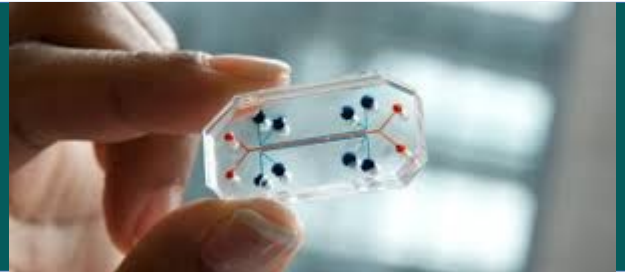
Minimally Invasive Diagnostic Chips

Ghazali Ahmad
MSc Biomeical Engineering
Ph.D. Analytical Chemistry *(Candidate)*

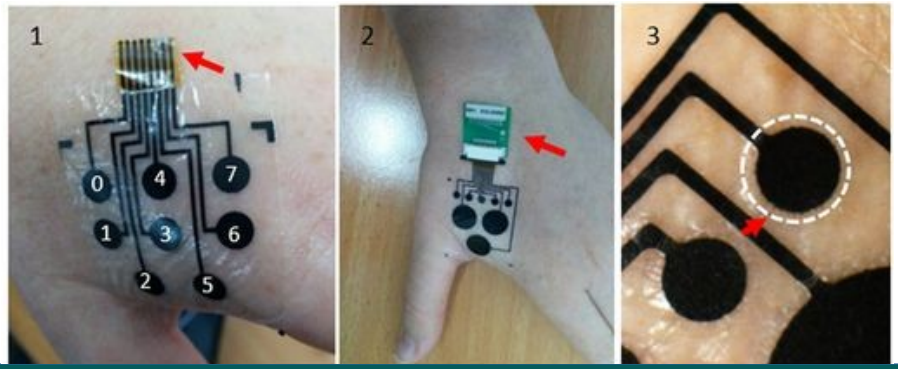


Overview

- The Device
- Business Idea/Market
- The material
- Minimally invasive
- Patents
- Cost (150-200K)
  - Overall process to manufacture chips
  -

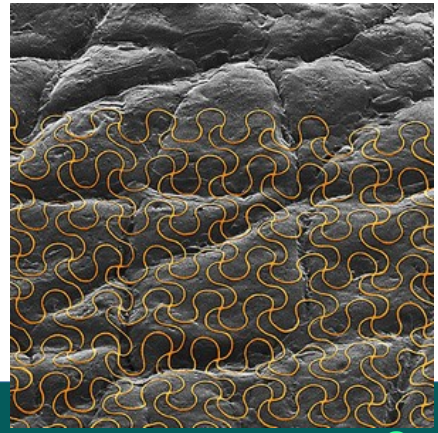
The Device

- The device is a **minimally invasive** *electrochemical* biosensor for:
  a) Research purposes
  b) Medical Purposes
- The diagnostic portion of the device will be called the “chip” or “strip”
- They are *Epidermal Electronics* (skin electronics) and can be self powered via paper batteries
- Application can even be through a rubber stamp or as a temporary tattoo



Lilach Bareket, Lilah Inzelberg, David Rand, Moshe David-Pur, David Rabinovich, Barak Brandes, and Yael Hanein. "Temporary-tattoo for Long-term High Fidelity Biopotential Recordings." Scientific Reports 6.1 (2016): 25727.

