

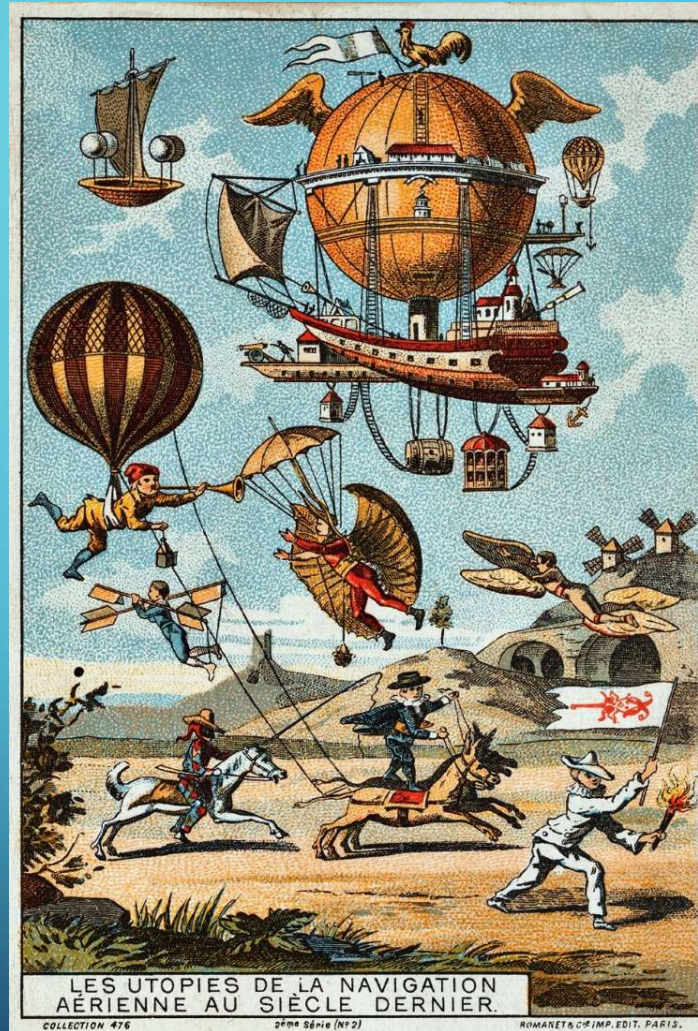
The image features a human hand on the right and a prosthetic hand on the left. A bright, glowing light emanates from the point where the index finger of the human hand is just inches from the tip of the prosthetic hand. The background is dark with faint, glowing grid lines. On the left side, there are vertical blue lines and circles resembling a circuit board or data stream. The title 'THE FUTURE MEDICINE' is written in bold yellow capital letters across the top left.

# THE FUTURE MEDICINE

RONNI GAMZU

TEL AVIV SOURASKY MEDICAL CENTER

*Today's Fringe  
Is Tomorrow's  
Mainstream*



Futuristic visions of flight from the 1800s

# TEN MEGATRENDS

1. Digital health/AI
2. OMICS
3. Molecular Diagnostics and targeted treatment
4. Nanomedicine
5. Cell/gene therapy
6. Stemcells & regenerative medicine
7. Bioprinting
8. Imaging: Augmented/virtual/realview/molecular
9. Robotics
10. Sensors & monitors

SCIENCE  
TECHNOLOGY

- INTERNET
- SOCIAL
- MOBILE
- CLOUD
- BIG DATA

## Bioconvergence of Sciences

- INTERNET
- SOCIAL
- MOBILE
- CLOUD
- BIG DATA
- 3D PRINTING
- RENEWABLE ENERGY
- INTERNET OF THINGS
- COGNITIVE SYSTEMS
- DRONES
- AUGMENTED REALITY
- GENOMICS
- BLOCKCHAIN
- ROBOTICS
- NANOTECH
- VIRTUAL REALITY
- PRECISION AGRICULTURE
- SC
- WIR
- BRAIN FLYING
- ARTIFICI
- REUSABLE
- AQUAPONIC
- BIOMETRIC SE
- HYPERLOOP
- 4D-5D PRINTING
- VISIBLE LIGHT COM
- BIOELECTRONICS
- PHOTONICS
- SYNTHETIC BIOLOGY
- GENETIC ENGINEERING
- ADVANCED MATERIALS
- QUANTUM COMPUTING
- ENERGY STORAGE
- VIRTUAL FARMING

