



**BioFluid Mechanics  
& BioHeat Transfer**



**Device Bio-Engineering**

**Bio-Engineering**

**Medical Physics**

**Genetic Engineering**



**Tissue Engineering**

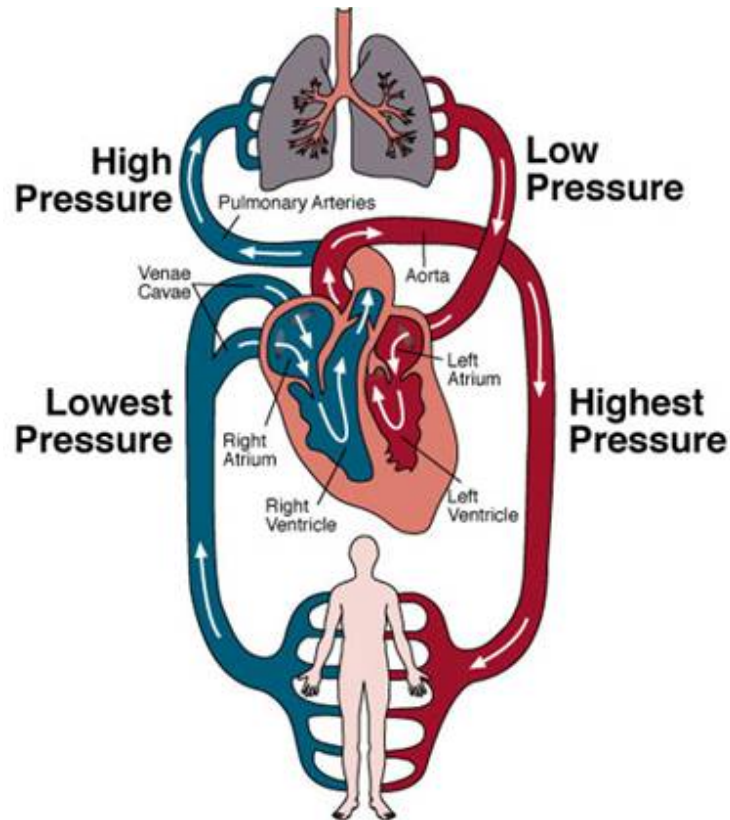
**Biomechanics**



Image shows three sets of tomatoes. The ordinary control tomatoes (extreme left) soften and shrivel up, while texture of gene-silenced tomatoes remains intact for up to 45 days.  
Photo credit: Asis Datta, Subhraj Chakraborty, National Institute of Plant Genome Research, New Delhi



# BioSystems Engineering: A state-of-the art example

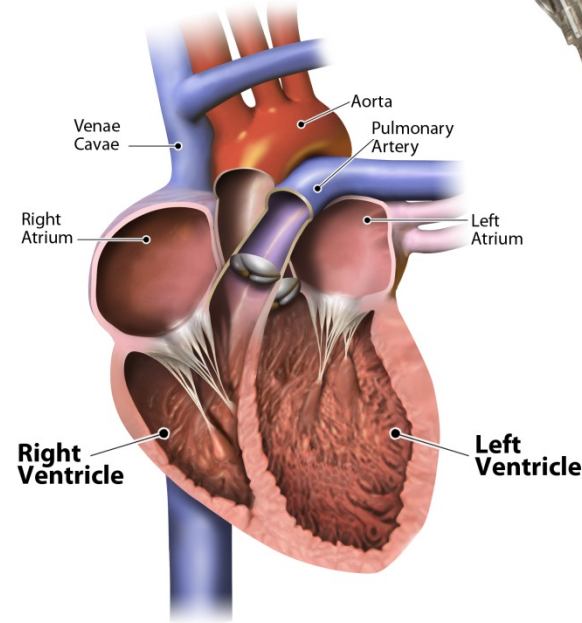
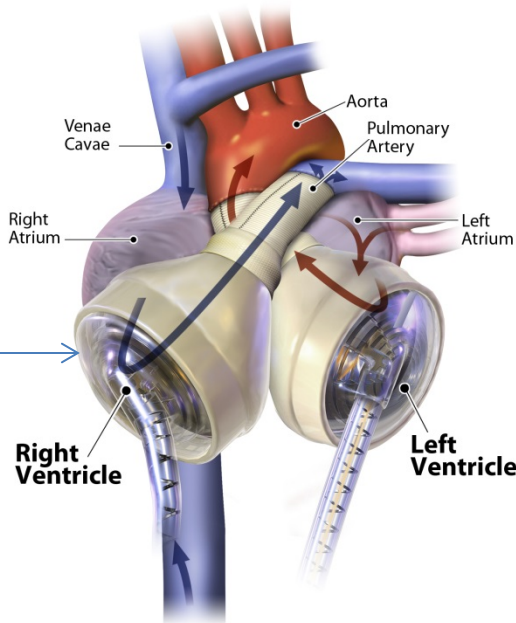


**Pulmonary Circuit**  
(πνευμονικο κυκλωμα)

**Systemic Circuit**

# BioSystems Engineering: Total Artificial Heart

A Total Artificial Heart (TAH) is a device that replaces the two lower chambers (ventricles) of the heart.



**Total Artificial Heart**

**Human Heart**

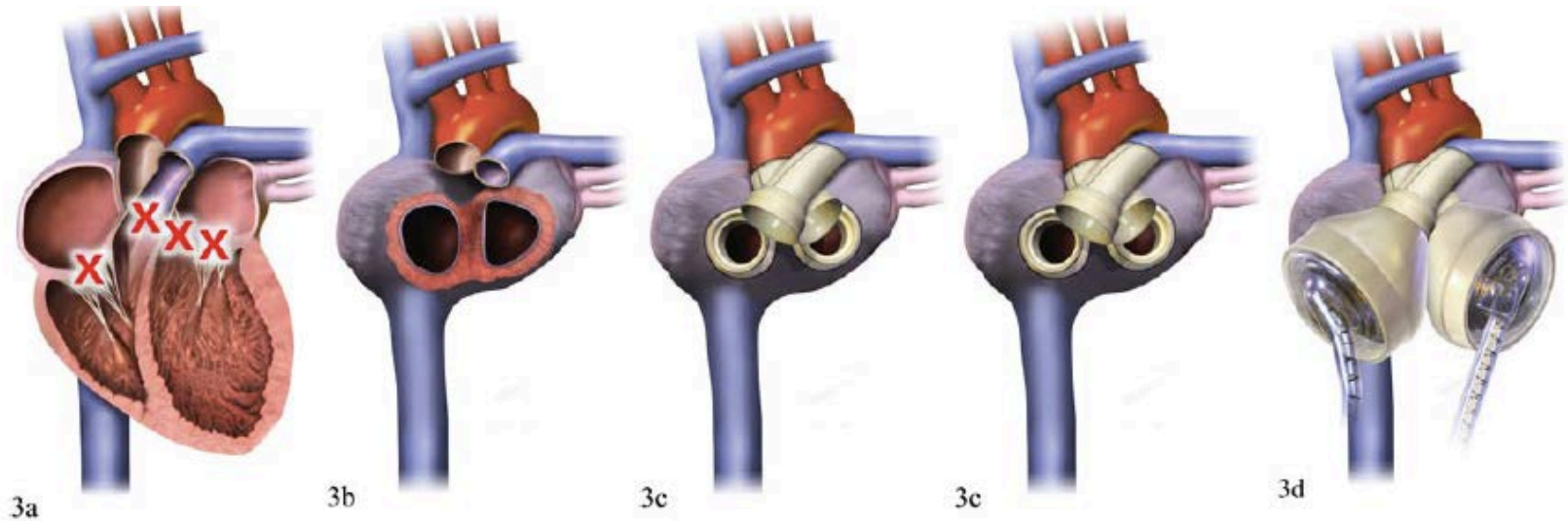
You might need a TAH for 1 of 2 reasons:

