resistant to bacterial colonization. Diamond and Related Materials, 2004; 10: 1761-3.

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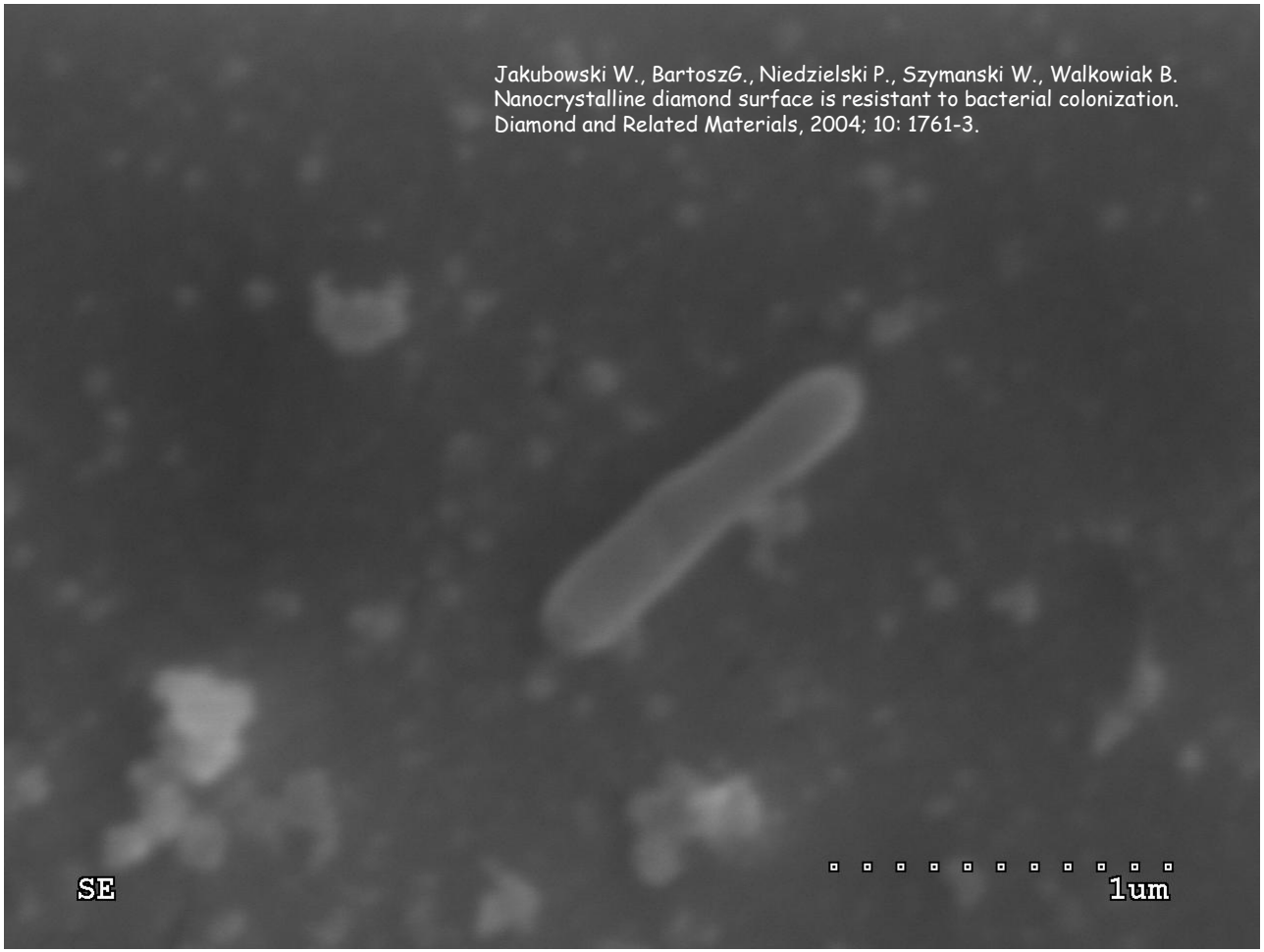
SEM Visualization of Biofilm Formation (1)



SEM Visualization of Biofilm Formation (2)

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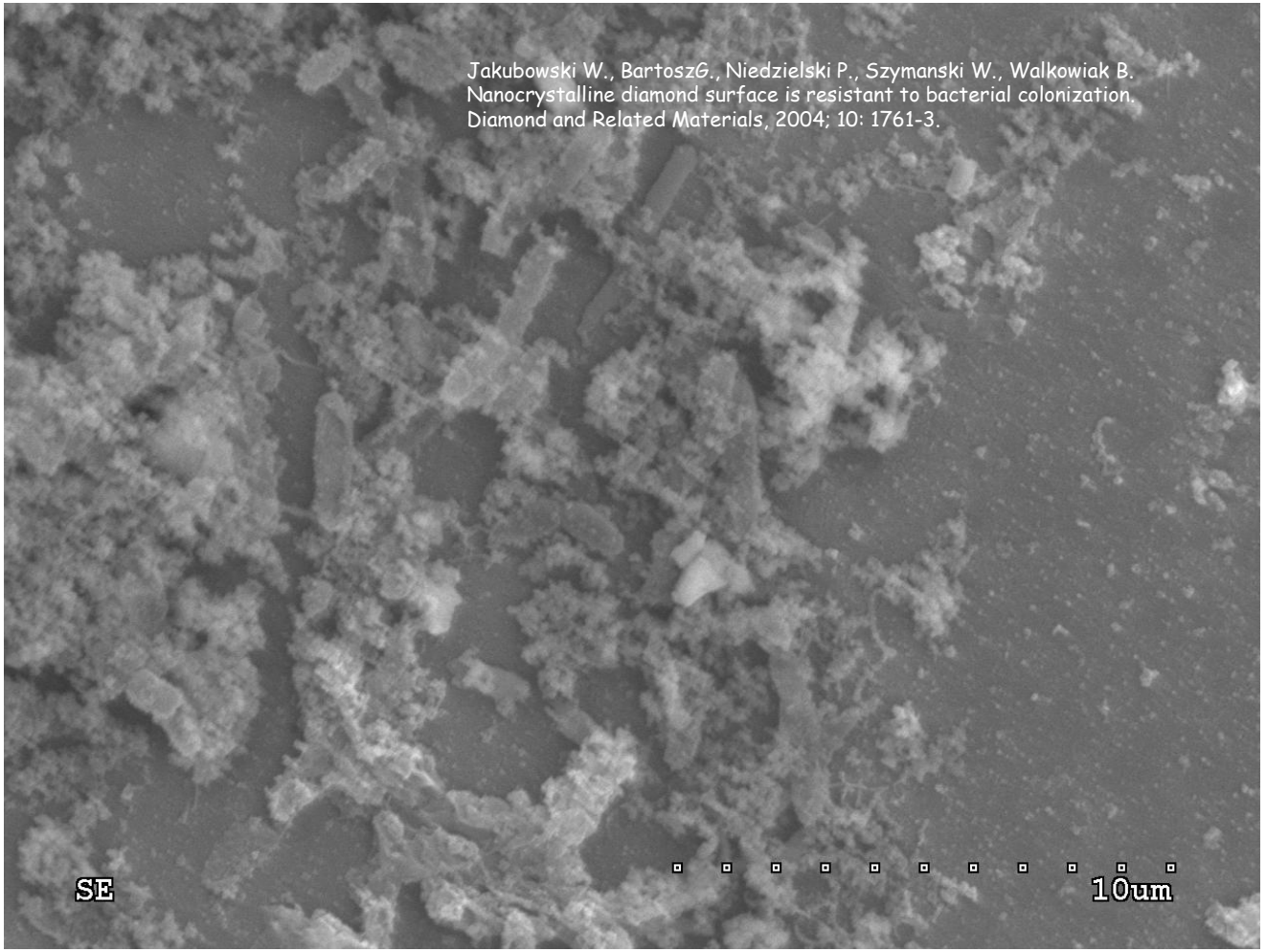
SEM Visualization of Biofilm Formation (3)



