Al-Farabi Kazakh National University
Higher School of Medicine
Department of Fundamental Medicine

Personalized medicine (the future of medicine)

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# LEARNING OUTCOMES
As a result of the lesson you will be able to:

- 1. Give the definition to the terms "personalized medicine", "gene therapy", "target delivery", "nanoparticles", "nanotechnology".
- 2. Explain how the Omics technologies can be used for individual diagnostics, treatment and profilactics of human diseases?
- 3. Analyze the modern and future methods of biomedicine used for treatment of human diseases (nanotechnology, biocompatible polymers, artificial tissues and organs, using the stem cells, radiation oncology and etc.). What are their dangers and perspectives?
- 4. Characterize the methods of gene therapy "*ex vivo*" and *"in vivo"*, give the specific examples.
- 5. Analyze the perspectives and dangers of human genome editing, its bioethical consequences.

Definitions

Personalized medicine, also referred to as **precision medicine**, is a medical model that separates people into different groups—with medical decisions, practices, interventions and/or products being tailored to the individual patient based on their predicted response or risk of disease.[1] The terms «**personalized medicine**, **precision medicine, stratified medicine and P4 medicine**» are used interchangeably to describe this concept[1][2] though some authors and organisations use these expressions separately to indicate particular nuances.[2]

While the tailoring of treatment to patients dates back at least to the time of **Hippocrates**,[3] the term has risen in usage in recent years given the growth of new diagnostic and informatics approaches that provide understanding of the molecular basis of disease, particularly genomics. This provides a clear evidence base on which to stratify (group) related patients.[1][4][5]

Among 14 Grand Challenges for Engineering, initiative sponsored by National Academy of Engineering (NAE), personalized medicine has been identified as a key and prospective approach to "**achieve optimal individual health decisions**", therefore overcoming the challenge of "Engineer better medicines".[6][7]