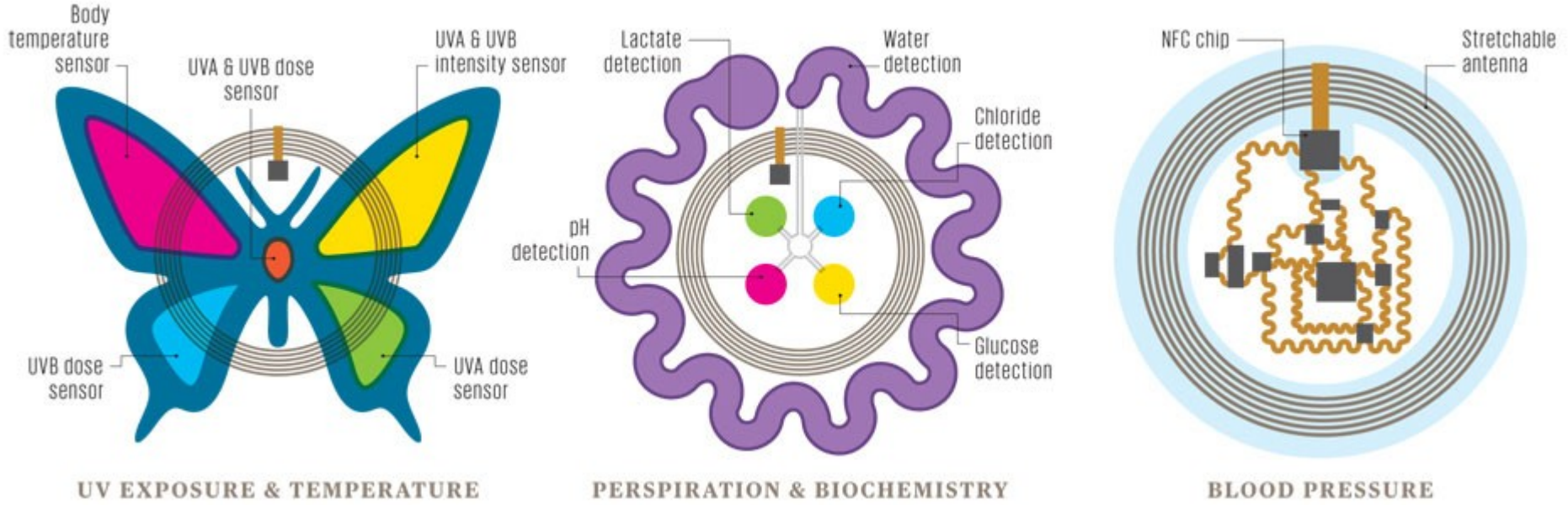
https://www.technologyreview.com/s/424989/stick-on-electronic-tattoos/



https://www.technologyreview.com/s/512061/electronic-sensors-printed-directly-on-the-skin/