- To keep you alive while you wait for a heart transplant
- You have end-stage heart failure in both ventricles

Read and Watch:

<http://www.papworthhospital.nhs.uk/transplantservices/total-artificial-heart.php>

# Implanting the TAH



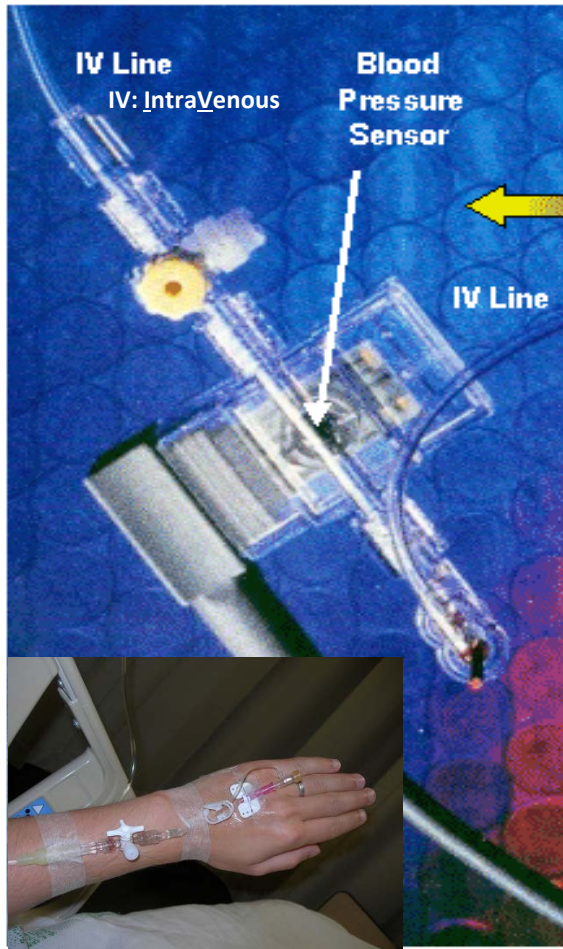
**The sequence in which the native heart is removed and the total artificial heart transplant is placed**

**An artificial heart or VAD (Ventricular Assist Device) is made out of metal, plastic, ceramic, and animal parts.**

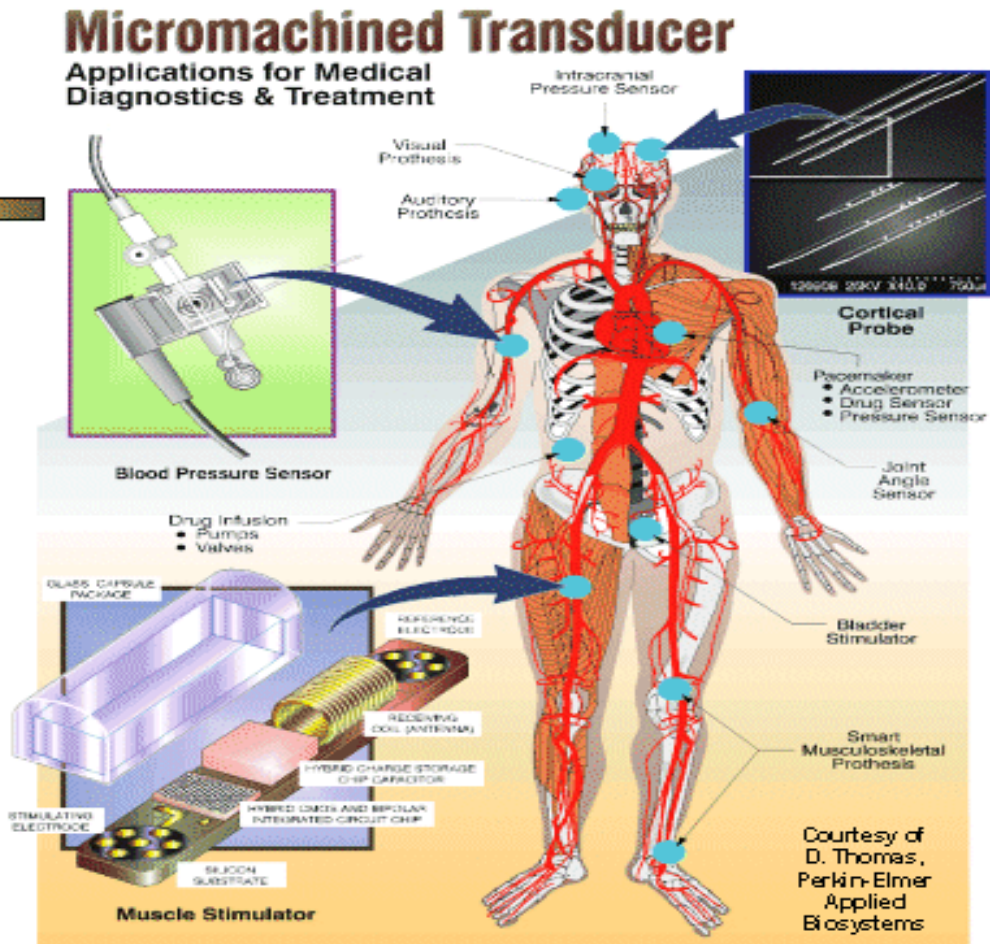


# BioMedical Transducers

Ex vivo...



In vivo...



# Artificial Retina

(τεχνητός αμφιβληστροειδής χιτώνας)