Cancer Patients → Tumour → Sequencing → Analysis, Modeling → Personalized Therapy
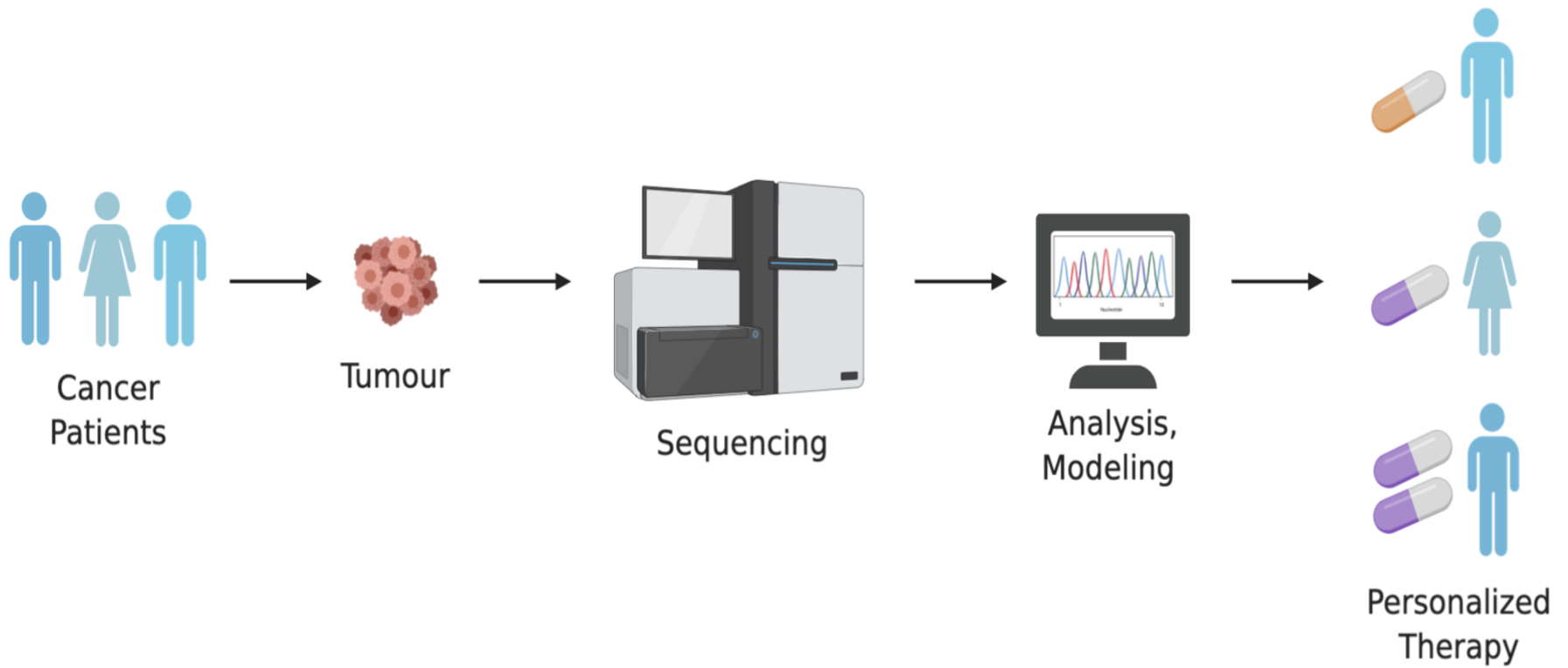
https://en.wikipedia.org/wiki/Personalized_medicine#/media/File:Personalized_Cancer_Therapy.png
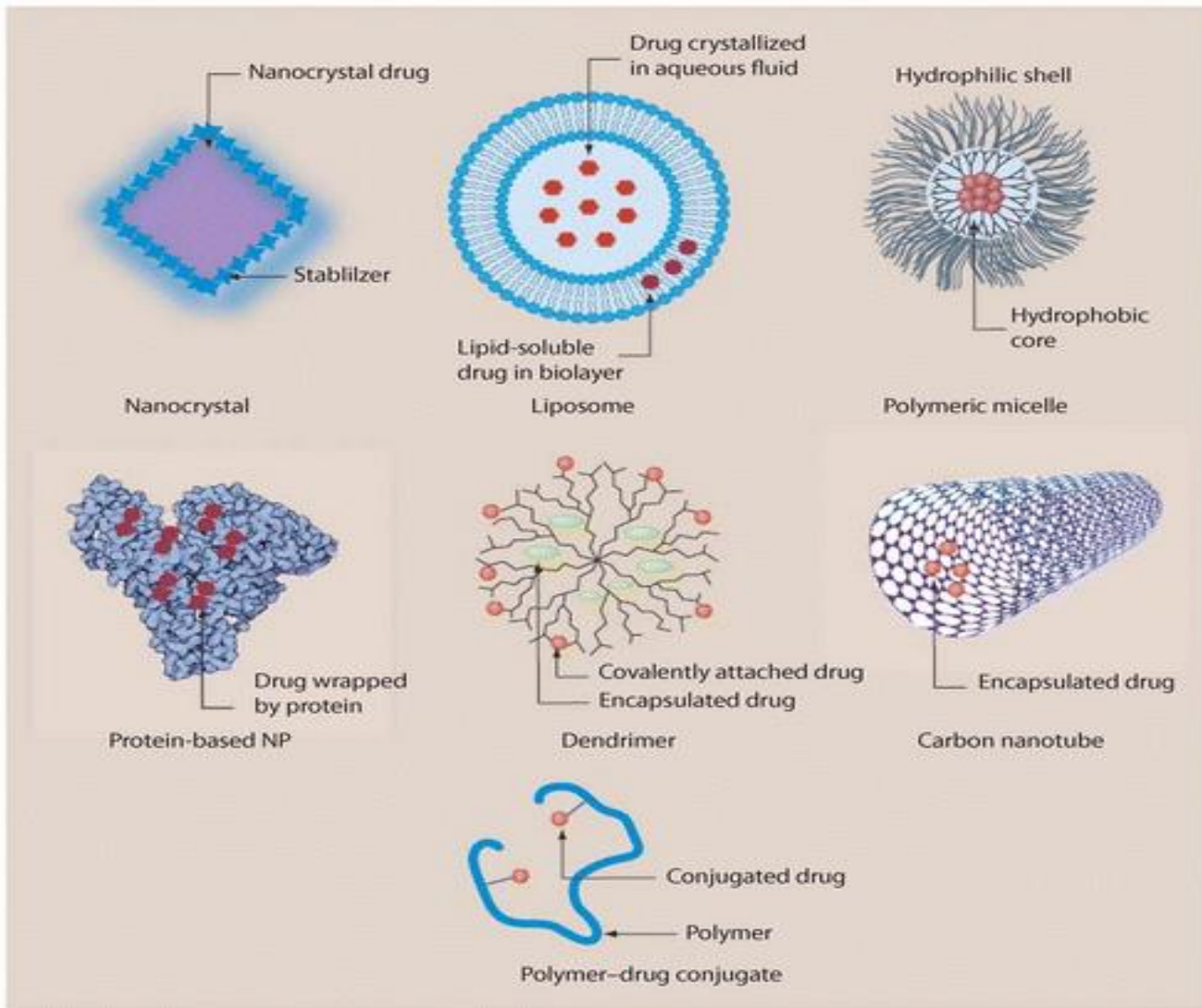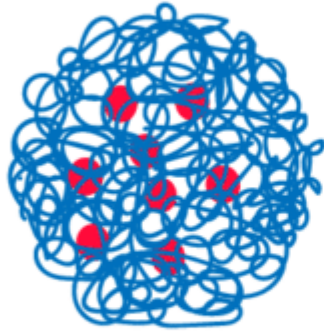
nanoparticles as a drug delivery system
futuremedicine.com
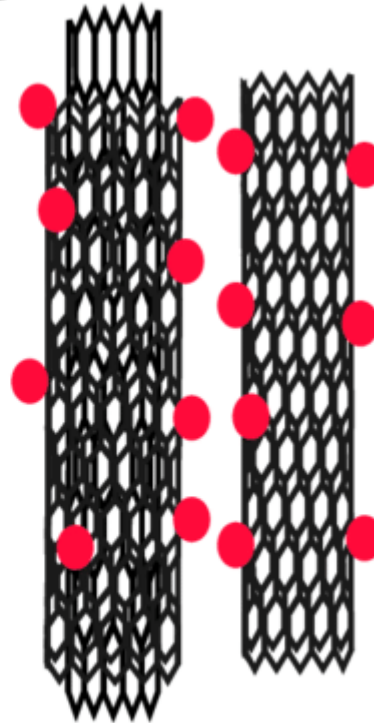
A Liposomes
   50 - 300 nm
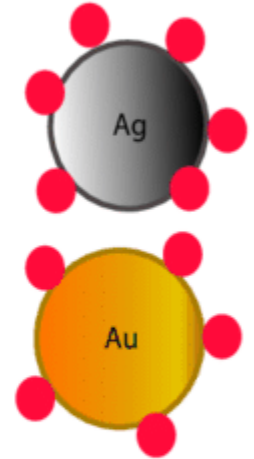
B Polimeric
   Nanoparticles
   up to 100 nm