- INTERNET
- SOCIAL
- MOBILE
- CLOUD
- BIG DATA
- GIGWARE
- 5G NETWORKS
- EDGE COMPUTING
- DISTRIBUTED COMPUTING
- SPATIAL COMPUTING
- WEB 3.0
- SATELLITE FLEETS
- NATURAL LANGUAGE GENERATION
- CHARGING STATIONS
- PREDICTIVE MACHINE VISION
- MACHINE READING COMPREHENSION
- GENERATIVE ADVERSARIAL NETWORKS
- SYNTHETIC DATA SETS
- ALGORITHMIC FACT CHECKING
- 3D PRINTING
- RENEWABLE ENERGY
- INTERNET OF THINGS
- COGNITIVE SYSTEMS
- DRONES
- AUGMENTED REALITY
- GENOMICS
- BLOCKCHAIN
- ROBOTICS
- NANOTECH
- PRECISION AGRICULTURE

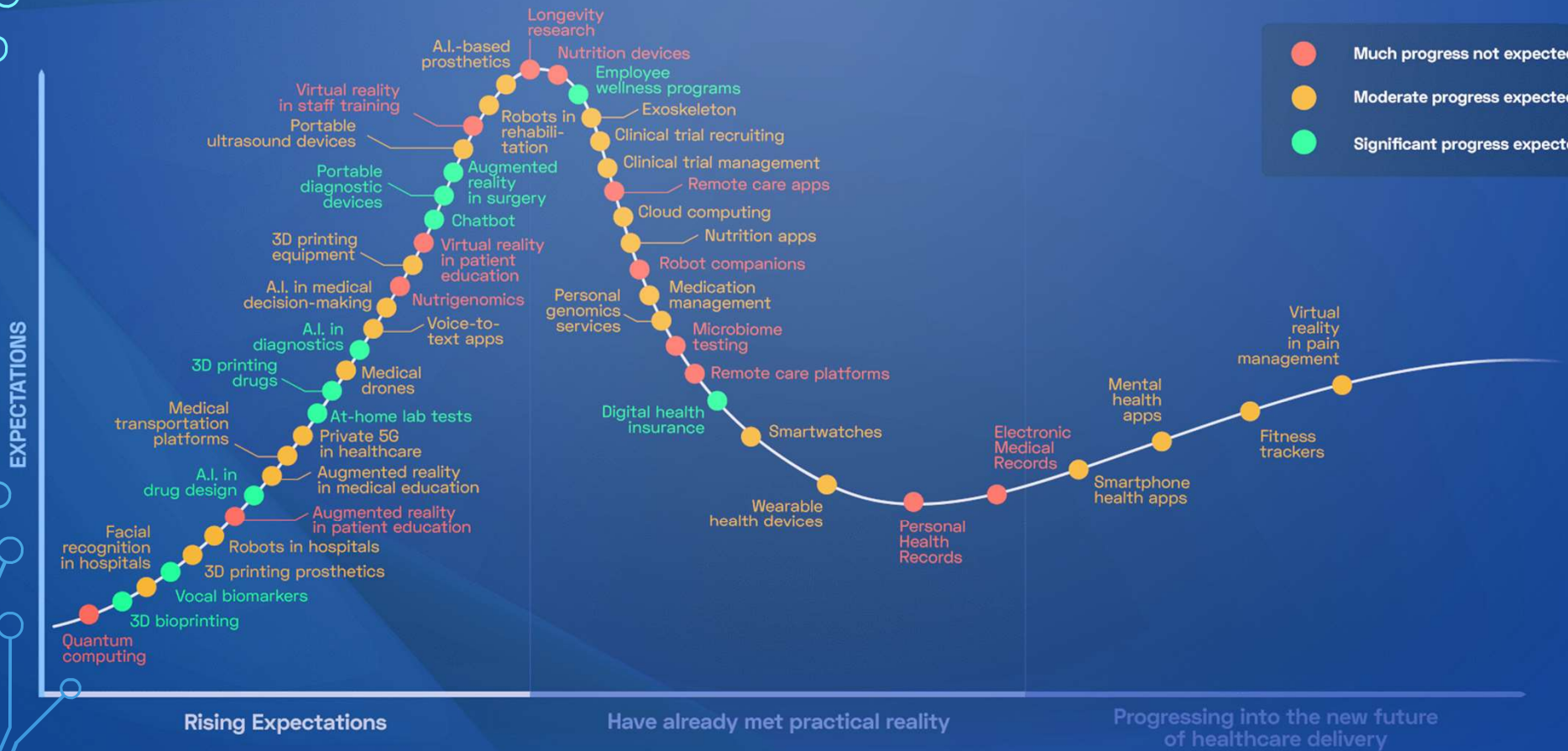
- THINKABLES
- TERAFORMING
- ASTEROID MINING
- BRIAN-TO-VEHICLE INTERFACES
- REGENERATIVE MEDICINE
- IVF GENETIC SCREENING
- MOLECULAR ROBOTS
- TOUCH-SENSITIVE PROSTHETICS
- REENGINEERING
- PERSISTENT AUDIO SURVEILLANCE
- DNA HARD DRIVES
- PERSONAL DATA RECORD
- GENETIC RECOGNITION
- SMART DUST
- SMART THREAD
- SUPERSONIC FLIGHT
- TATTOOABLES
- PERSISTENT RECOGNITION
- BEHAVIORAL BIOMETRICS
- DRONE-ENABLED INFRASTRUCTURE
- ZERO CARBON NATURAL GAS
- ROBOT BEES
- DRONE GENERATED RENEWABLES