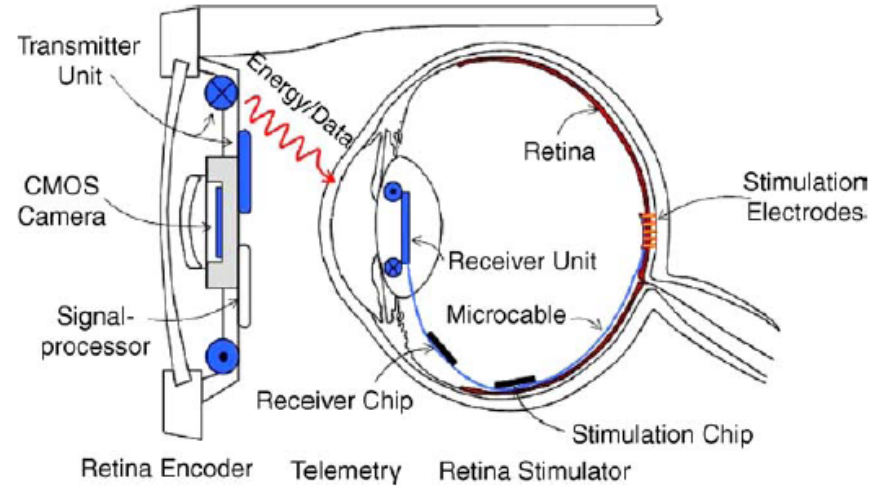
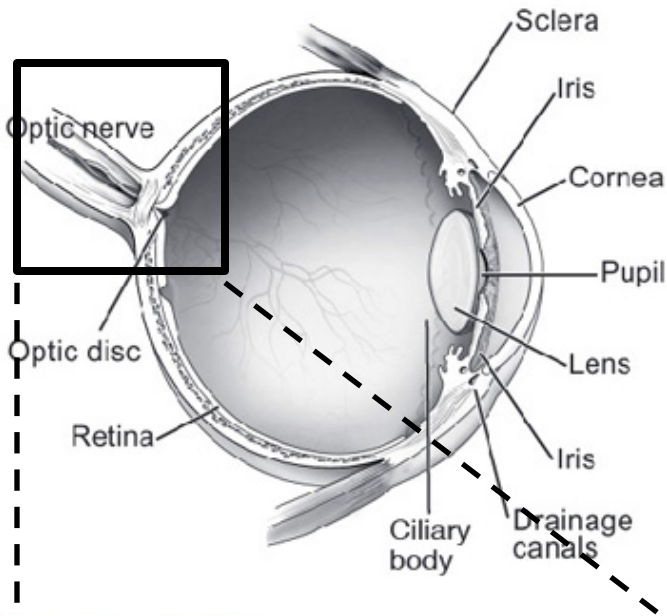
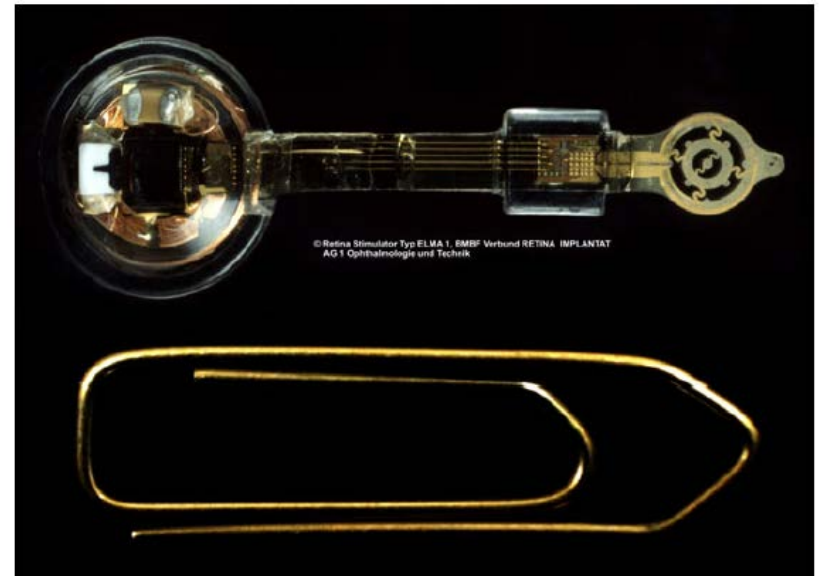
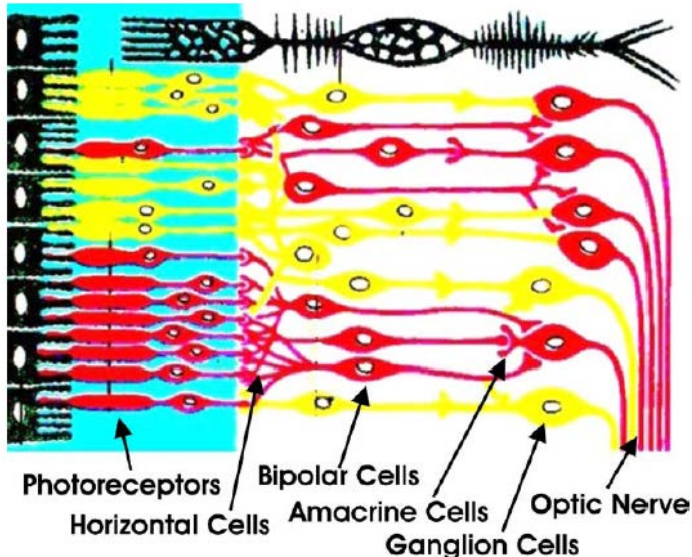


Fig. 2. Concept for a telemetric vision aid [11].



# Artificial Retina

<https://www.youtube.com/watch?v=AaKio5l-5Pc>



# Portable Medical Devices

## The Blood Pressure Meter



Then...