C Superparamagnetic
   Iron Oxide
   Nanoparticles
   10 - 250 nm
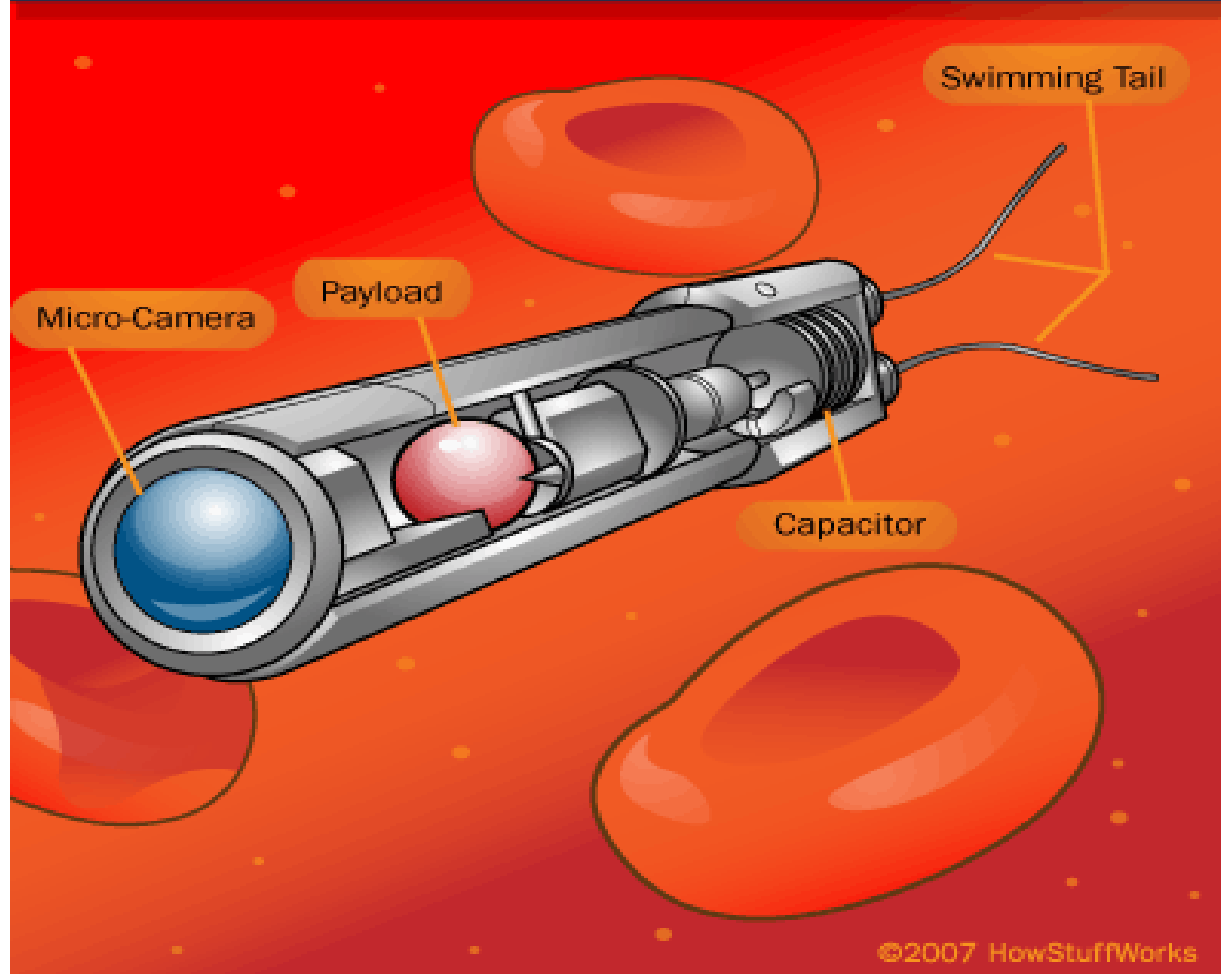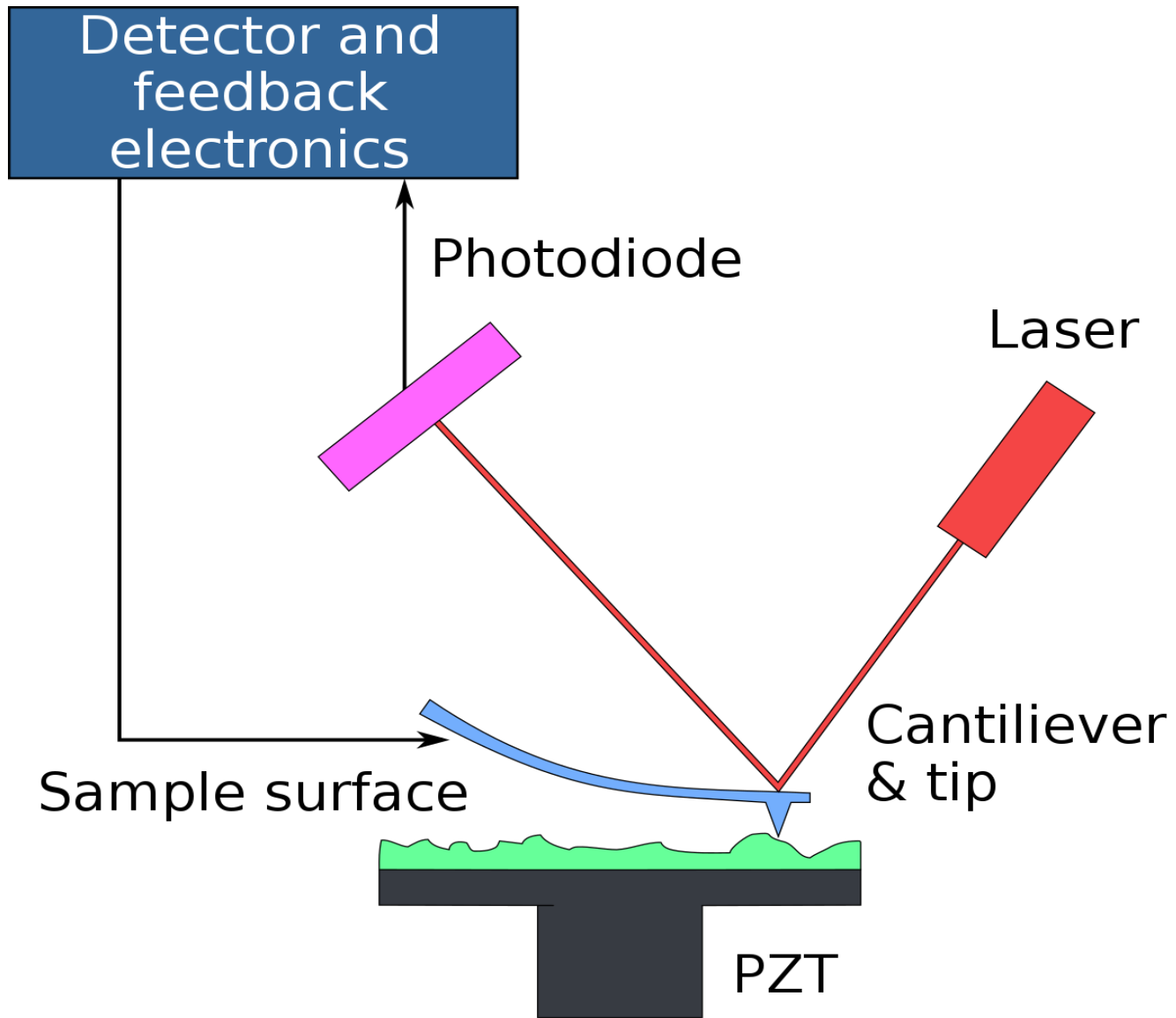
D Carbon
   Nanotubes
   1 - 10 nm dimention