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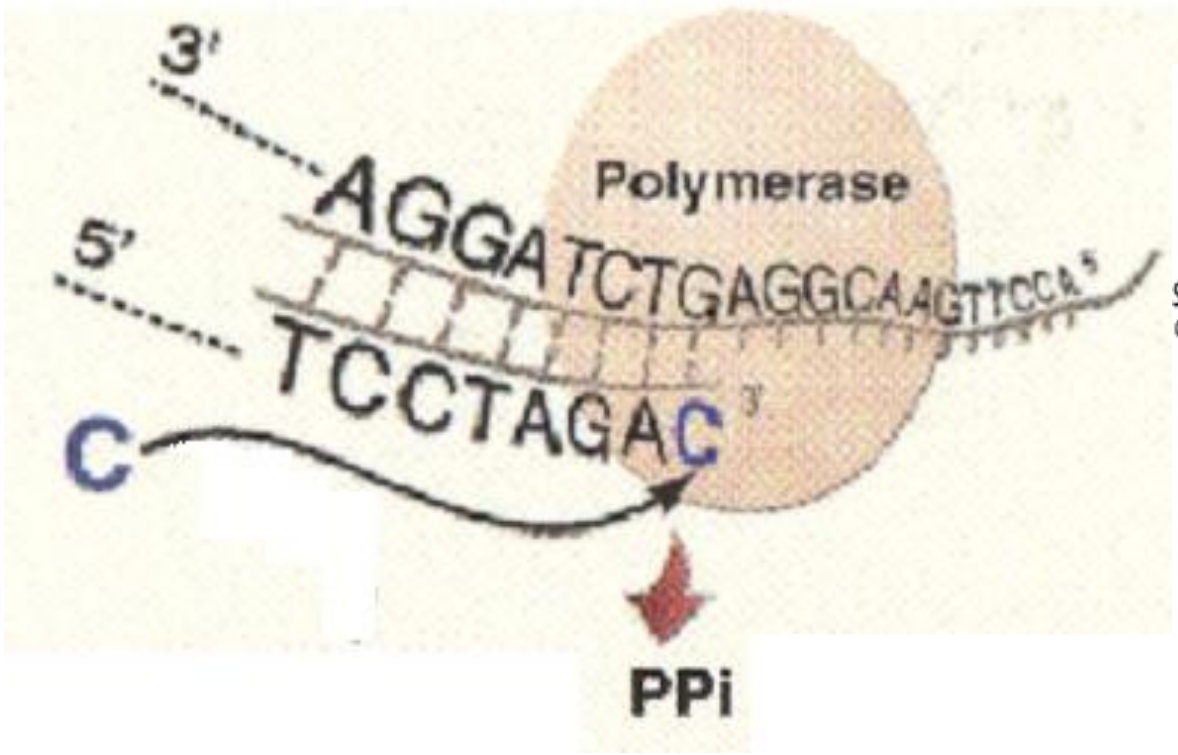
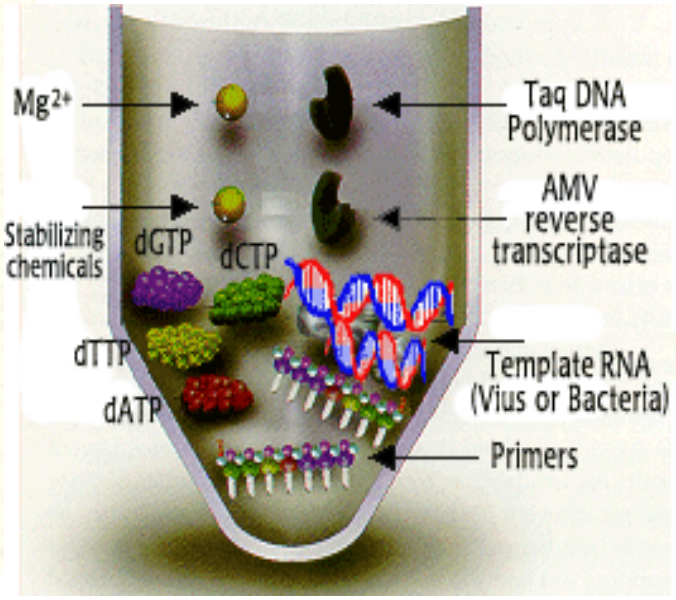
New Research and Diagnostic Capabilities- PCR Technique

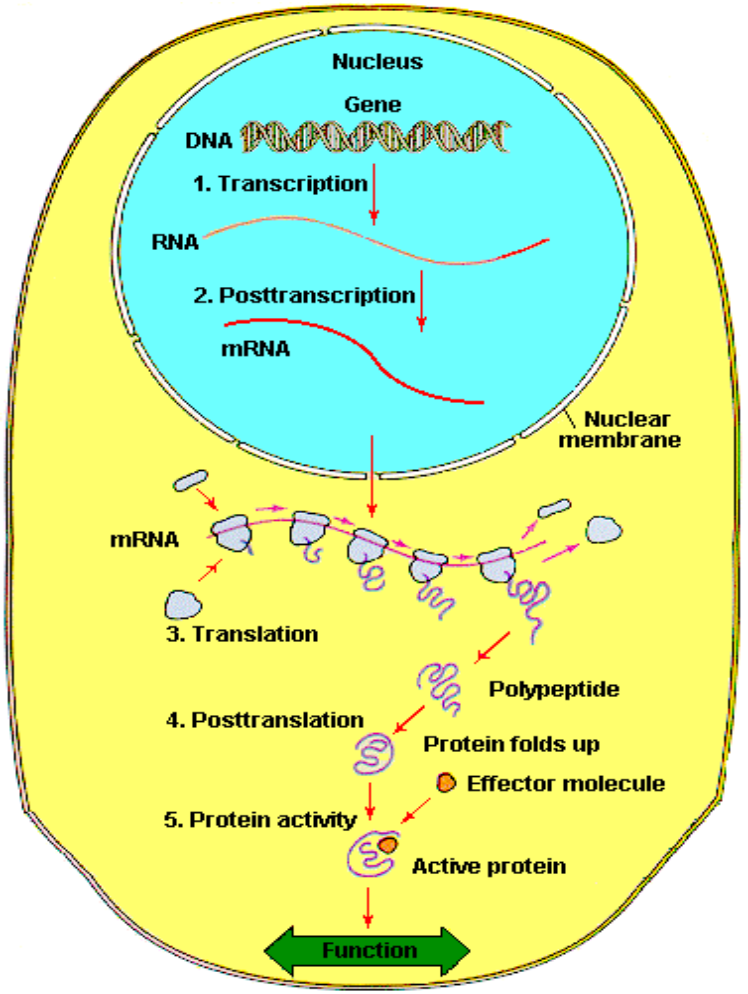




Source: INTERNET

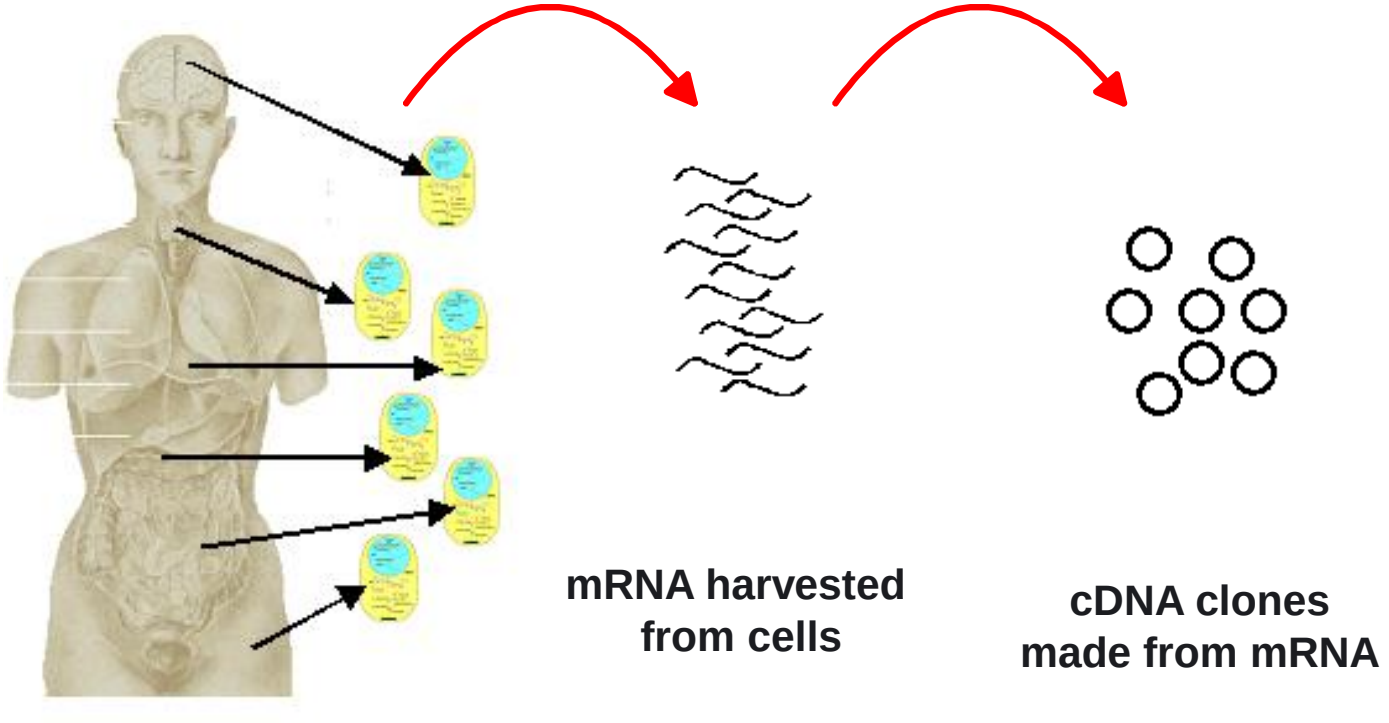
New Research Capabilities – Microarray Techniques