Figure 3: BodyMedia FITTM system featuring a wearable armband and display

Today

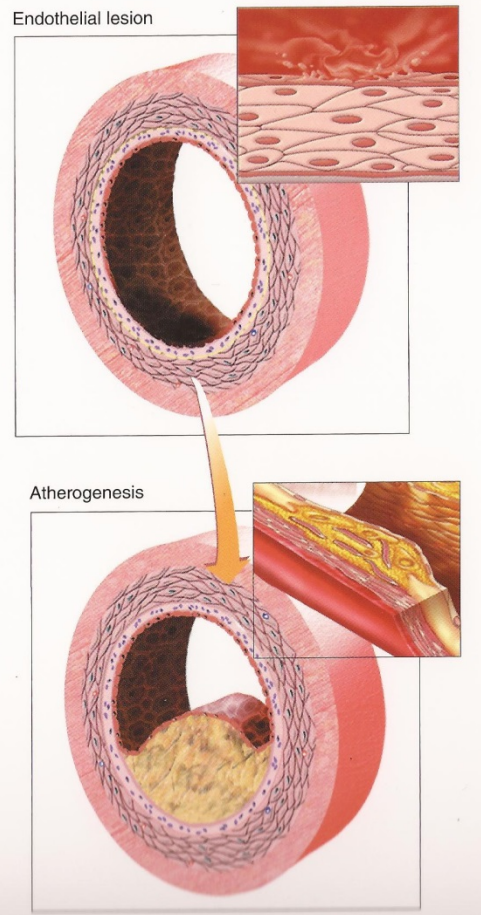
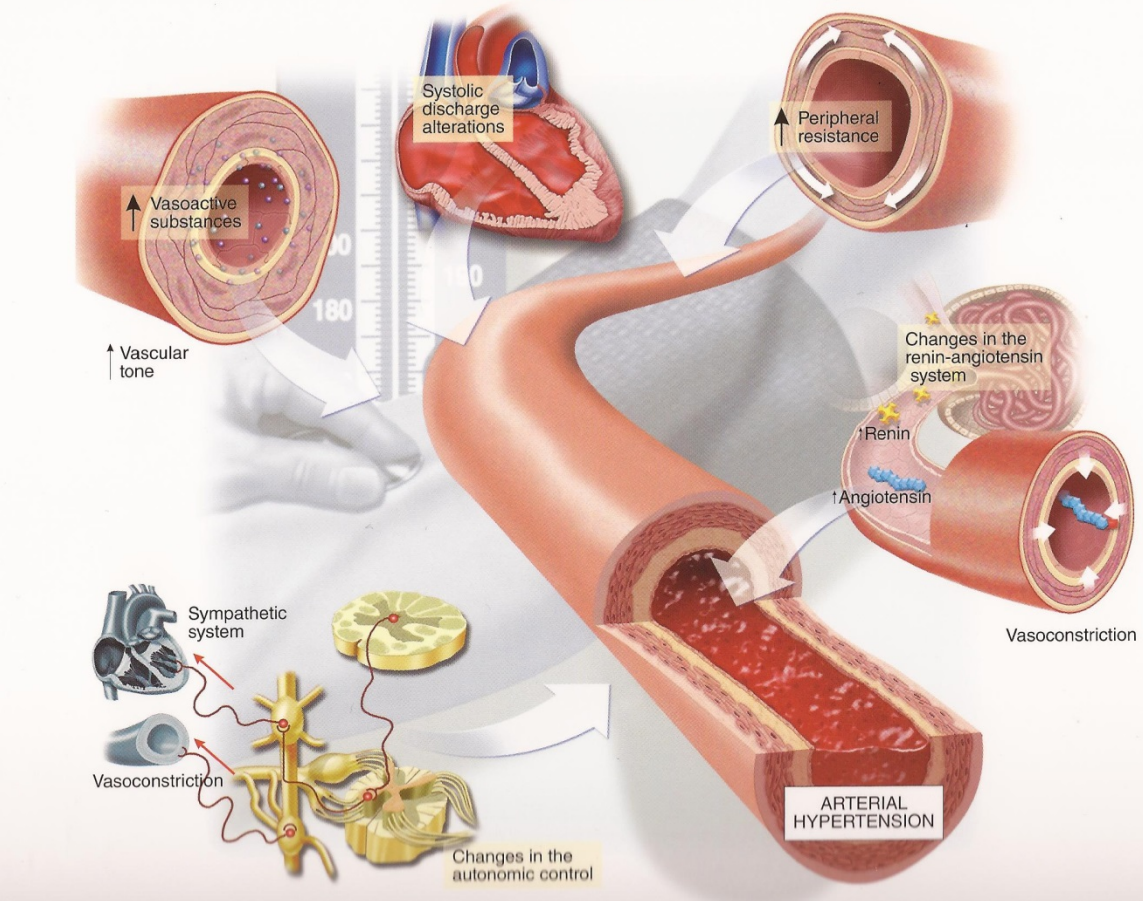
Why measure blood pressure?



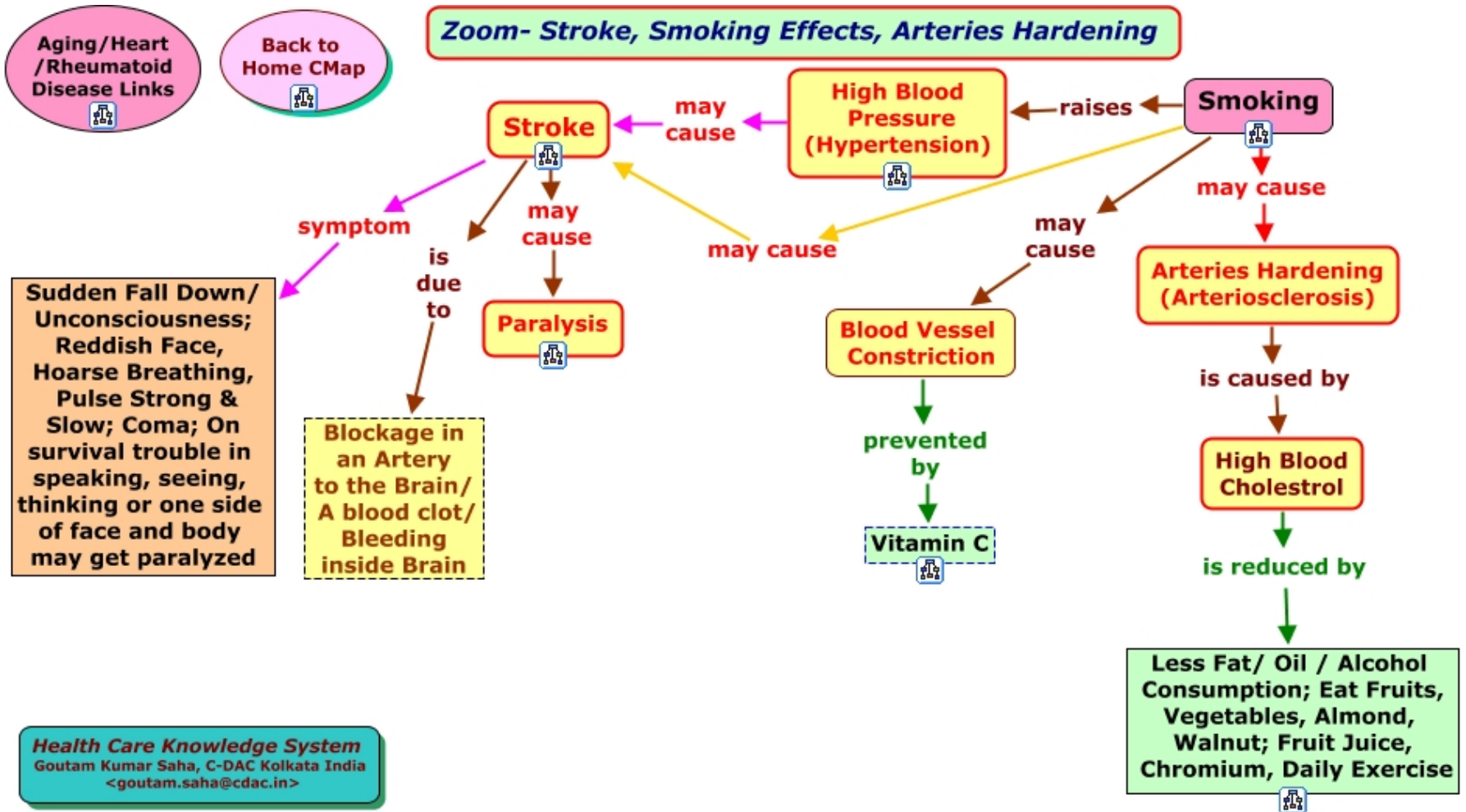
# HyperTension and Heart Diseases

## Essential arterial hypertension

### Main causes



# Question: How does Smoking affect arteries?



# In Summary...

- 1. Smoking damages the lining ( $\varphi_{\alpha}$ ) of your arteries, leading to a build up of fatty material (atheroma) which narrows the artery.**
- 2. The carbon monoxide in tobacco smoke reduces the amount of oxygen in your blood. This means your heart has to pump harder to supply the body with the oxygen it needs.**
- 3. Nicotine stimulates your body to produce adrenaline, which makes your heart beat faster and raises your blood pressure, making your heart work harder.**
- 4. Your blood is more likely to clot, which increases your risk of having a heart attack or stroke.**



# The Good News...

## SMOKING

About 18 percent of American women smoke. Smoking is a major risk factor for heart disease – but it's one that you can control. Find tools to help you quit at [women.smokefree.gov](http://women.smokefree.gov).