- SOLAR HIGHWAYS
- TOKENOMICS
- NANOBOT NURSES
- SOFT ROBOTICS
- SELF ASSEMBLING ROBOTS
- CREATIVE AI
- COMPUTATIONAL PHARMACIES
- PERSONAL ROBOTS
- VOICE PRINTS
- FACE PRINTS
- CONNECTED CLOTHING
- GENERATIVE ALGORITHMS FOR VOICE, SOUND AND VIDEO
- SYNTHETIC VOICES
- GENETICS
- FILE-BRAIN SIMULATION
- ARTIFICIAL PHOTOSYNTHESIS
- REUSABLE ROCKETRY
- AQUAPONICS
- BIOMETRIC SENSORS
- HYPERLOOP
- 4D-5D PRINTING
- VISIBLE LIGHT COMMUNICATIONS
- BIOELECTRONICS
- BIOPHOTONICS
- PHOTONICS
- SYNTHETIC BIOLOGY
- GENETIC ENGINEERING
- ADVANCED MATERIALS
- QUANTUM COMPUTING
- ENERGY STORAGE
- VIRTUAL REALITY
- VERTICAL FARMING
- PRECISION AGRICULTURE
- WIRELESS POWER TRANSMISSION
- BRAIN-COMPUTER INTERFACE
- FLYING CARS
- ARTIFICIAL PHOTOSYNTHESIS
- REUSABLE ROCKETRY
- AQUAPONICS
- BIOMETRIC SENSORS
- HYPERLOOP
- 4D-5D PRINTING
- VISIBLE LIGHT COMMUNICATIONS
- BIOELECTRONICS
- BIOPHOTONICS
- PHOTONICS
- SYNTHETIC BIOLOGY
- GENETIC ENGINEERING
- ADVANCED MATERIALS
- QUANTUM COMPUTING
- ENERGY STORAGE
- VIRTUAL REALITY
- VERTICAL FARMING
- PRECISION AGRICULTURE