- **Human Genome**
  - 30-40,000 Genes,
    similar to most other Mammals
- **Other organisms**
  - Yeast 6,200 genes
  - E.coli 1,500 genes
- **A human cell express around 8,000 genes at any given time**



Source: INTERNET

Introduction to Microarray Technology



Cells harvested from different tissues

mRNA harvested from cells

cDNA clones made from mRNA

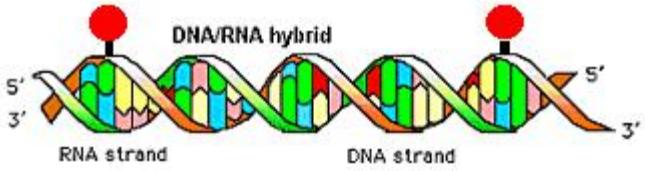
Source: INTERNET

Microarray Technology – Probe Preparation

Fluorescent Labeling & DNA Hybridization

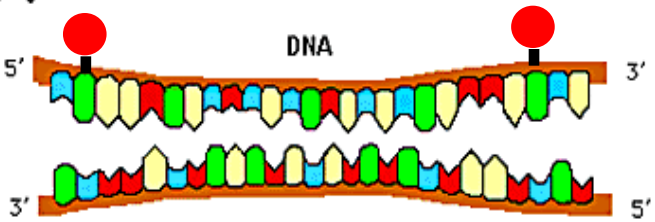
mRNA is isolated

and fluorescently labeled by Reverse Transcription

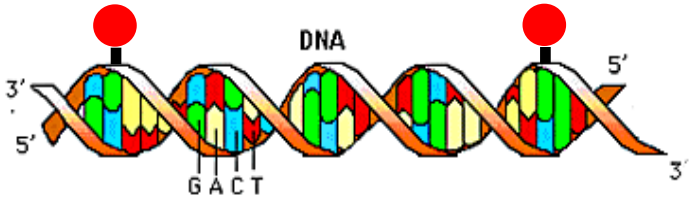


labeled 1st strand cDNA

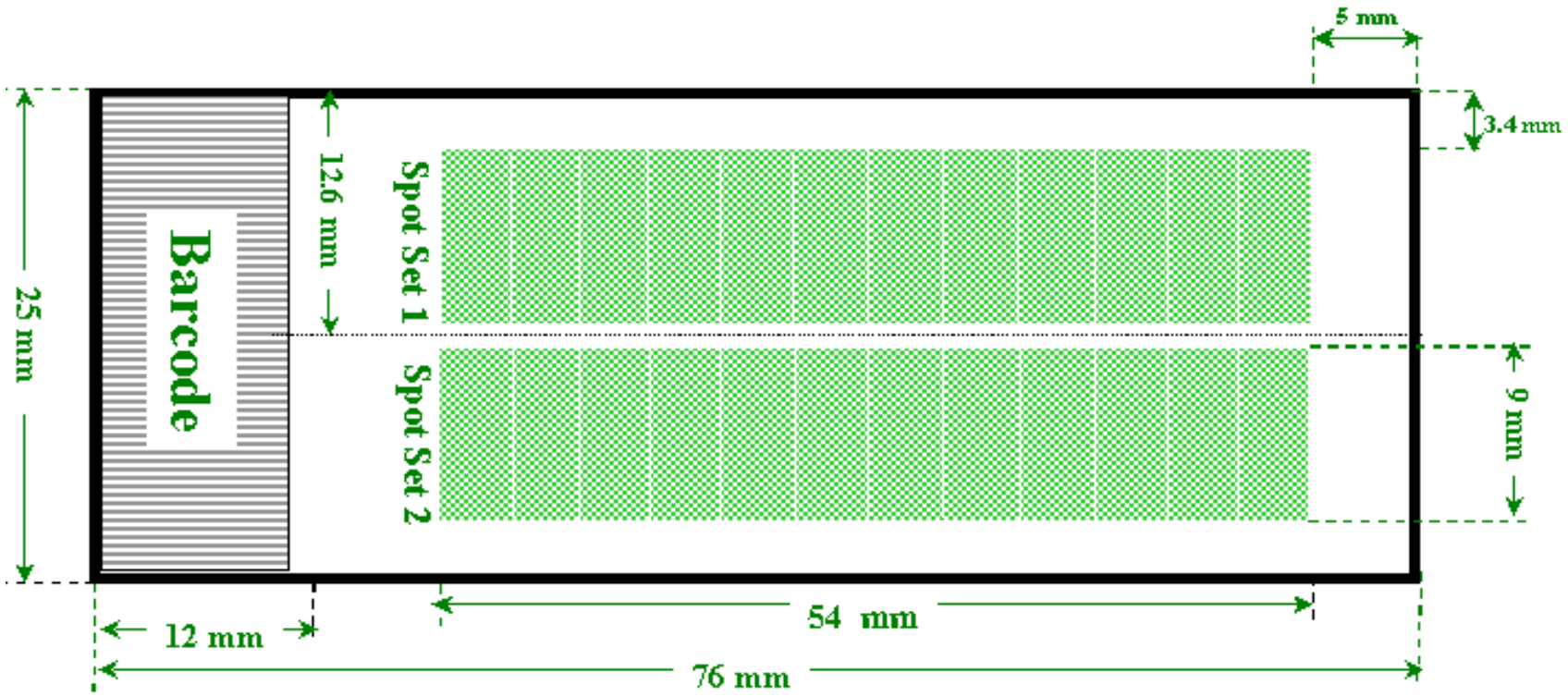
is hybridized to cDNA spotted on the Microarray