**SMOKERS** ARE TWO TO SIX TIMES MORE LIKELY TO SUFFER A HEART ATTACK

vs.  **NON-SMOKERS**



 **\$4.80**

AVERAGE PRICE OF A PACK OF CIGARETTES

**MORE THAN \$1,700**

HOW MUCH YOU COULD SAVE IN ONE YEAR IF YOU QUIT A PACK A DAY HABIT



**2012**

HEART DISEASE RISK BEFORE YOU QUIT SMOKING

**2013**

1 YEAR AFTER QUITTING, YOUR RISK MAY DROP BY MORE THAN HALF

### Sources

- National Center for Health Statistics. (2012). *Summary health statistics for U.S. adults: National Health Interview Survey*.
- National Heart, Lung, and Blood Institute. (2005). *Your guide to a healthy heart*.
- Centers for Disease Control and Prevention. (2011). *Fact sheet: economic facts about U.S. tobacco production and use*.
- U.S. Public Health Service, National Center for Chronic Disease Prevention and Health Promotion. (2004). *The health consequences of smoking a report of the Surgeon General*.

HeartTruth.gov



<https://www.pinterest.com/pin/464926361502620805/>

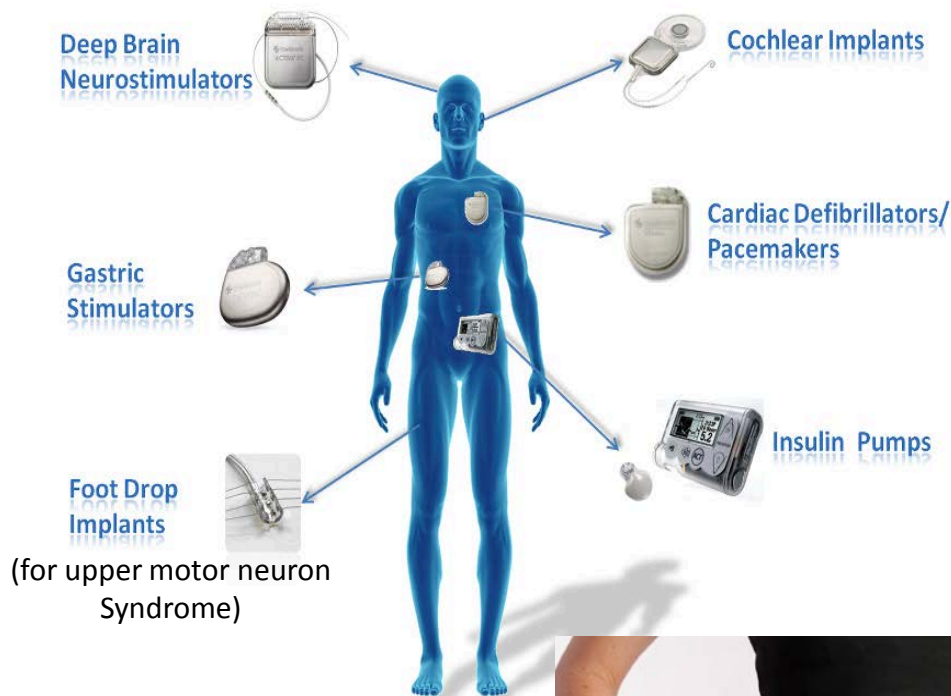
# From Wearable Consumer Electronics to Wearable Medical Devices

## Wearable electronics

With chips shrinking and sensors becoming cheaper, personal computing is moving from that smartphone in your pocket to your arm, your wrist, right out to your fingertips.



## WIRELESS IMPLANTABLE MEDICAL DEVICES



[http://www.huffingtonpost.com/gregory-weinkauf/glucose-monitoring\\_b\\_1503881.html](http://www.huffingtonpost.com/gregory-weinkauf/glucose-monitoring_b_1503881.html)



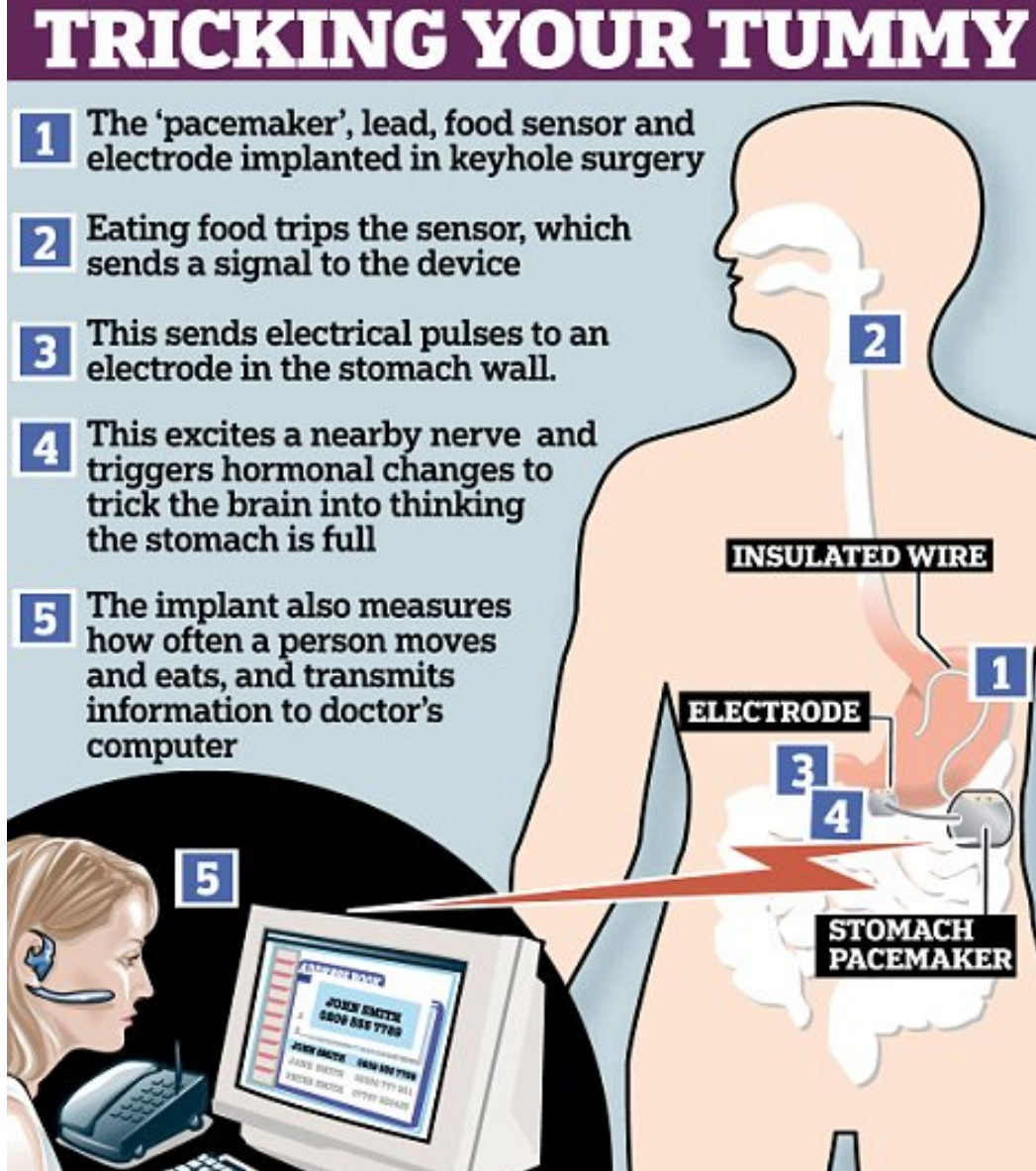
# Gastric Stimulator



- For Treating Gastroparesis (γαστροπάρεση): Paralyzed Stomach
- Wires transmit low-energy electrical pulses to the stomach.
- The device's battery lasts from 5-10 years