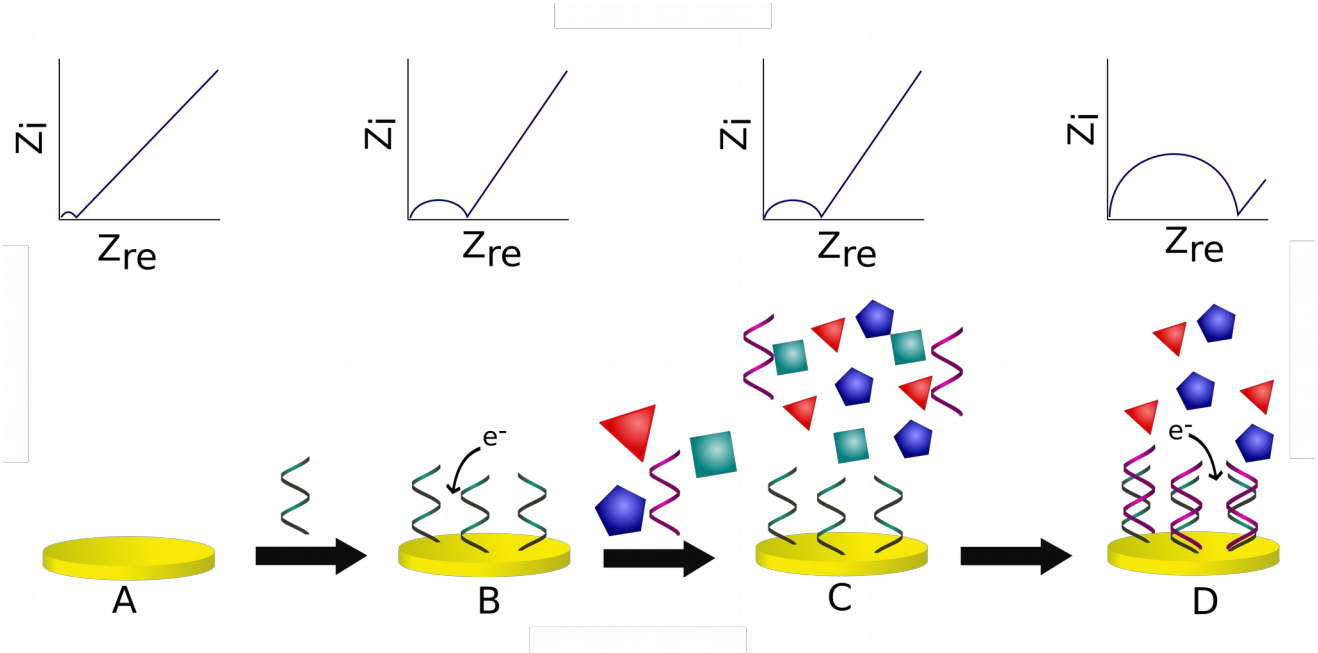
The Device

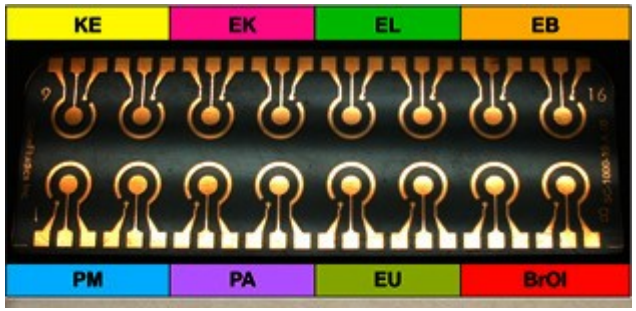
- Can be decorated and serve multiple purposes
- Can also send wireless signals

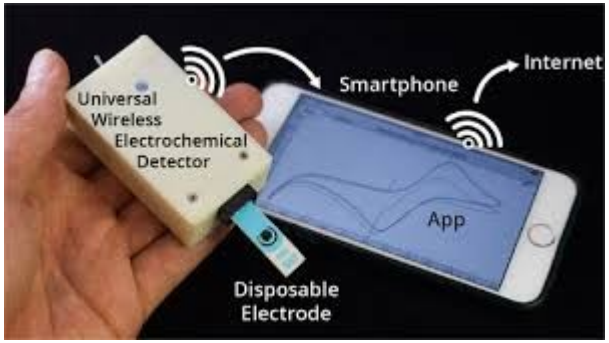


https://spectrum.ieee.org/biomedical/devices/a-temporary-tattoo-that-senses-through-your-skin