# 1 / DIGITAL HEALTH / AI



# Hype Cycle Of The Top 50 Emerging Digital Health Trends In 2021

- Much progress not expected
- Moderate progress expected
- Significant progress expected



## Top 10 AI Applications



Robot-Assisted Surgery\*\*

**\$40B**



Virtual Nursing Assistants

**\$20B**



Administrative Workflow Assistance

**\$18B**



Fraud Detection

**\$17B**



Dosage Error Reduction

**\$16B**



Connected Machines

**\$14B**



Clinical Trial Participant Identifier

**\$13B**



Preliminary Diagnosis

**\$5B**



Automated Image Diagnosis

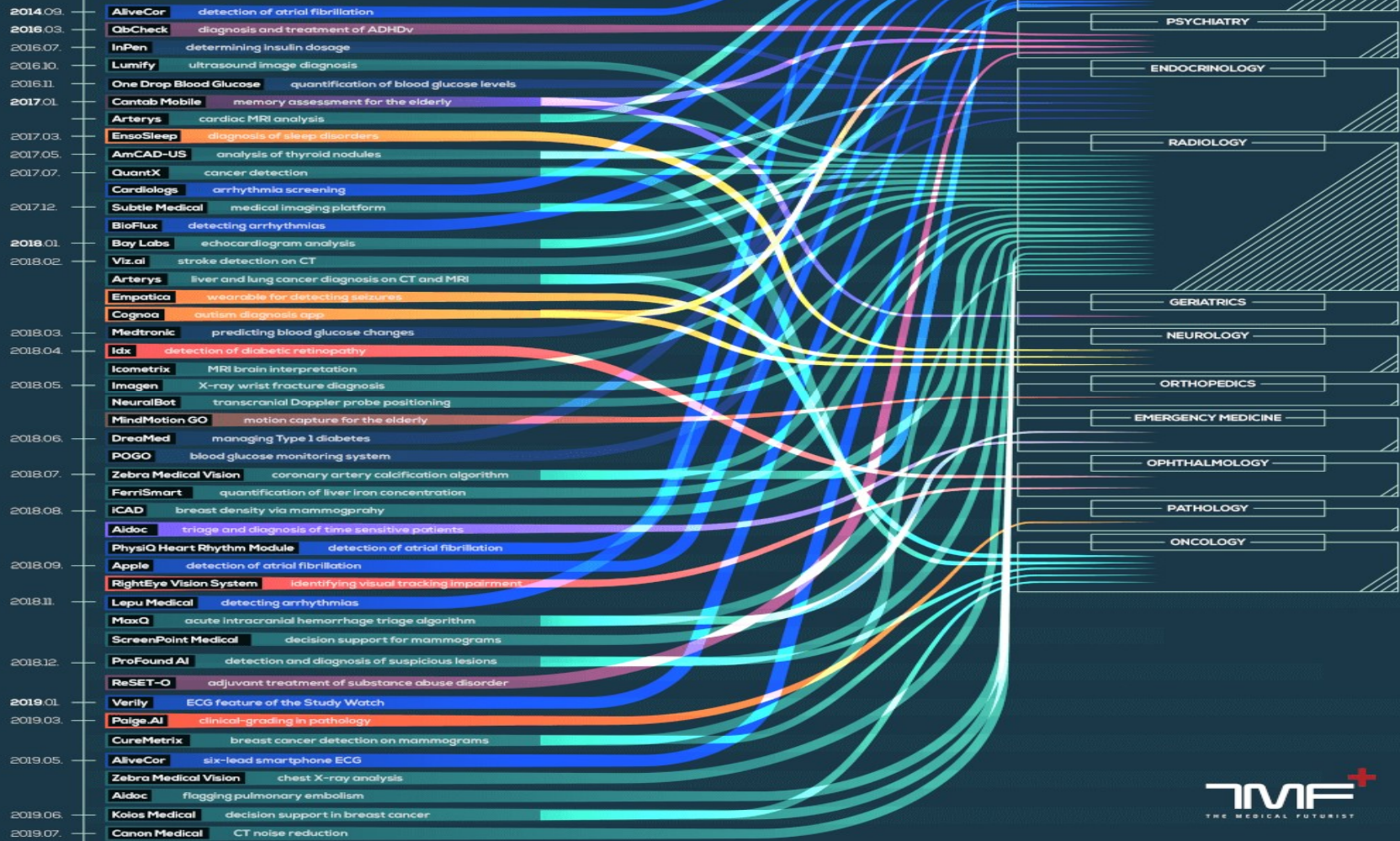
**\$3B**



Cybersecurity

**\$2B**

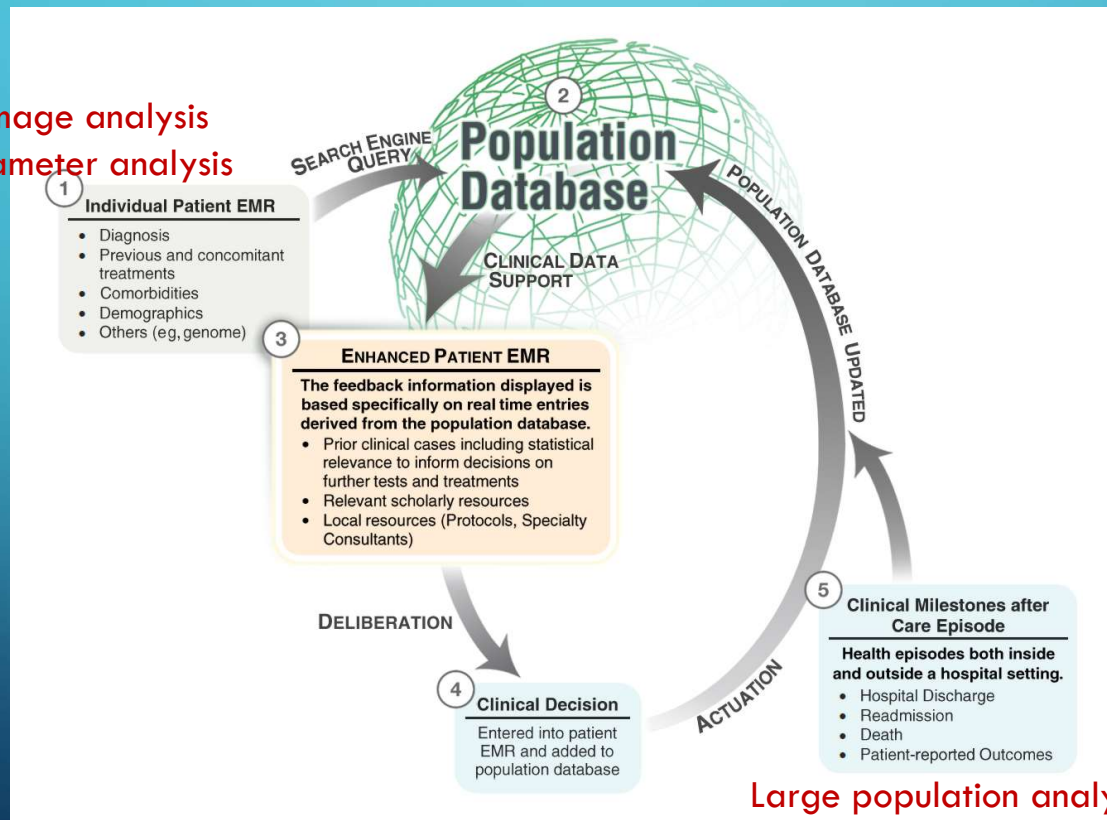