E Gold and Silver
   Nanoparticles
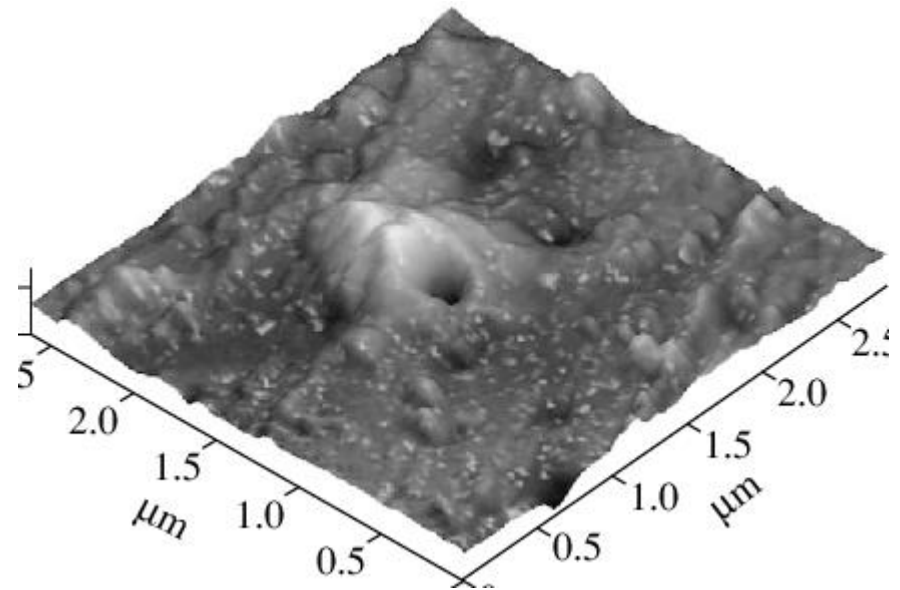   1 - 150 nm

nanoparticle drug delivery systems
researchgate.net

Nanobots | Metallurgy for Dummies
metallurgyfordummies.com

Detector and feedback electronics
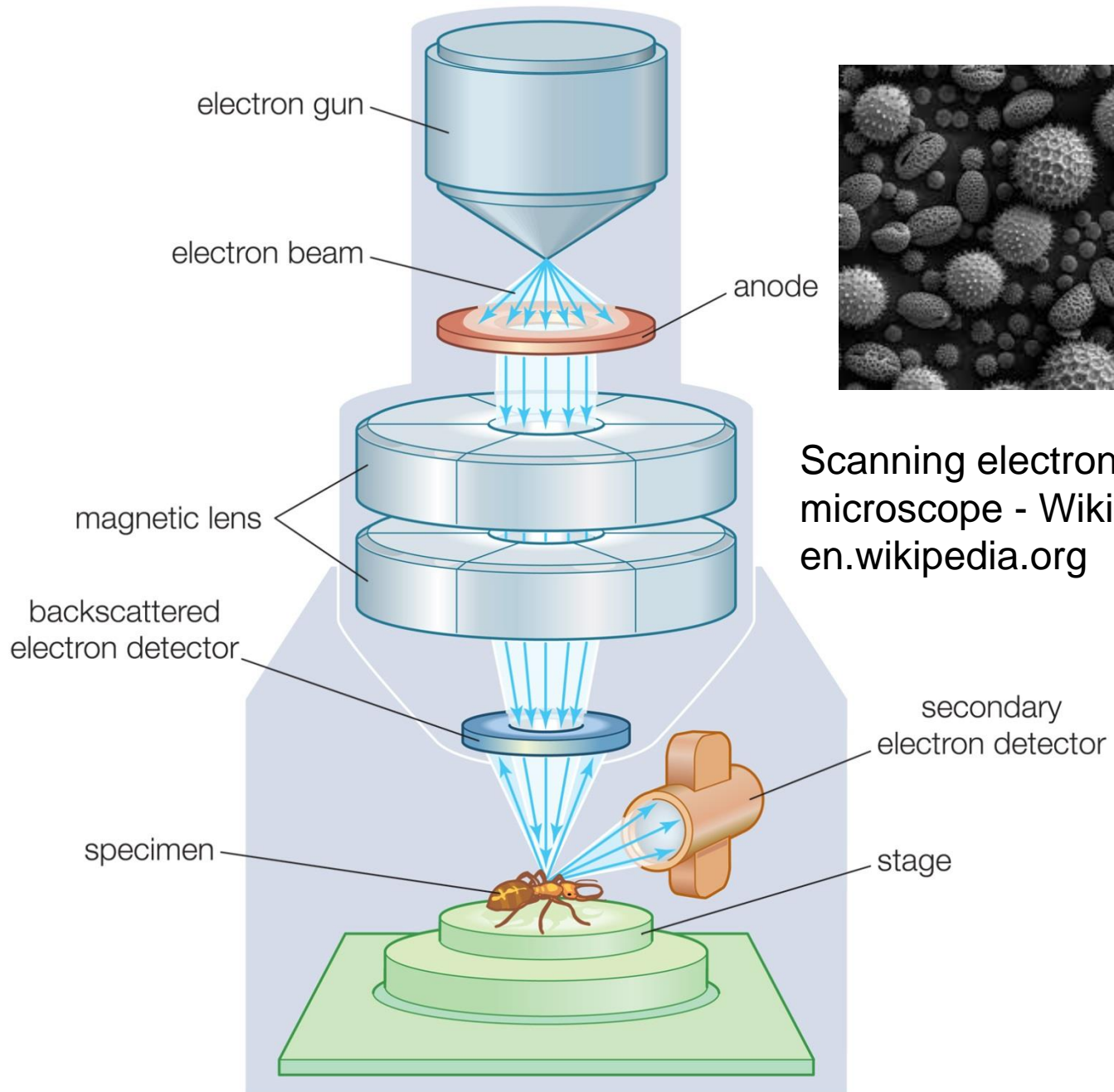
Photodiode