fluorescent signal from the Microarray is detected and quantified



Microarray Spotter: Spotting Geometry

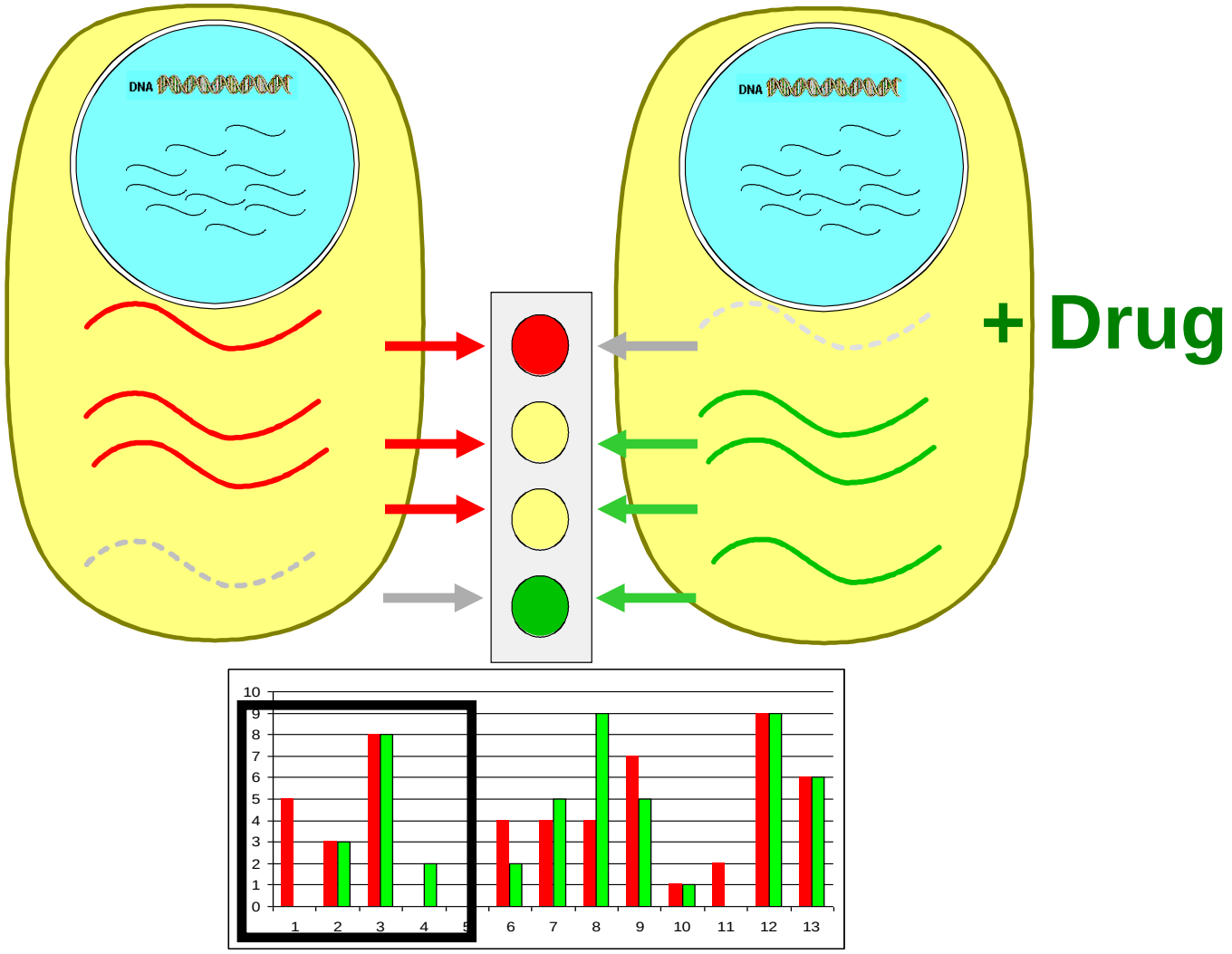


Nominal Spot Diameter = 150-200 μm

Nominal Distance Between Spots = 280-300 μm

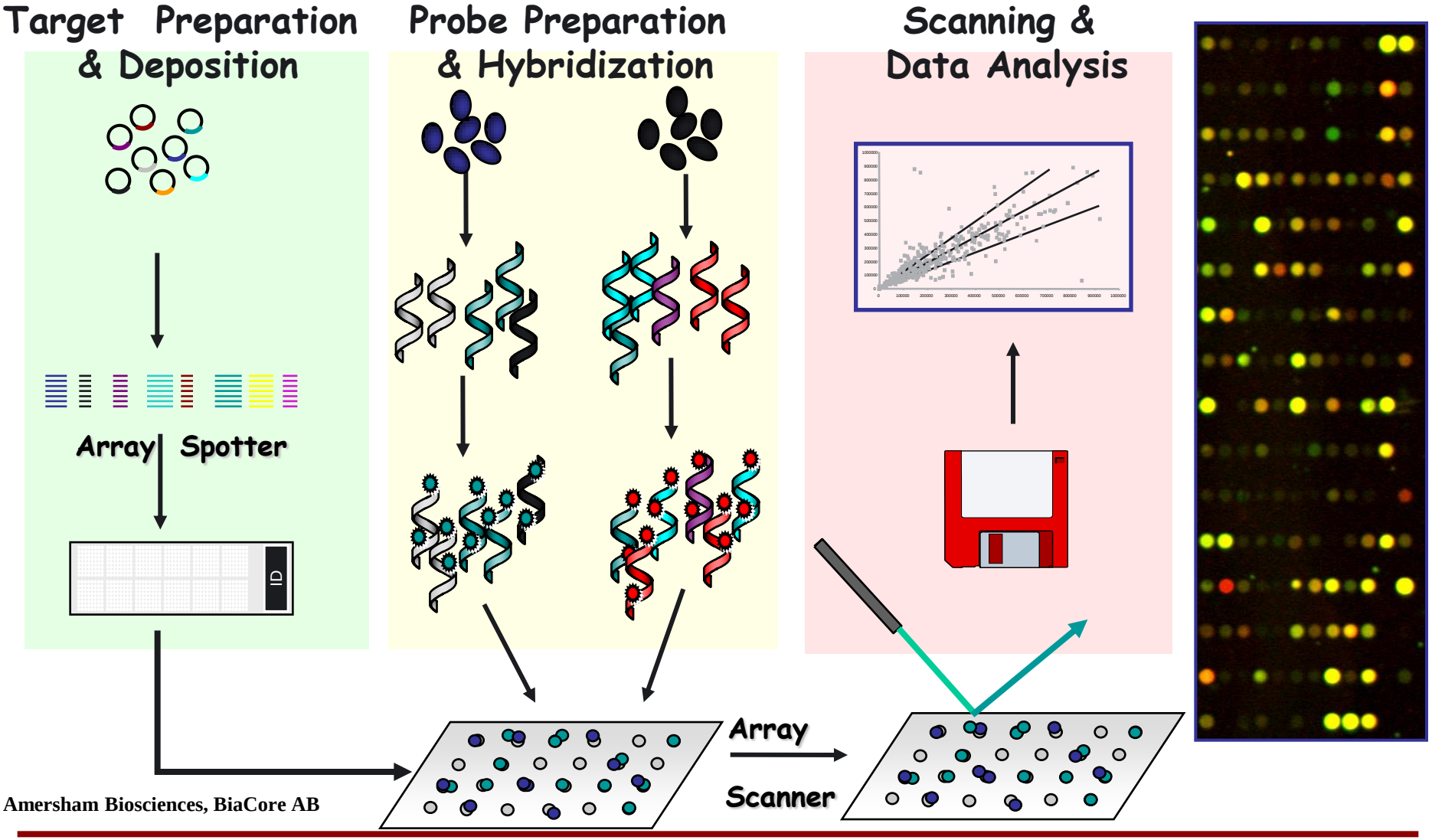
Amersham Biosciences, BiaCore AB

Microarrays Measure Amount of mRNA



Source: INTERNET

Two-color Microarray Hybridization



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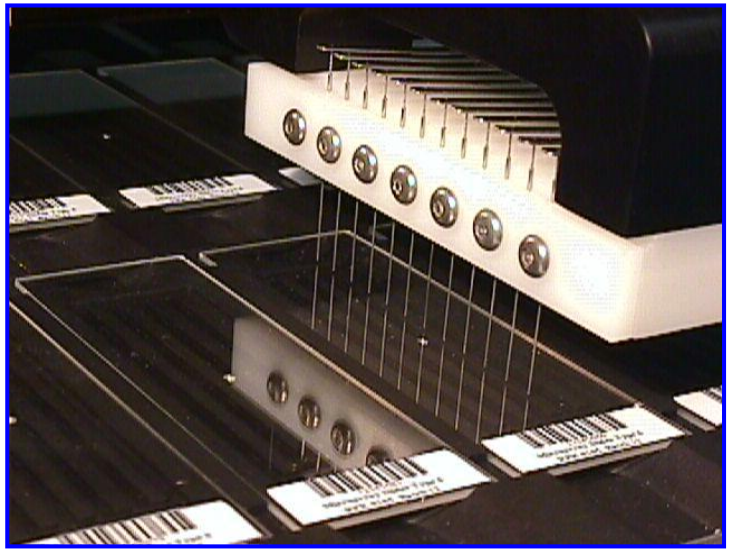
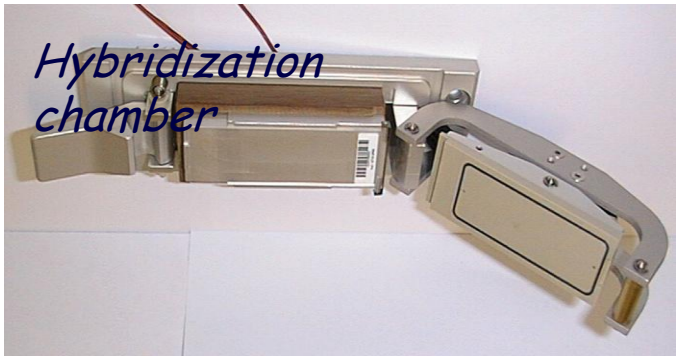
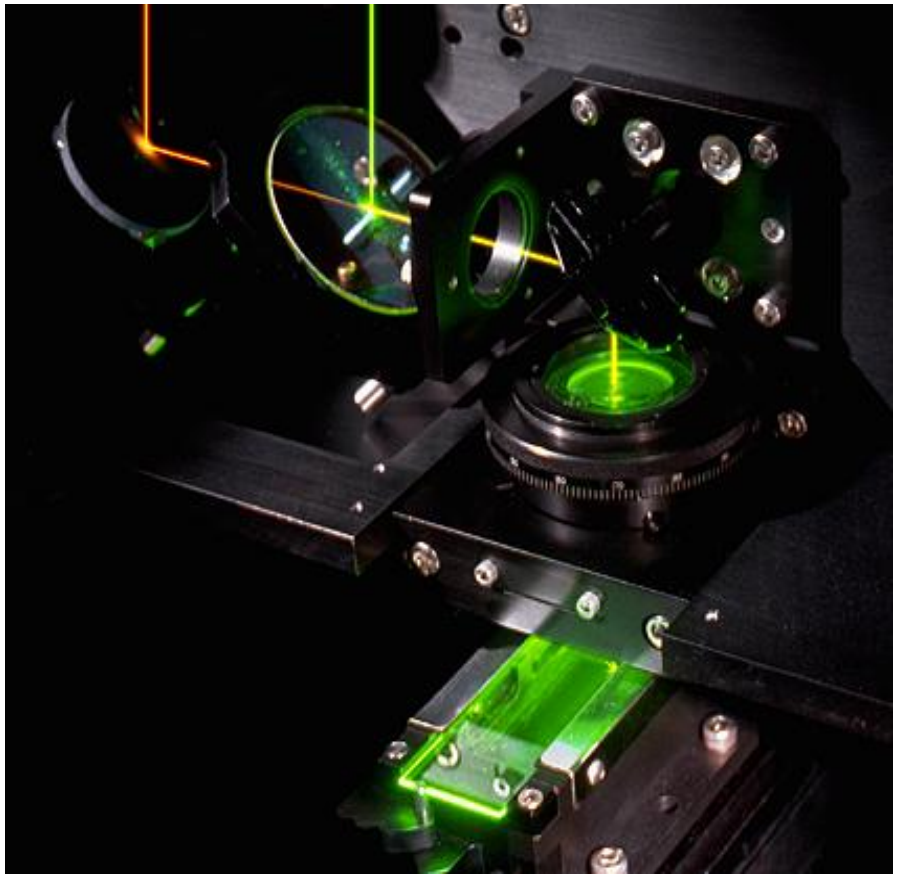
Equipment for Transcryptomics