# FDA APPROVALS FOR ARTIFICIAL INTELLIGENCE-BASED ALGORITHMS IN MEDICINE





# ARTIFICIAL INTELLIGENCE & DECISION SUPPORT ENHANCED EMR

Assisted Image analysis  
Multi-parameter analysis

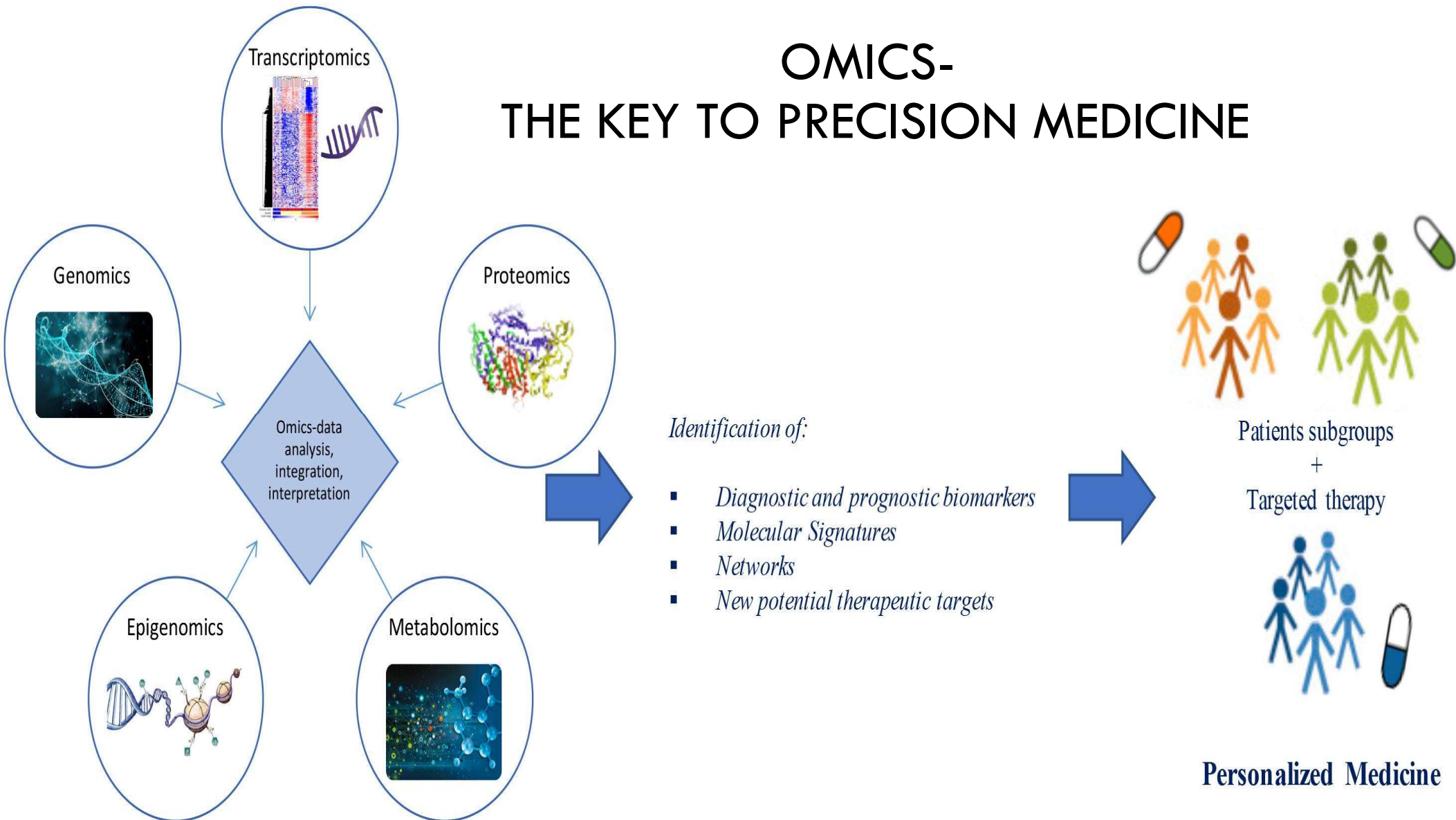


Large population analysis

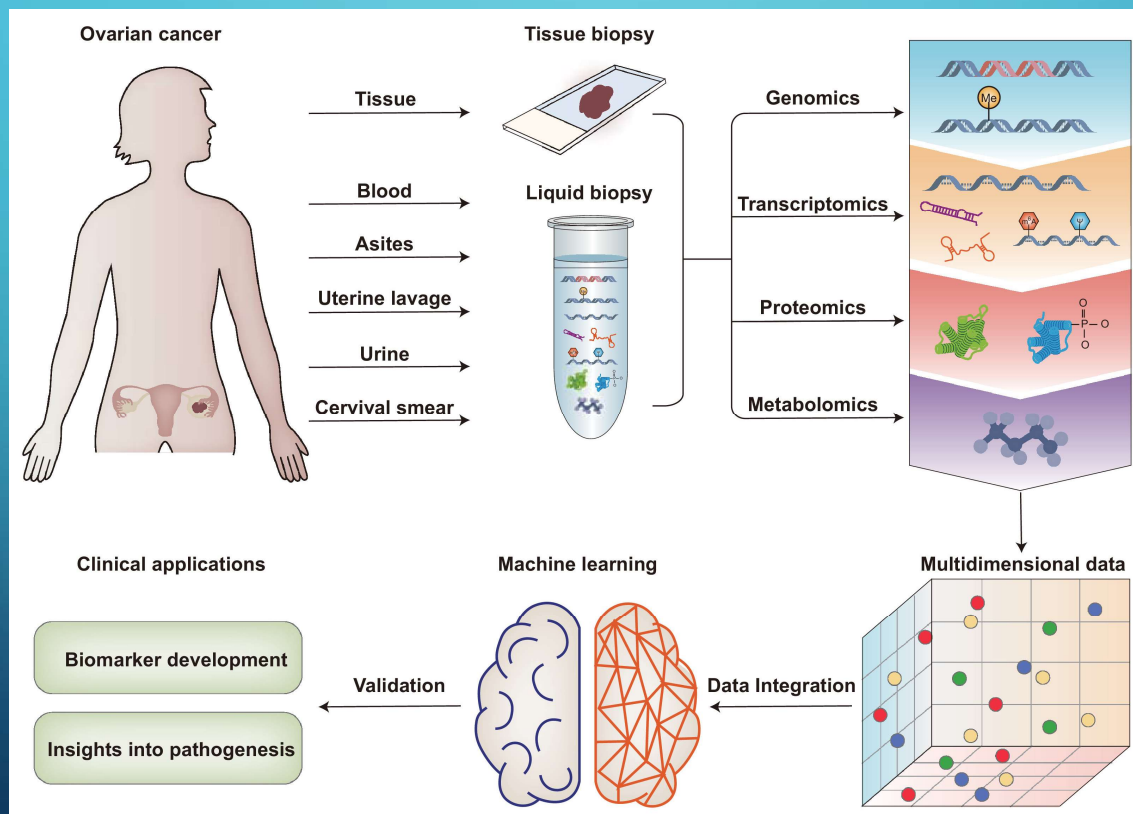


## 2 / OMICS

# OMICS- THE KEY TO PRECISION MEDICINE



# OMICS TO PATHOGENESIS