Laser

Cantiliever & tip

Sample surface

PZT

Atomic force microscopy - Wikipedia
en.wikipedia.org

Three-dimensional atomic-force image of the surface
researchgate.net

Atomic Force Microscope
iitk.ac.in

electron gun

electron beam

anode

magnetic lens

backscattered electron detector

secondary electron detector

specimen

stage

Scanning electron microscope - Wikipedia en.wikipedia.org

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Typical STM schematic

Piezotube control signals

Piezotube and control electrodes

Tunneling current amp

Distance control & scanning unit

Sample

Tunneling voltage

Display and data processing

Tunneling electron microscopy images
researchgate.net

Scanning tunneling microscope
testandmeasurementtips.com
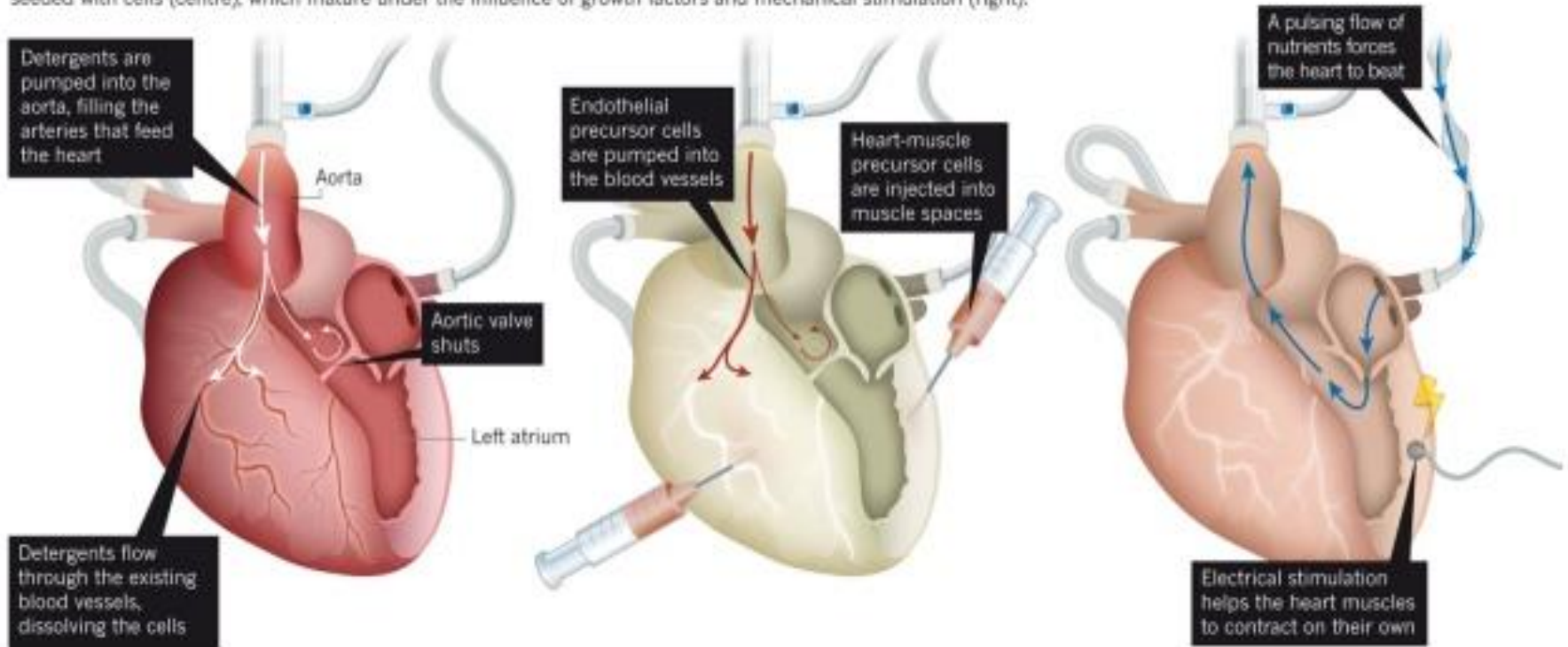
Examples & applications of some polymers

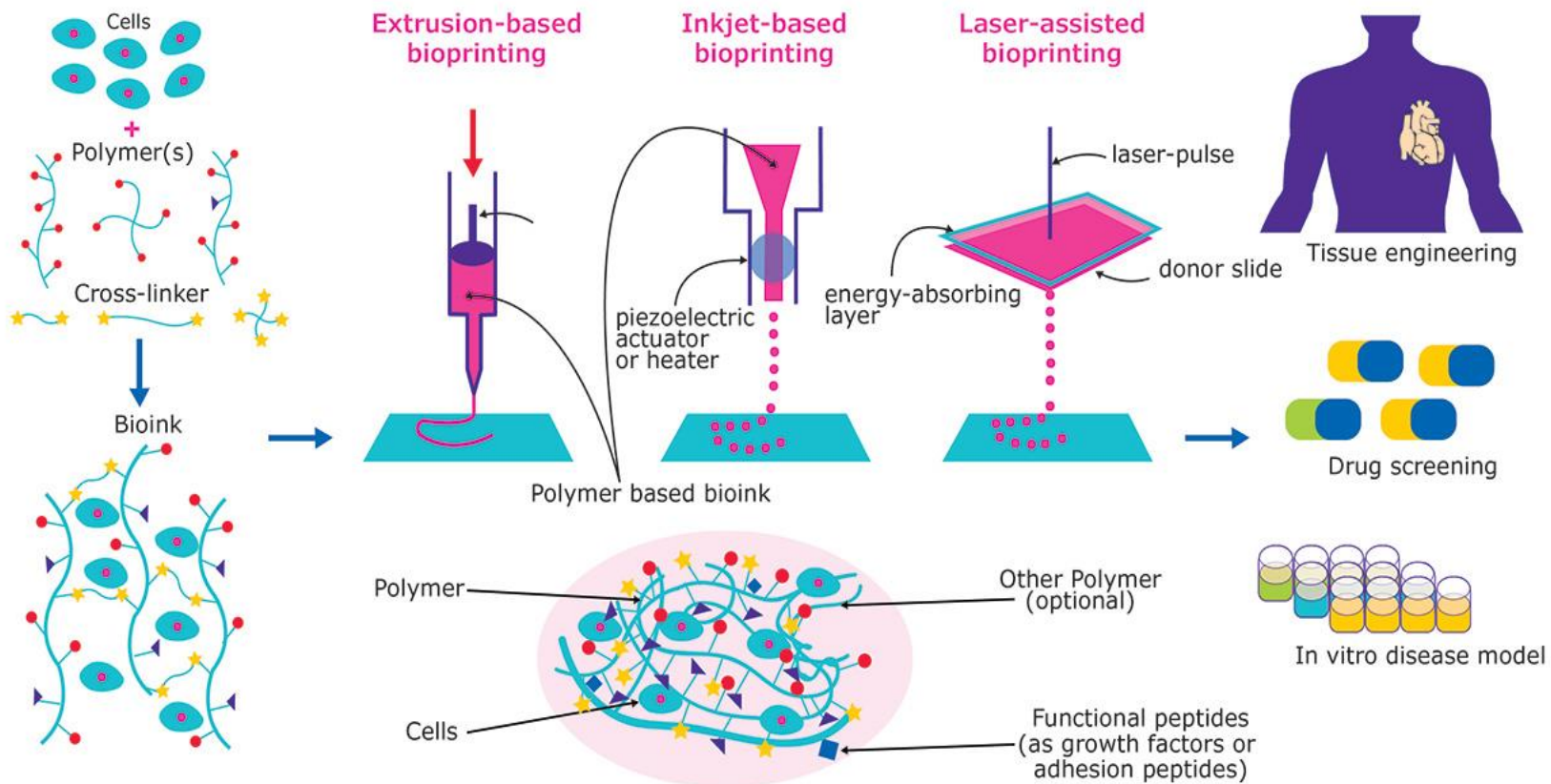| Name of polymer	Typical applications
Polyvinylchloride (PVC)	Blood tubing, as blood bags.
Polytetrafluoroethylene (PTFE)	Tubing, endoscopes, cannulas, catheter linings, Synthetic blood vessels, Surgical sutures.
Polyethersulfone (PES)	Tubing, catheters
Polyethylene (PE)	Orthopedic sutures, artificial tendons
Polyetheretherketone (PEEK)	Dentistry products, rigid tubing
Polysulfone (PS)	Surgical and medical devices, clamps, artificial Heart components, heart valves
Polypropylene (PP)	Heart valves