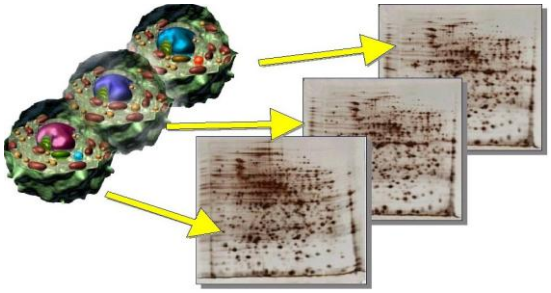


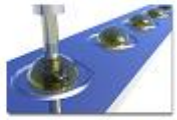


Amersham Biosciences, BiaCore AB

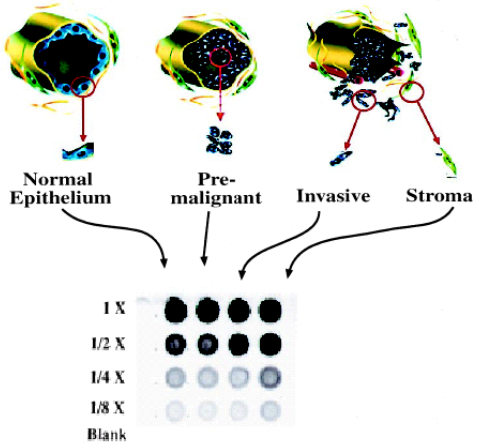
Present Understanding of Proteomics

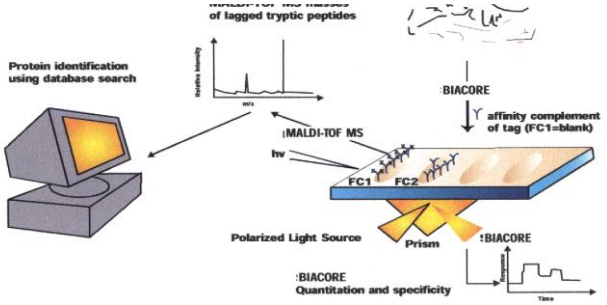
Proteomics = Structural classical proteomics + Functional proteomics





Automated MALDI Spotting

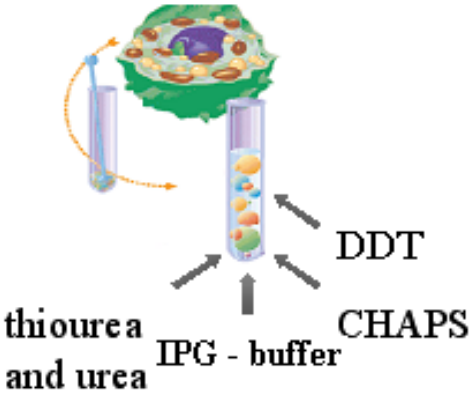




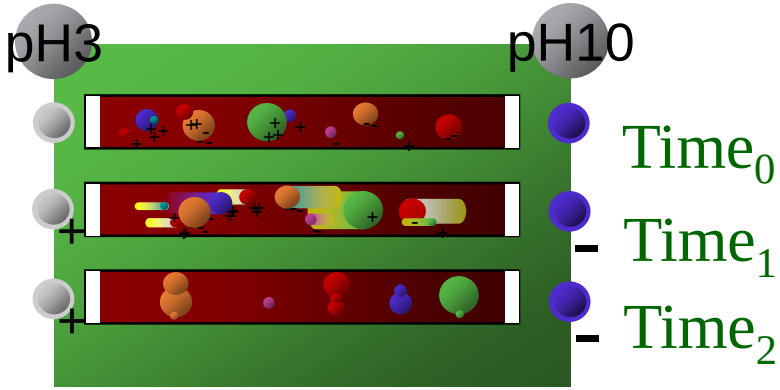
Amersham Biosciences, BiaCore AB and Paweletz C.P. Oncogene (2001) 20, 1981-89

Strategy for 2D Electrophoresis

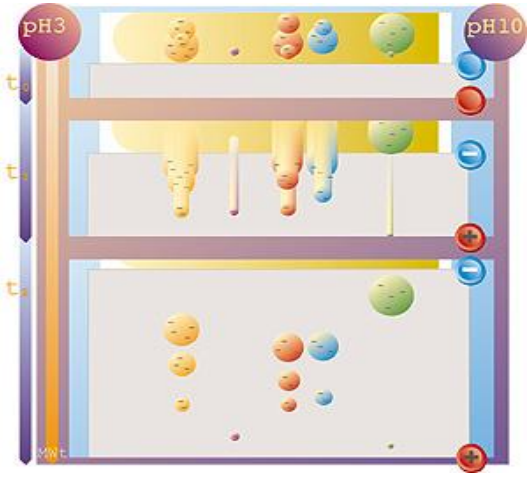
Sample preparation



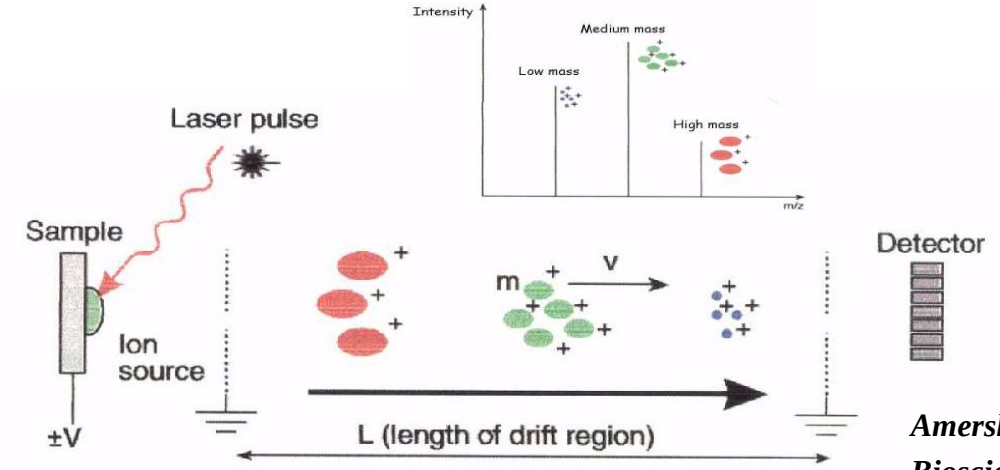
IEF



SDS-PAGE



Protein identification (Mass Spec)