# Or for Weight Loss



# Why you need a Wi-Fi spot on your foot?

## Human gait energy scavenger



low-power short range  
radio communication  
no connecting wires required



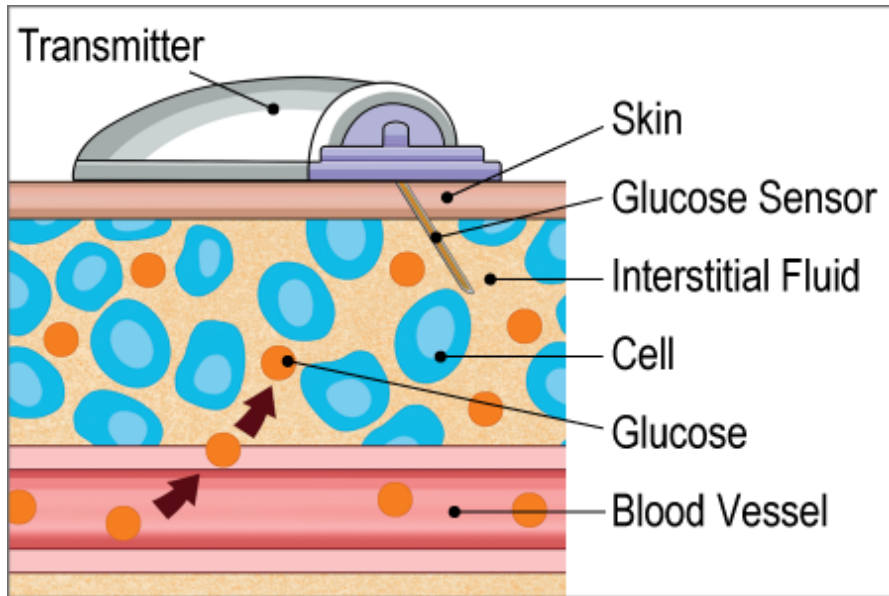
high-power long range  
radio communication  
to cellular network



harvester powered  
always-on Wi-Fi hot spot

Tens of times increase in the mobile device battery life

# Wearable Continuous Glucose Monitor



<https://www.youtube.com/watch?v=C0PeoDgs4hg>

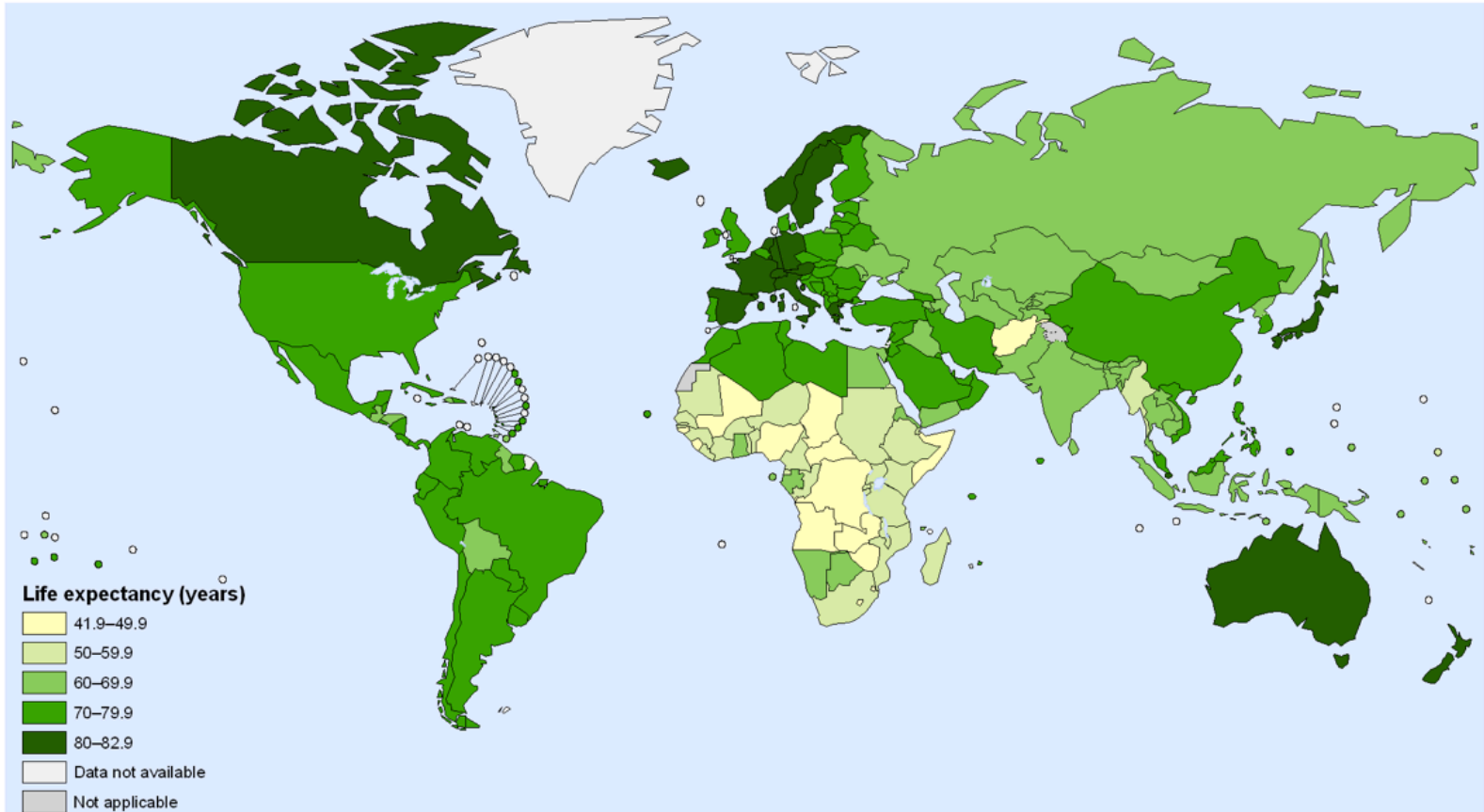
Left Image:

<http://www.medtronicdiabetes.com/customer-support/sensors-and-transmitters-support/calibration-sensor>



# Global Health and Bio-Engineering

Life expectancy at birth, 2008



The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted lines on maps represent approximate border lines for which there may not yet be full agreement.