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Biocompatible Polymers
slideshare.net
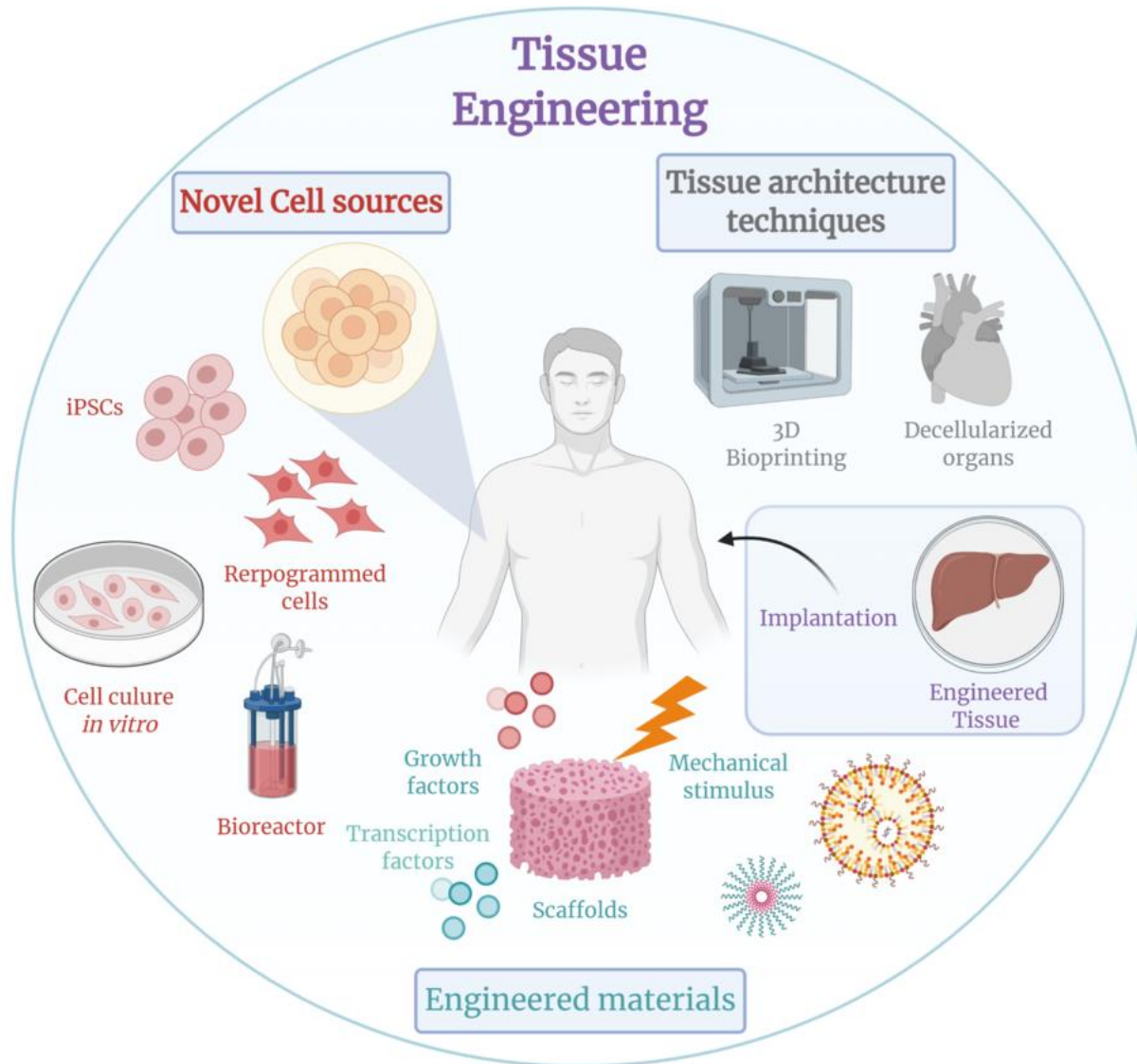
Tissue engineering - Wikipedia
en.wikipedia.org

CUSTOMIZED ORGANS

To construct a new heart, researchers first remove all cells from a donor organ (left), leaving a protein scaffold. That is seeded with cells (centre), which mature under the influence of growth factors and mechanical stimulation (right).