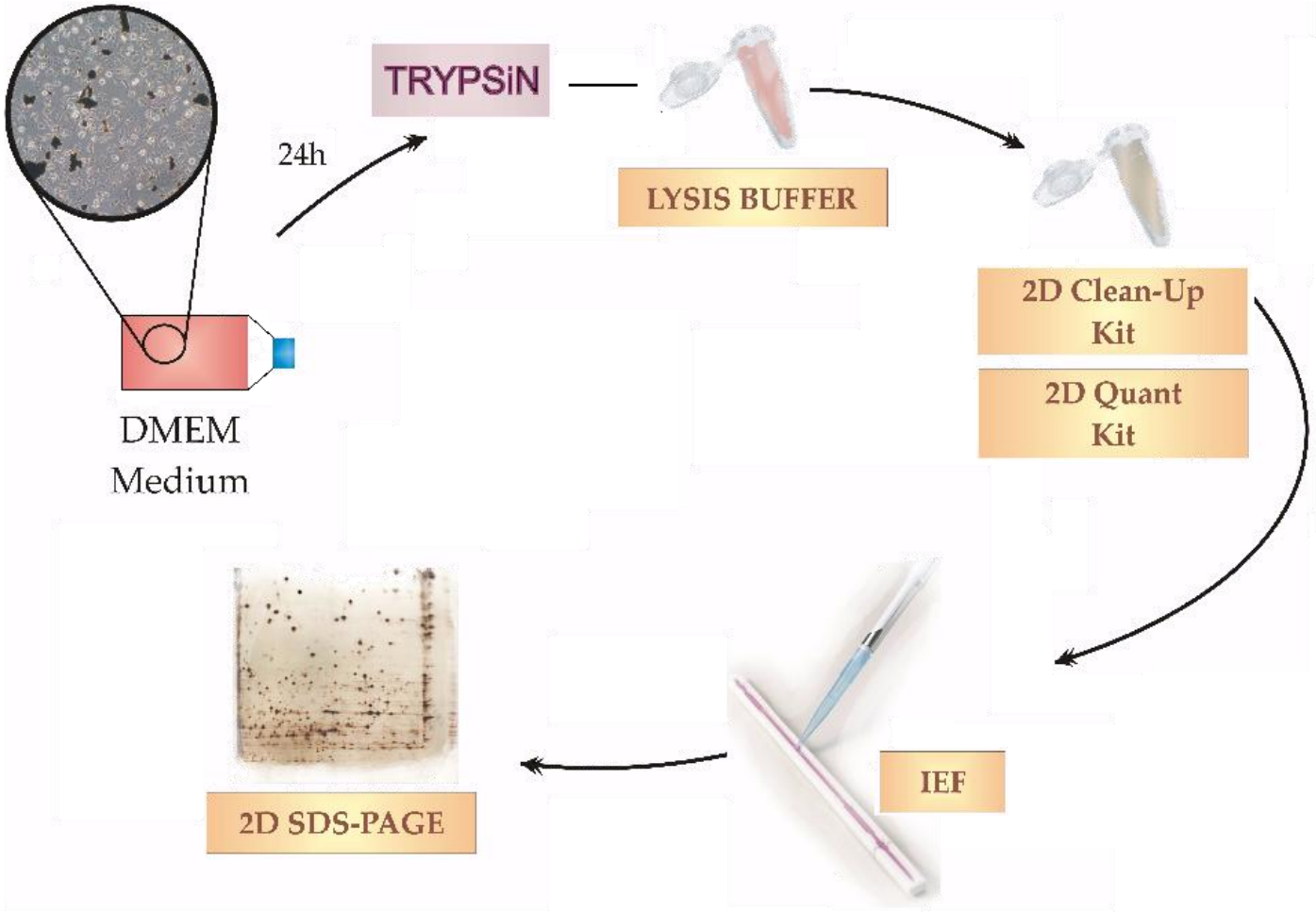


Amersham Biosciences

Equipment for Proteomics

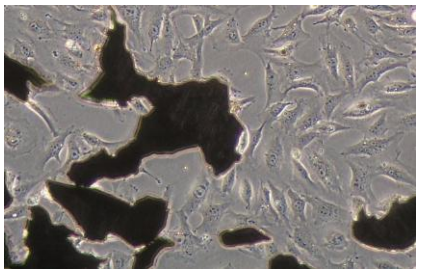
Amersham Biosciences

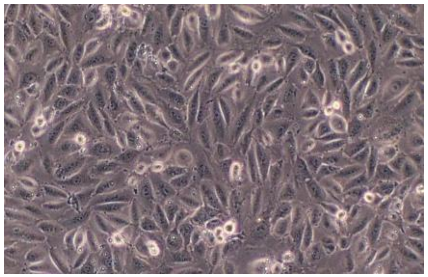
Changes in Protein Expression Profile in Endothelial Cells

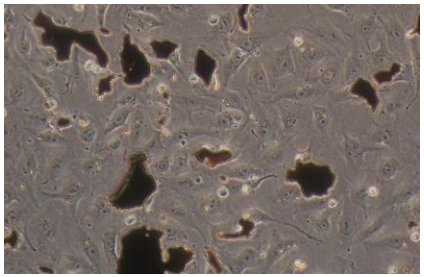


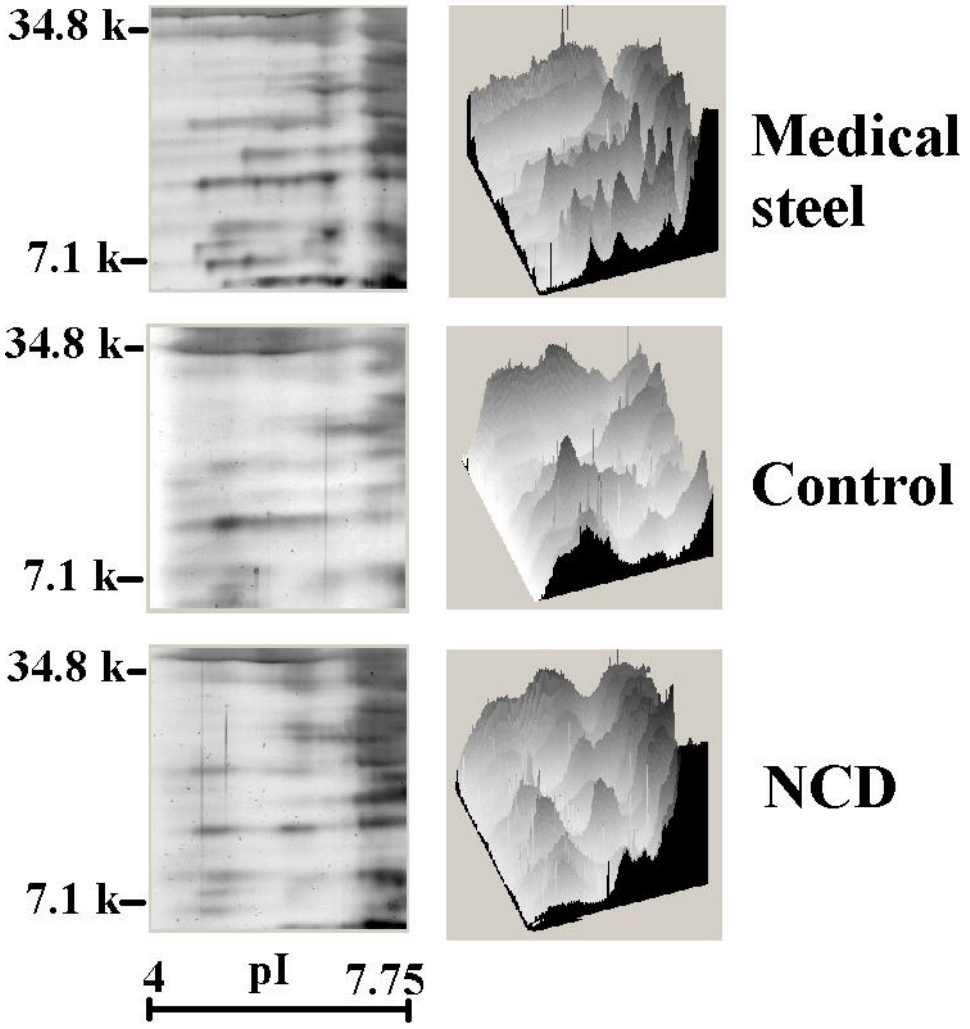
Jerczyńska H. et. al. Engineering of Biomaterials, 2005

Changes in Protein Expression Profile in Endothelial Cells





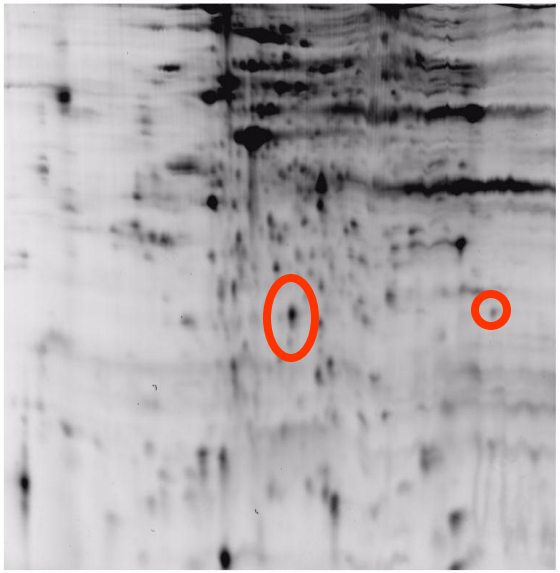




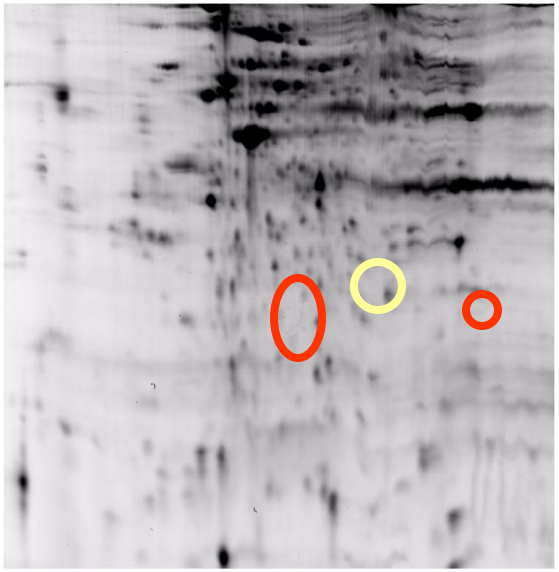
Jerczyńska H. et. al. Engineering of Biomaterials, 2005

Changes in Protein Expression Profile in Endothelial Cells

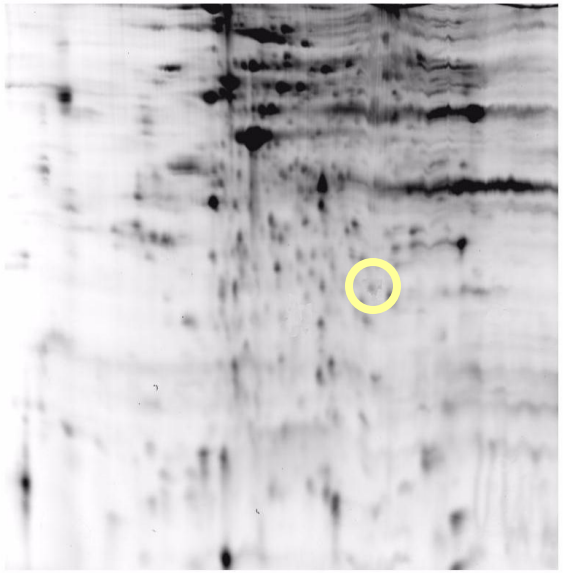
Proteome of endothelial cells studied with 2D DIGE