Data Source: World Health Organization  
Map Production: Public Health Information  
and Geographic Information Systems (GIS)  
World Health Organization



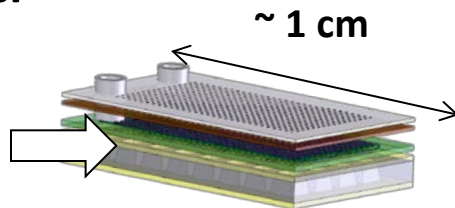
© WHO 2010. All rights reserved.

# Point-of-care (POC) Biochips

NEED to perform testing in the field

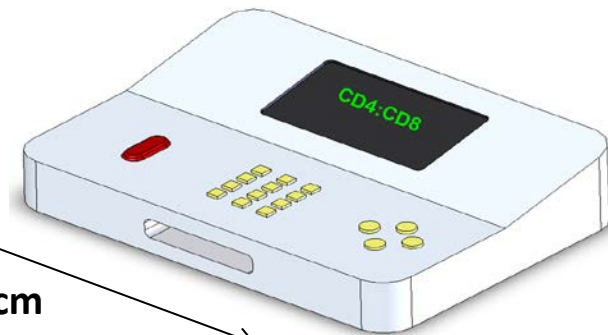
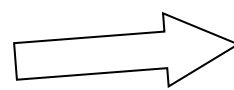