Detergents are pumped into the aorta, filling the arteries that feed the heart

Aorta

Aortic valve shuts

Left atrium

Detergents flow through the existing blood vessels, dissolving the cells

Endothelial precursor cells are pumped into the blood vessels

Heart-muscle precursor cells are injected into muscle spaces

A pulsing flow of nutrients forces the heart to beat

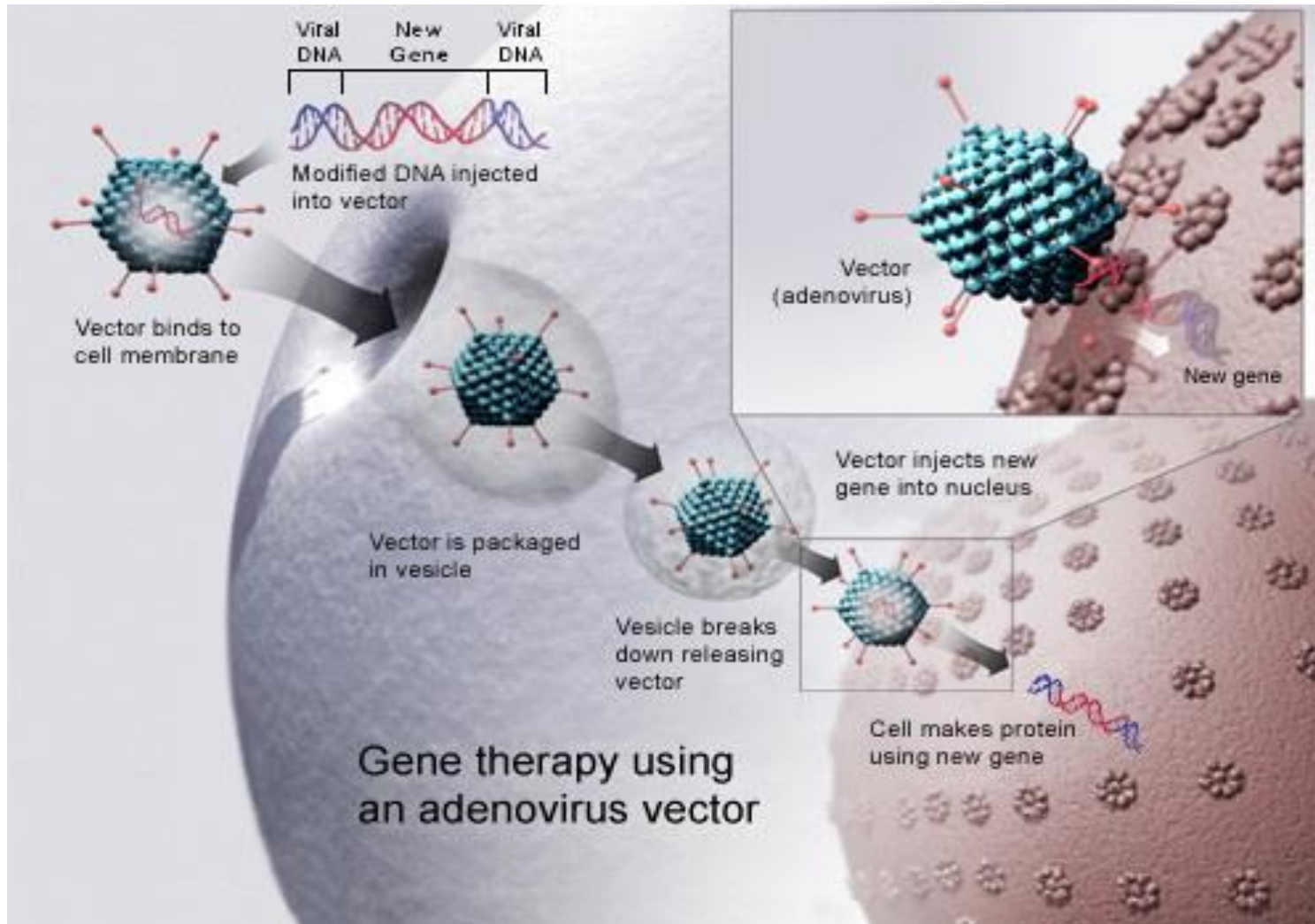Electrical stimulation helps the heart muscles to contract on their own
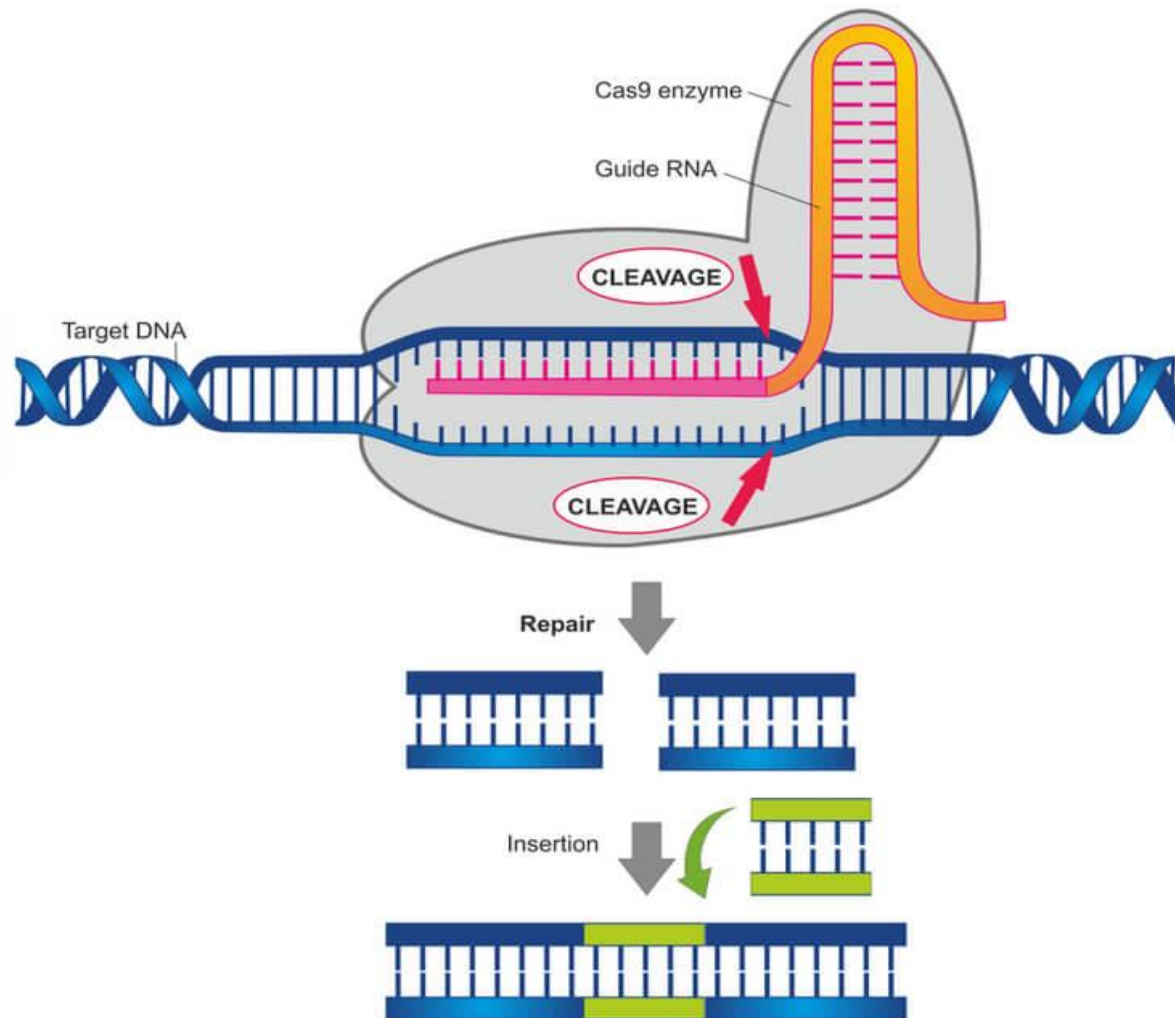
Tissue engineering: How to build a heart
nature.com