Medical steel



Control



NCD

Walkowiak et al., unpublished data, 2007

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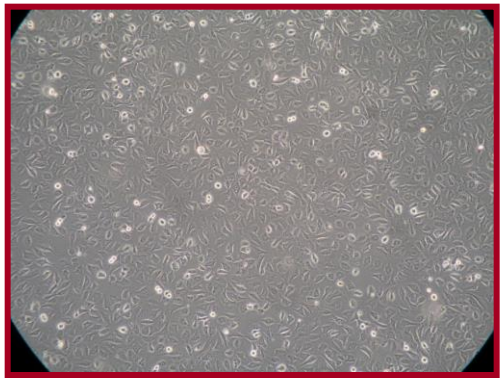
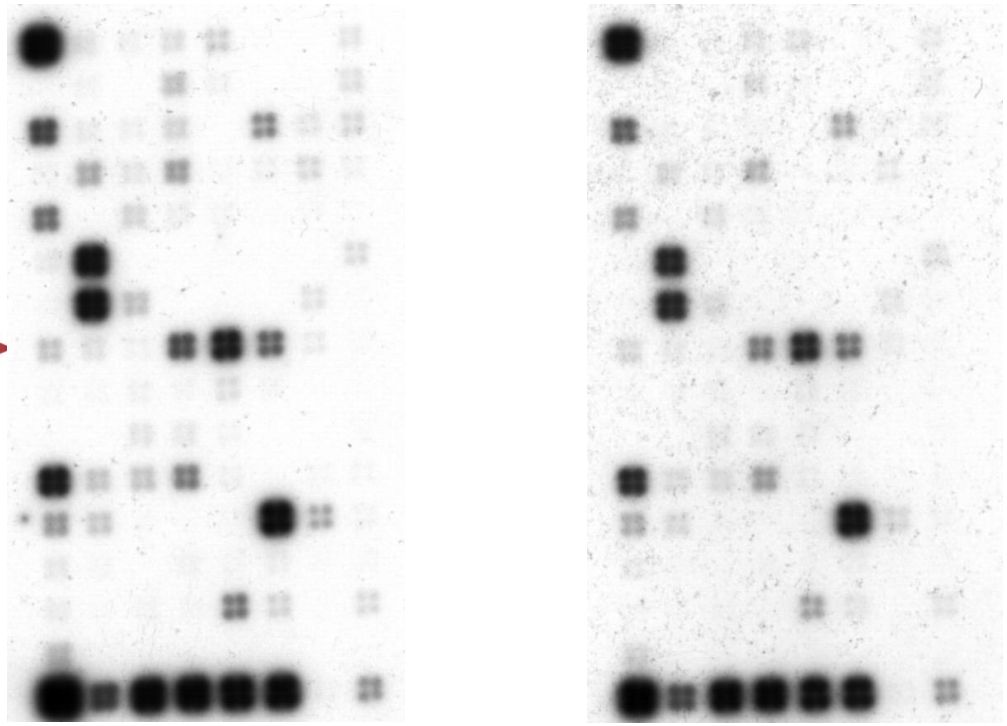
Changes in Gene Expression Profile in Endothelial Cells

EA.hy 926 cells cultured in the presence of medical steel powder:



purification of RNA, amplification, hybridization chemiluminescence

OHS-020
Oligo GEArray Human Cell Cycle



control

medical steel

Piotr Komorowski, PhD thesis in preparation, 2008

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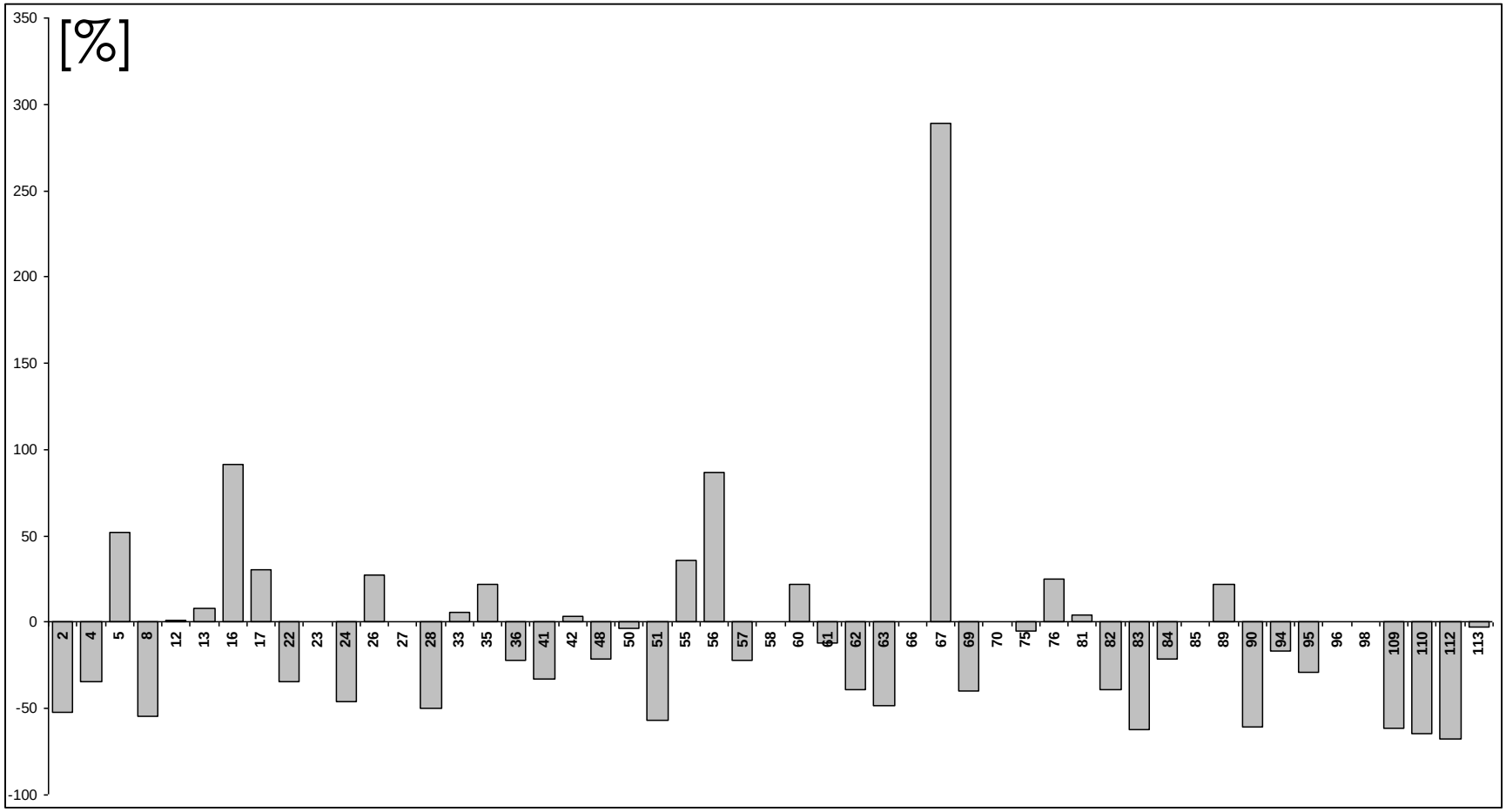
Changes in Gene Expression Profile in Endothelial Cells