1. Blood is obtained from the patient's finger



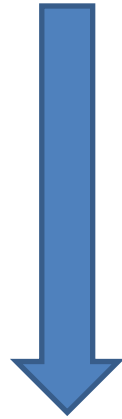
Lab-on-chip System

2. The sample is being processed by the biochip



3. The biochip is placed inside the data analysis device for blood analysis.

# World Health Organization



*Quality Criteria for POC systems*

**ASSURED**

**Affordability, Sensitivity, Specificity, User friendly, Rapid and robust, Equipment free and Delivered**

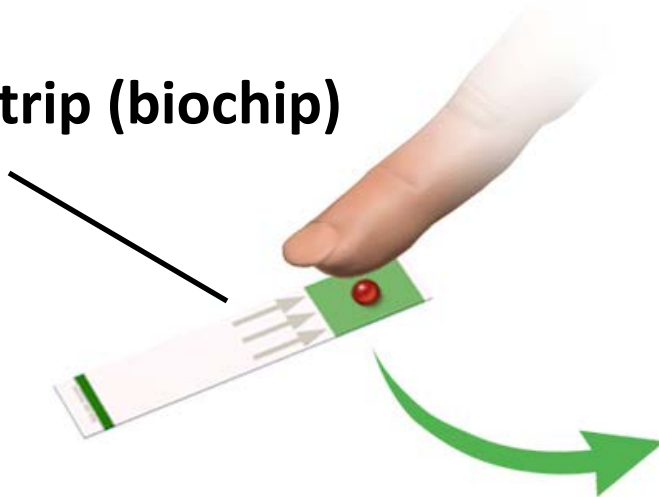


# Glucose Point-of-care Monitor



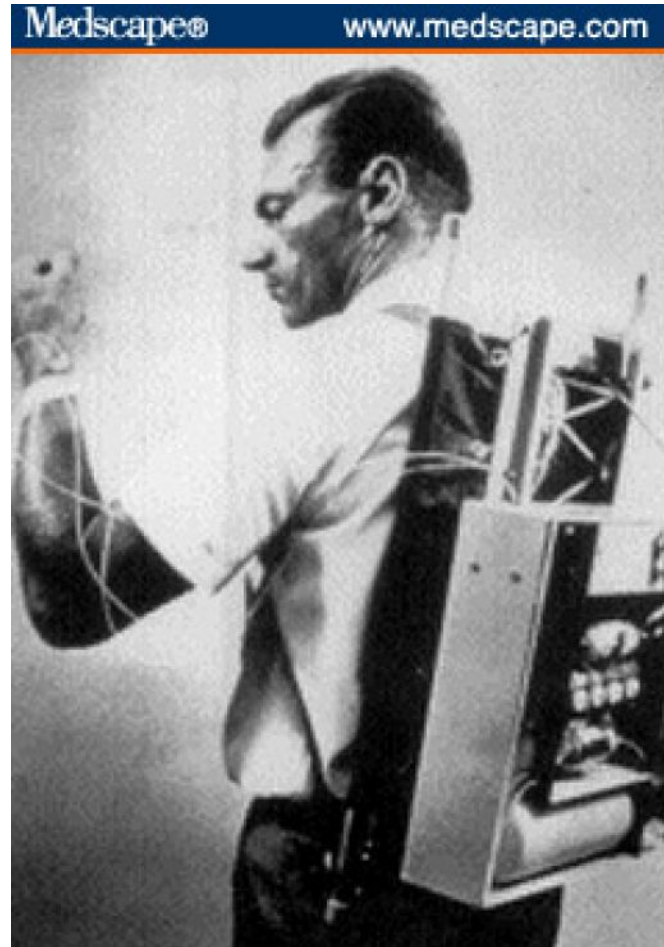
1. Lancet

2. Blood Strip (biochip)



3. Glucometer

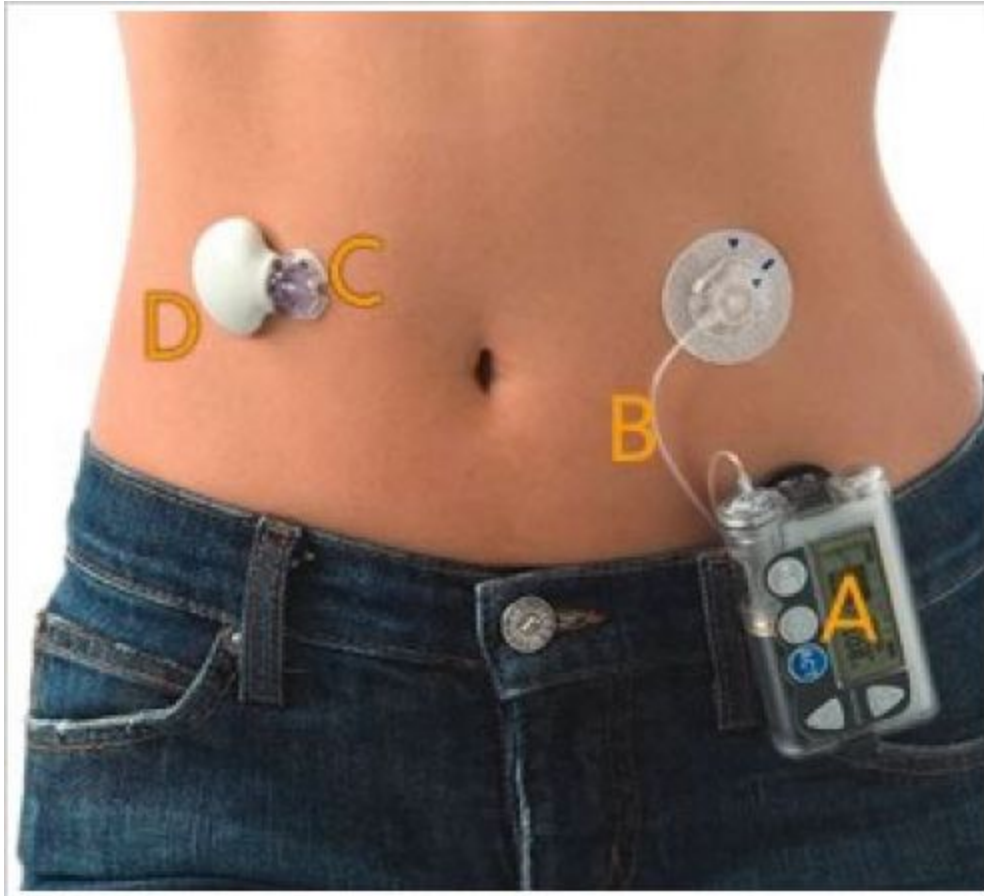
# The future of Glucose Monitoring



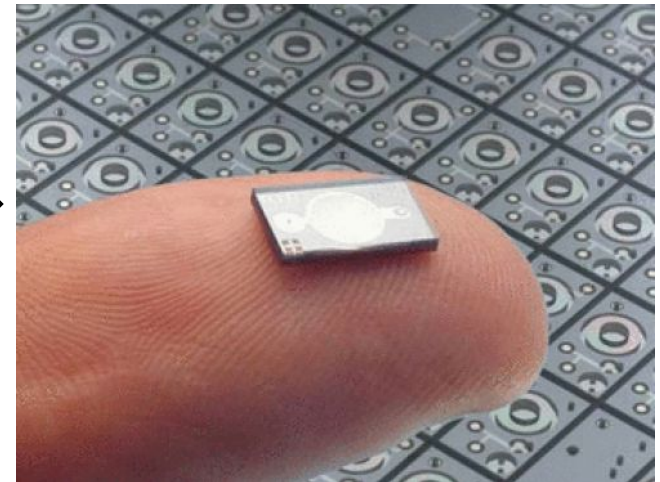
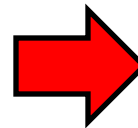
**FIRST INSULIN PUMP 1978**

<http://wbisbill.hubpages.com/hub/Insulin-Pump-Therapy---Way-To-Go-For-Diabetes---My-Story#>

# The future of Glucose Monitoring



Micro/Nano Technology – A  
MicroPump



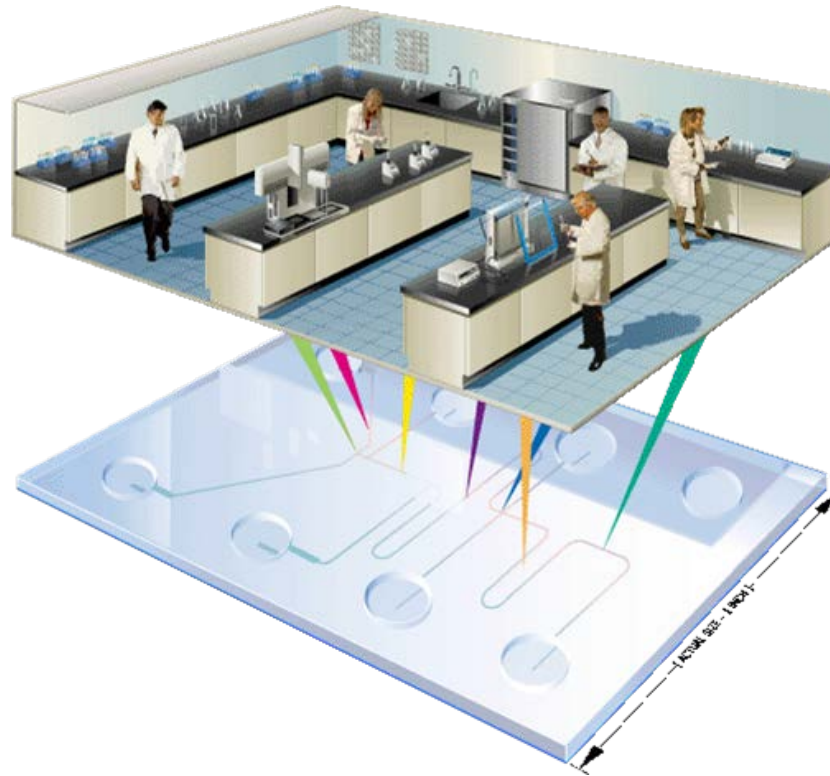
A - The Pump itself

B- The Cannula

C -Continuous Glucose Monitoring Sensor



# The Vision: The 'Lab on Chip' Concept



**Lab-on-a-chip (LOC)** is a term for devices that integrate (multiple) laboratory functions on a single chip of only millimeters to a few square centimeters in size and that are capable of handling extremely small fluid volumes down to less than pico liters.

<http://lab-on-chip.gene-quantification.info/>

# Capsule endoscopy

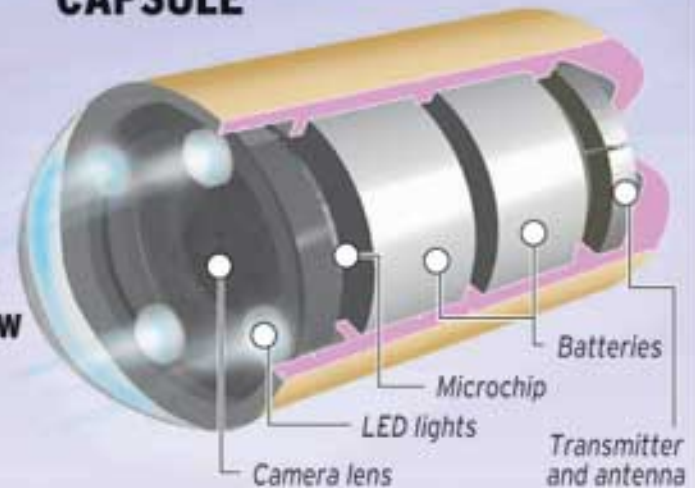
A capsule fitted with a disposable mini video camera can examine parts of the small intestine that standard scopes can't reach for diagnosing unexplained bleeding or other abnormalities. The video data is transmitted and stored in a recorder worn on a belt, and is later downloaded to a computer that the doctor can study.

## THE PROCEDURE

- 1** Fasting necessary prior to swallowing capsule
- 2** Capsule glides smoothly through digestive tract
- 3** Wireless recorder worn on a belt around waist receives signals transmitted by capsule through sensors placed on patient's body
- 4** Capsule naturally excreted



## THE CAPSULE



### Advantages:

- Painless
- No sedation
- Provides 3-D, color images of small intestines without surgery
- Allows doctors to make early, accurate diagnosis of problems so they can recommend most appropriate treatment

### Size:





BioFluid Mechanics & BioHeat Transfer



Device Bio-Engineering

Genetic Engineering

Bio-Engineering

Medical Physics



Tissue Engineering

Biomechanics



Image shows three sets of tomatoes. The ordinary control tomatoes (extreme left) soften and shrivel up, while texture of gene-silenced tomatoes remains intact for up to 45 days. Photo credit: Asis Datta, Subhraj Chakraborty, National Institute of Plant Genome Research, New Delhi





# Project Ideas

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