TO TREAT



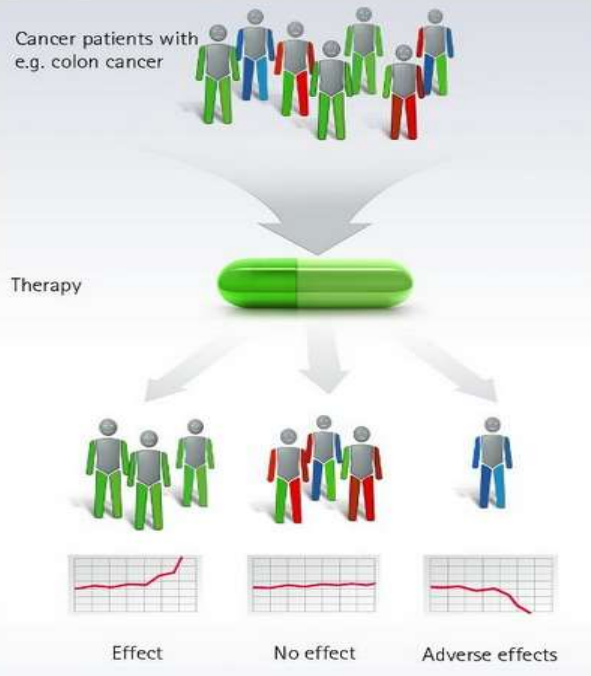
# 3/ PERSONALIZED MEDICINE



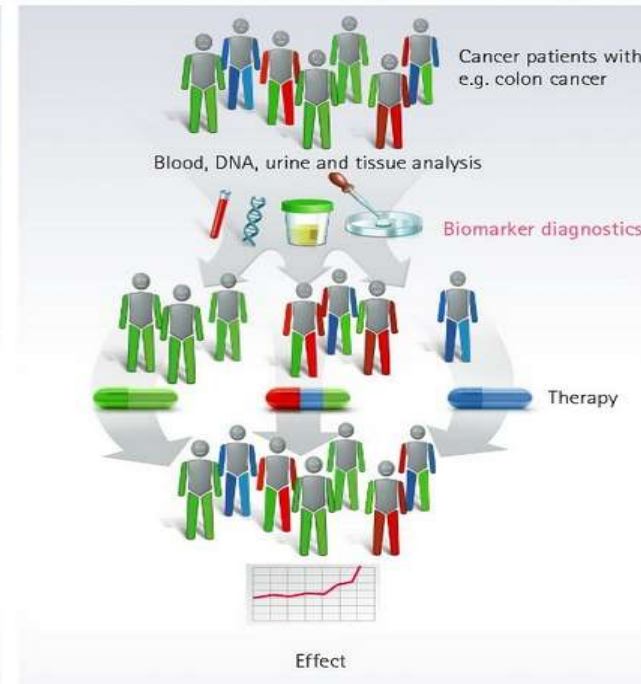
# MOLECULAR DIAGNOSTIC & TARGETED TREATMENT

## Personalized medicine: tailored treatments

Medicine of the present: one treatment fits all

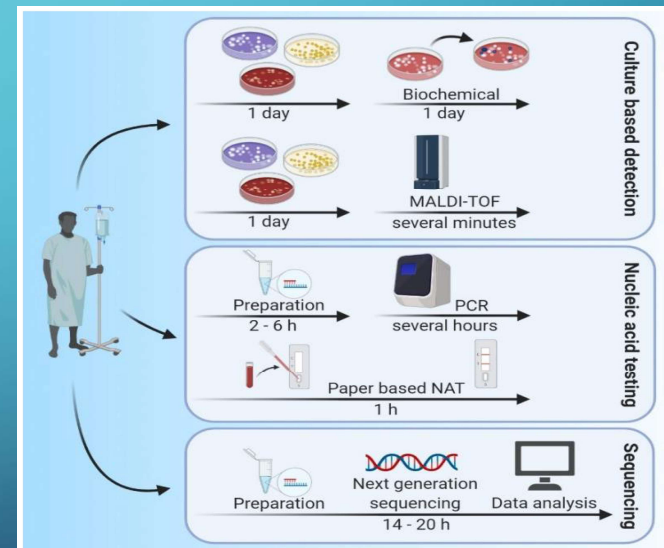
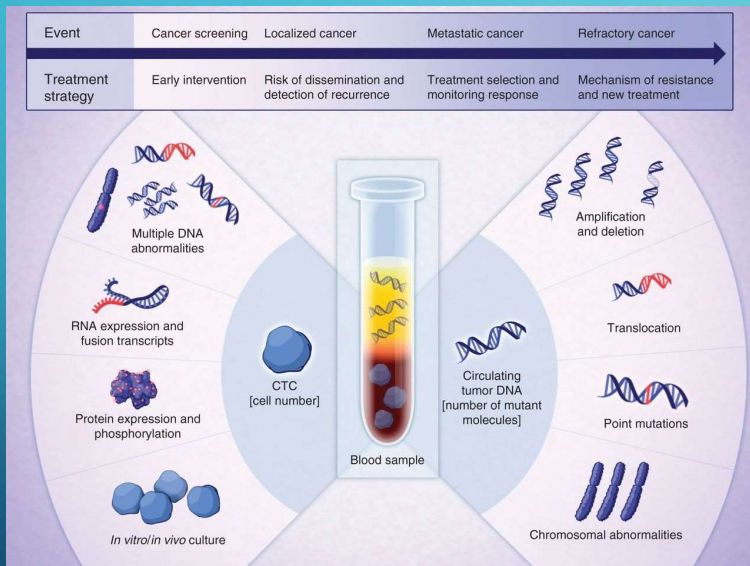