Piotr Komorowski, PhD thesis in preparation, 2008

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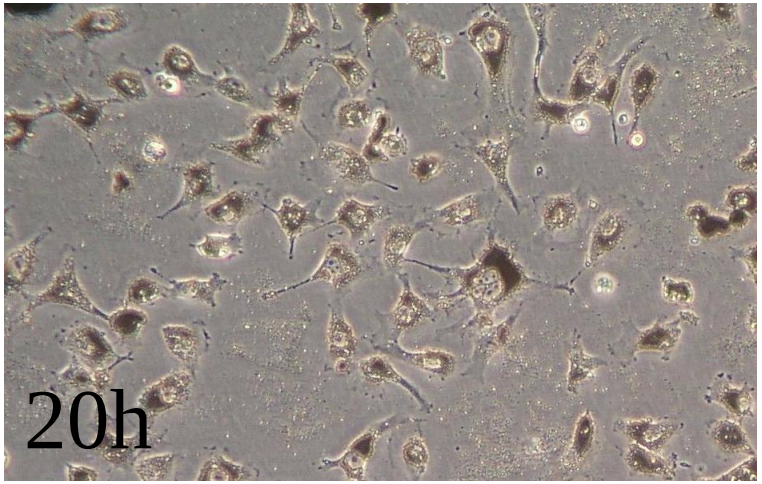
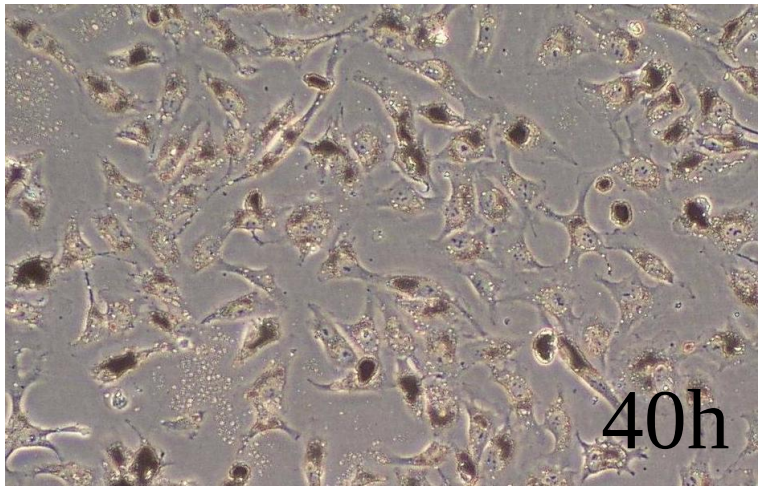
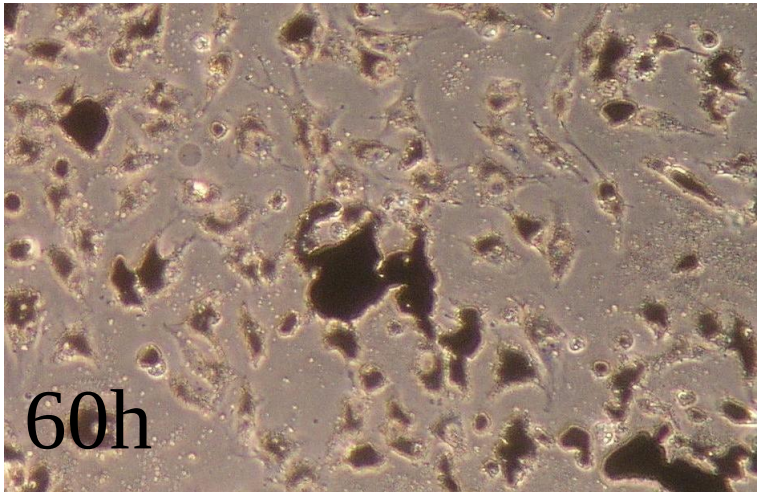
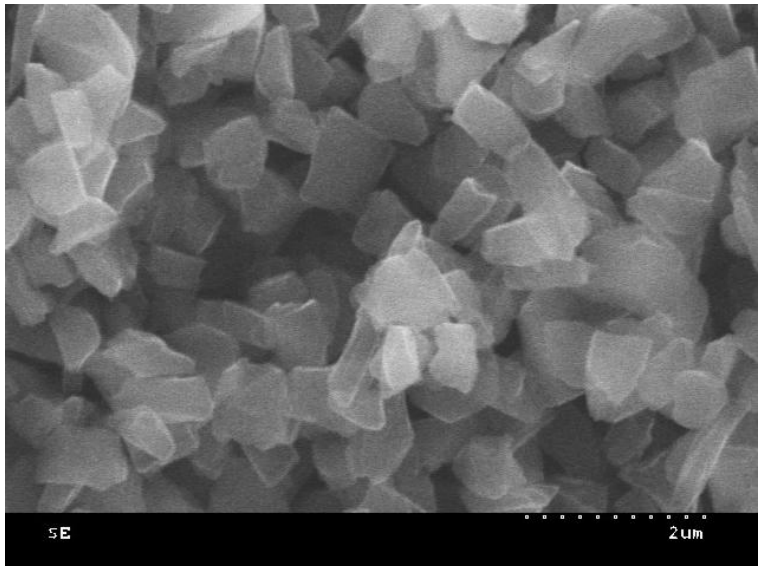
Microdiamond Particles in Contact with Endothelial Cells









Walkowiak et al., DRM 2008, accepted

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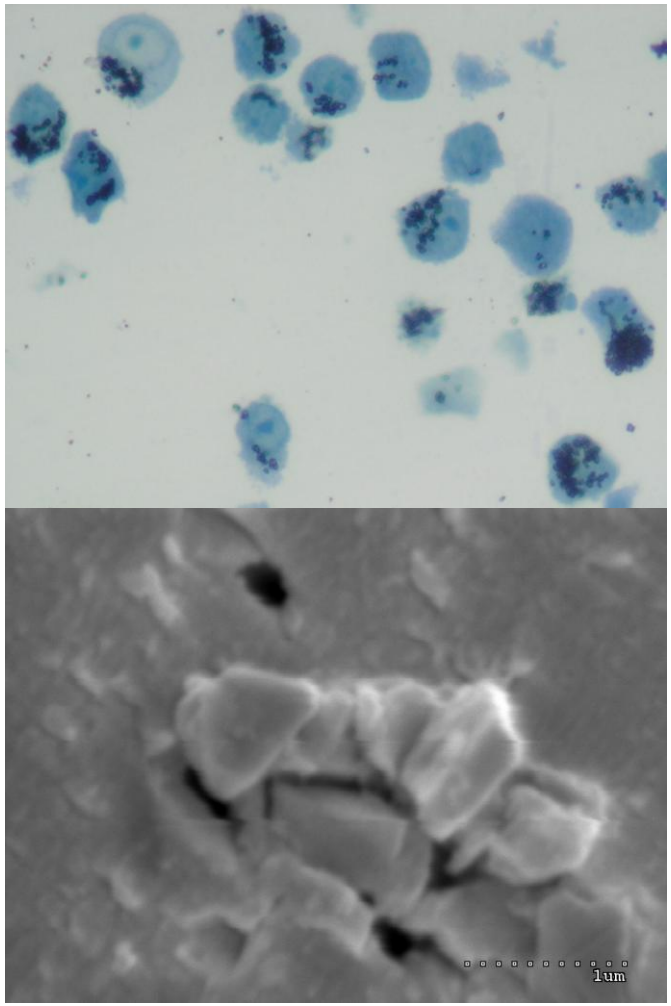
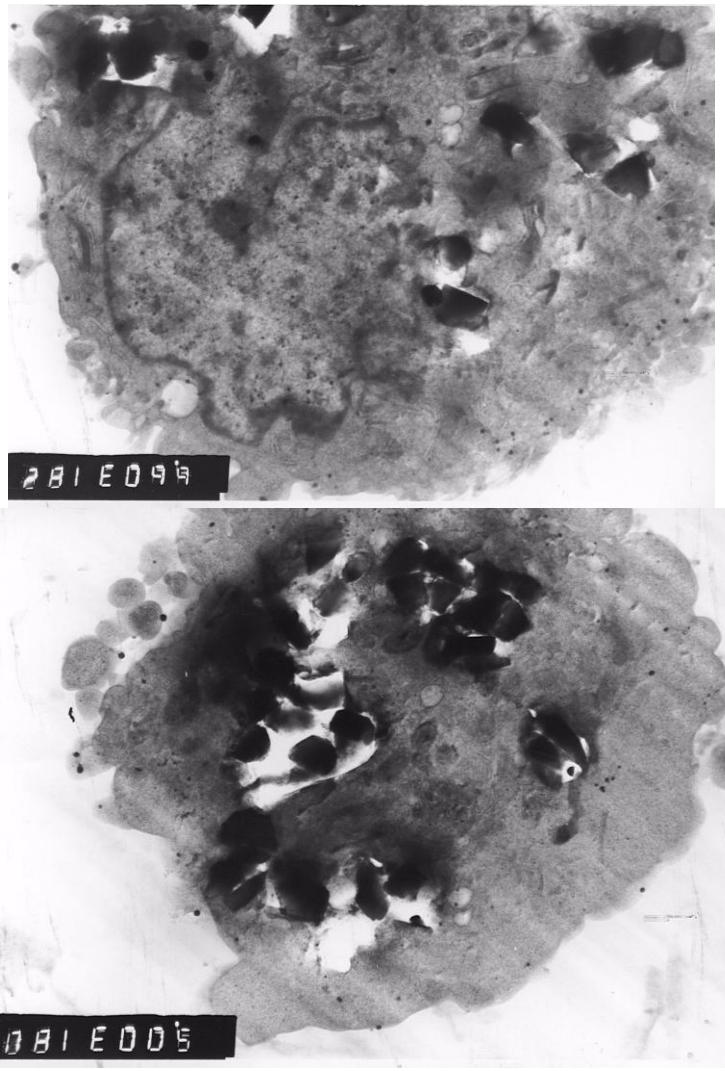
Microdiamond Particles in Contact with Endothelial Cells





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BIOPHYSICS

Prezentacja multimedialna współfinansowana przez Unię Europejską w ramach Europejskiego Funduszu Społecznego w projekcie pt.

„Innowacyjna dydaktyka bez ograniczeń - zintegrowany rozwój Politechniki Łódzkiej - zarządzanie Uczelnią, nowoczesna oferta edukacyjna i wzmacniania zdolności do zatrudniania osób niepełnosprawnych”