Electrochemical Sensors Concept



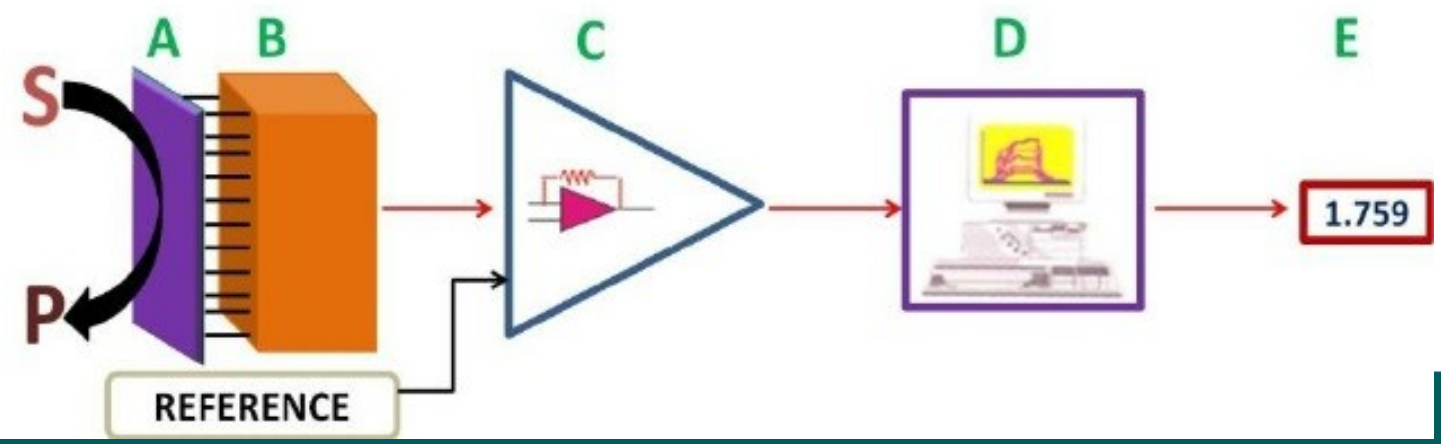




Why Electrochemcial?

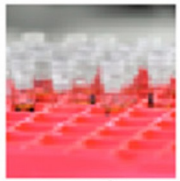
- The world’s most successful biosensor is the glucometer, an electrochemical (E-chem) sensor
- E-chem sensors are highly sensitive, very stable, cheap and easily interpreted

Expensive!



Components of a Biosensor

Medical samples



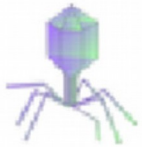
Food samples

Chemical pollutants

Analytes

Nucleic Acid

Antibody



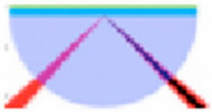
Virus

Enzyme

Bioreceptors

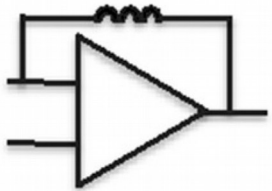
Electrochemical

Optical



Exp sive!

Transducers



Signal amplification

Data processing

Sensor Arrays, Selection and Diagnostic Strength

- The number of possible diseases we can detect are of the order of 3^n
- For 20 biomarkers, there are 3^{20} = 3,486,784,401 possible combinations
- Each biomarker is not specific to a disease i.e. there is no 1:1 correlation between any biomarker-*X* and some disease *Y* (for the most part)
- However, biomarker profiles are specific to diseases
  - Profile is the the combination of multiple biomarkers
  - Like a finger print
- Diagnosis is performed using process of elimination

Arrays, Selection and Diagnostic Strength

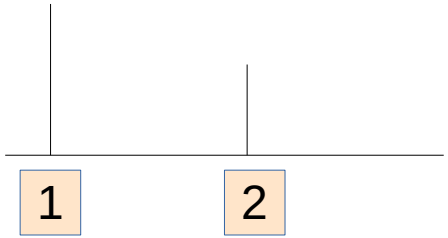
- From an engineering perspective all diagnosis is a cost-benefit-probability analysis
- Diagnosis: *The identification of the nature of an illness or other problem by examination of the symptoms*
- Since diagnosis is an inference, there is always a probability of error associated with it
- Medical Diagnostic errors are the 3rd leading cause of death in America (behind cancer and heart disease)[1]
- A more objective approach needs to be developed

1 - Makary, M. A. & Daniel, M. Medical error—the third leading cause of death in the US. BMJ 353, i2139 (2016)