3D Bioprinting: Bioink Selection Guide
sigmaaldrich.com
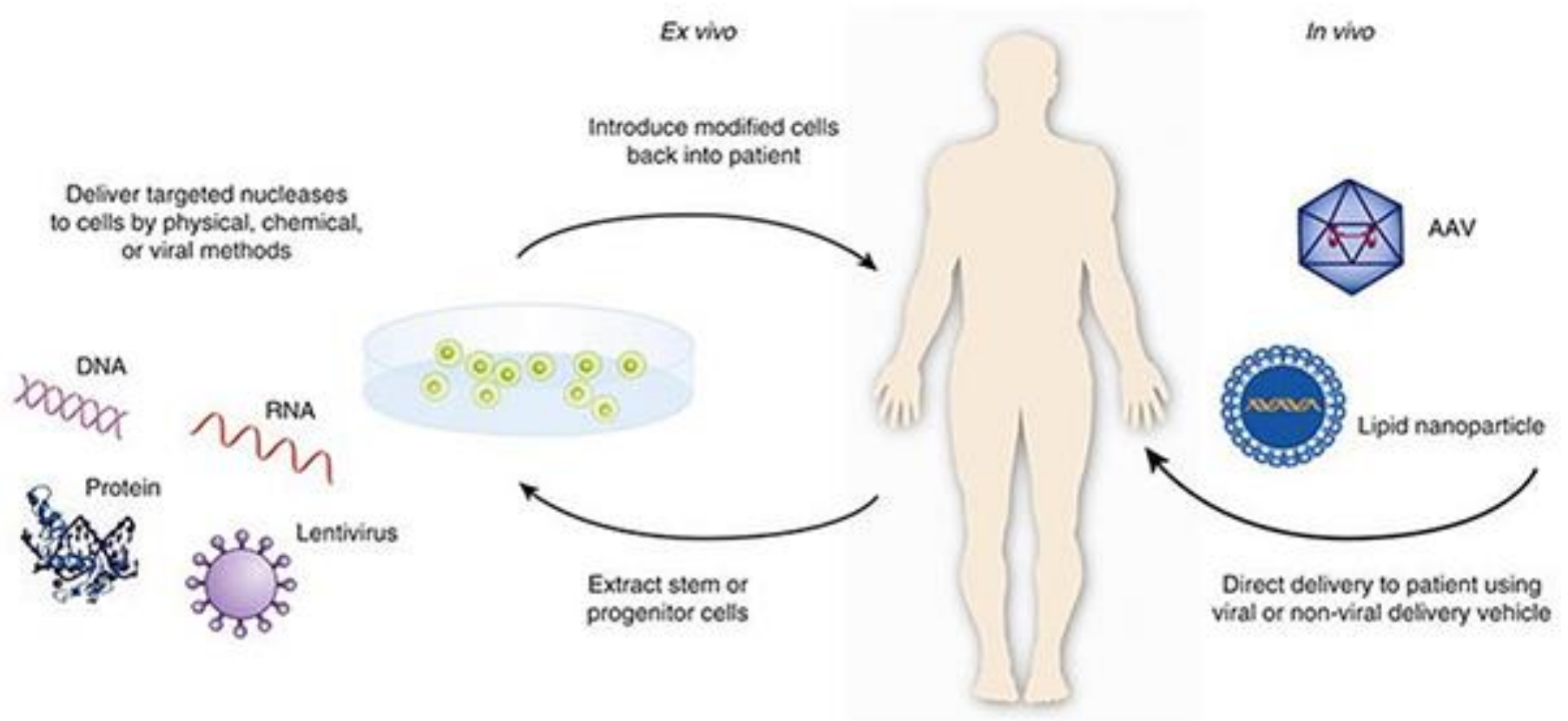
What is Gene Therapy? | FDA
fda.gov

Gene therapy - Wikipedia
en.wikipedia.org

CRISPR-Cas9 : Introduction and discovery
youtube.com

CRISPR-Cas9: The Gene Editing Tool Changing the World
labiotech.eu

References

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2.	"Many names for one concept or many concepts in one name?". PHG Foundation. Retrieved 6 January 2015.

3.	Egnew TR (1 March 2009). "Suffering, meaning, and healing: challenges of contemporary medicine". Annals of Family Medicine. 7 (2): 170–5. doi:10.1370/afm.943. PMC 2653974. PMID 19273873.

4.	"The Case for Personalized Medicine" (PDF). Personalized Medicine Coalition. 2014. Retrieved 6 January 2016.

5.	Smith R (15 October 2012). "Stratified, personalised, or precision medicine". British Medical Journal. Retrieved 6 January 2016.

6.	Lesko LJ (June 2007). "Personalized medicine: elusive dream or imminent reality?". Clinical Pharmacology and Therapeutics. 81 (6): 807–16. doi:10.1038/sj.clpt.6100204. PMID 17505496. S2CID 17860973.

7.	"Grand Challenges - Engineer Better Medicines". www.engineeringchallenges.org. Retrieved 2020-08-03.