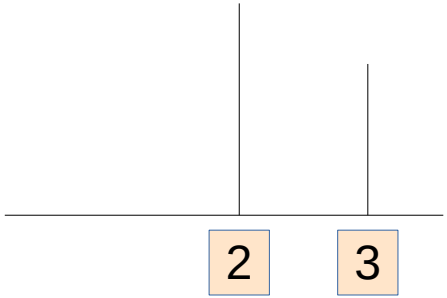
Illustration of Array Diagnostics

Profile Disease A

Profile Disease B



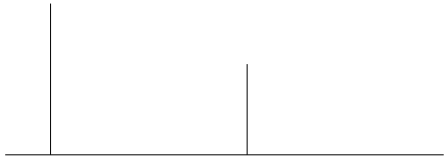
Profile Disease C



Patient 1 Profile

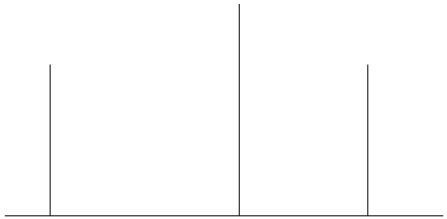
A + B +C

Patient 2 Profile



B

Patient 3 Profile



A+C

Profile Determination using AI

- AI is a mature technology capable of finding patterns humans cannot

AI program able to predict human rights trials with 79 percent accuracy

By James Vincent | Oct 24, 2016, 8:05am EDT

Source PeerJCompSci

2- Aletras, N., Tsarapatsanis, D., Preoţiuc-Pietro, D., & Lampos, V. (2016). Predicting judicial decisions of the European Court of Human Rights: A Natural Language Processing perspective. PeerJ Computer Science, 2(10), PeerJ Computer Science, Oct 24, 2016.

Market

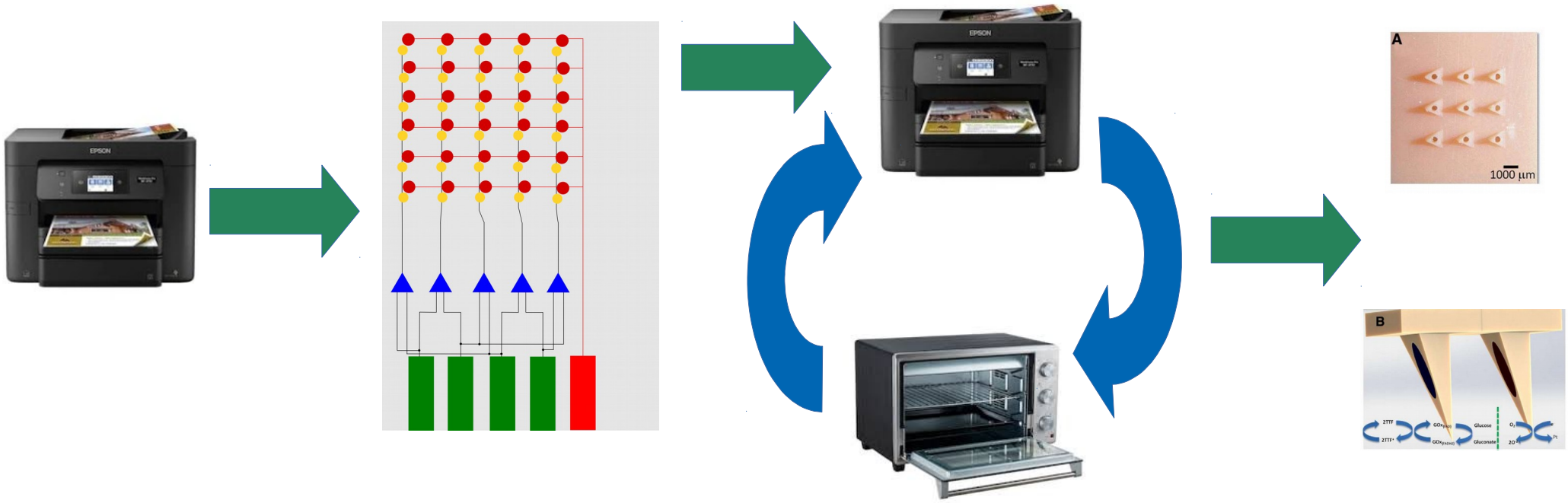
- We can potentially do any disease
- We have at least 2 different markets:

1) Medical
   - Diagnosis
   - Prognosis
   - Glucose Measurement

2) Research
   - Sell “Blank” chips to researchers (Universities, companies, etc.)

Overview of Fabrication

Why gold?



Projected Seed Cost

Item	Purpose	Cost ($ CAD)	
3x High Res-Printer	To prepare the devices	30,000	
Inks/ Solutions	To grow the needle	5,000	
10x PET Sheets (30x30 cm)	The substrate (450 chips/sheet)	3,590	
Biomarkers (x60)	Diagnosis/prognosis	30,000	
Adhesive cover		100	
(Potentiostat) Measurement device		300	
Potentiostat Software		2,000	
		TOTAL	**70,990**

Thank you!

Overview of Fabrication