Medicine of the future: more personalized diagnostics

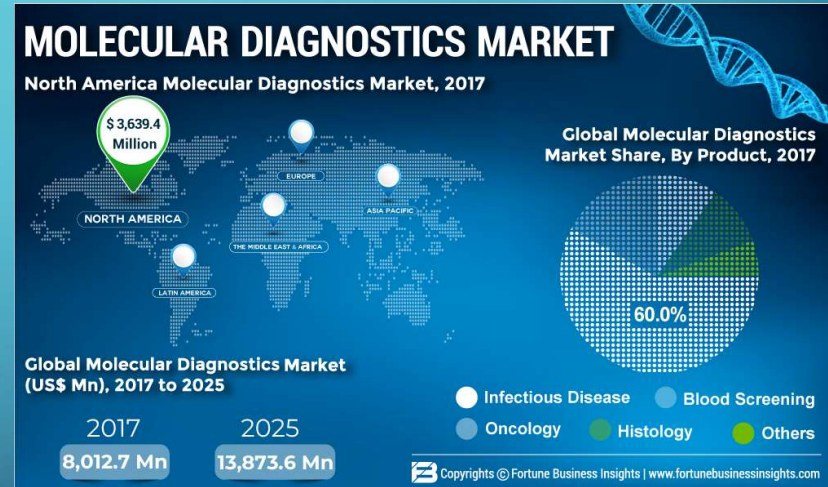
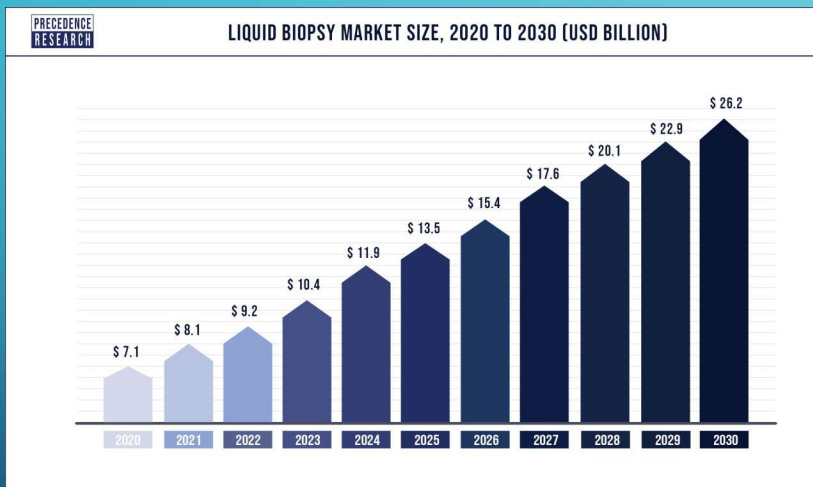


Source: Bayer Healthcare website

# MOLECULAR DIAGNOSIS / LIQUID BIOPSY



# THE PROSPECTS

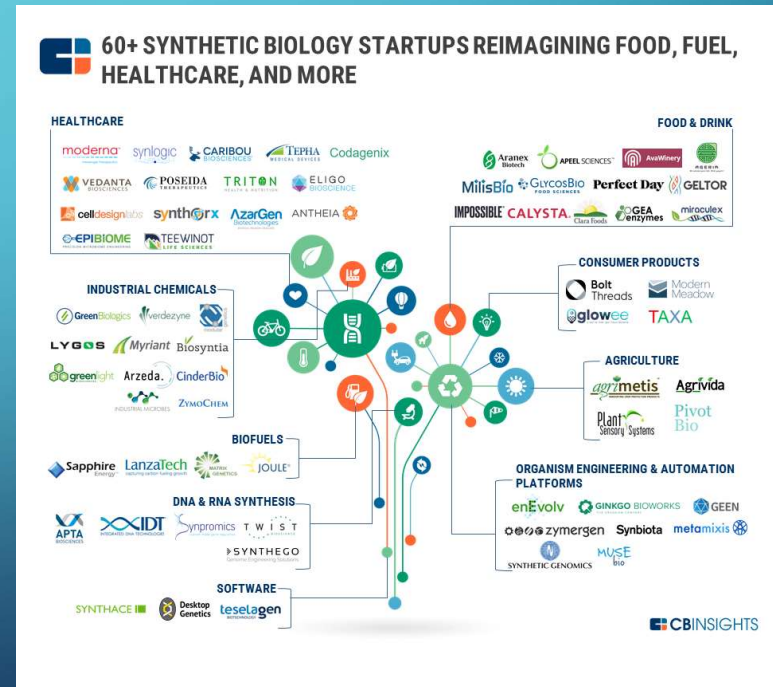
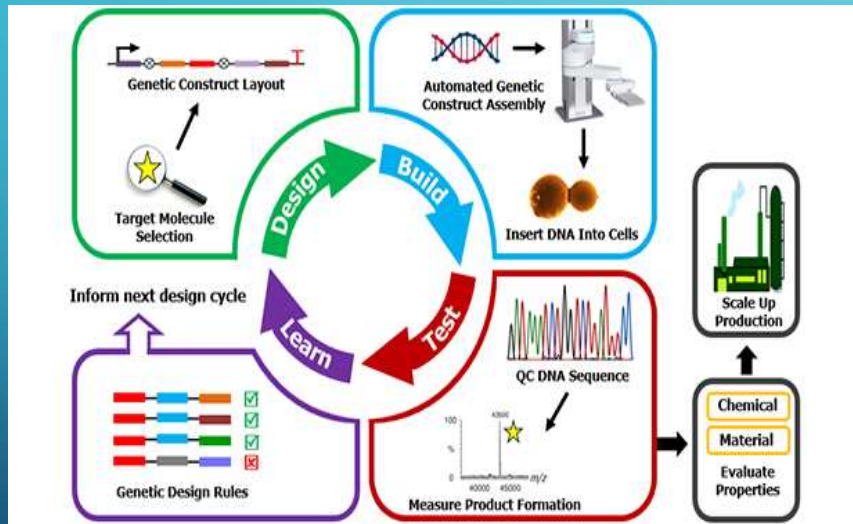




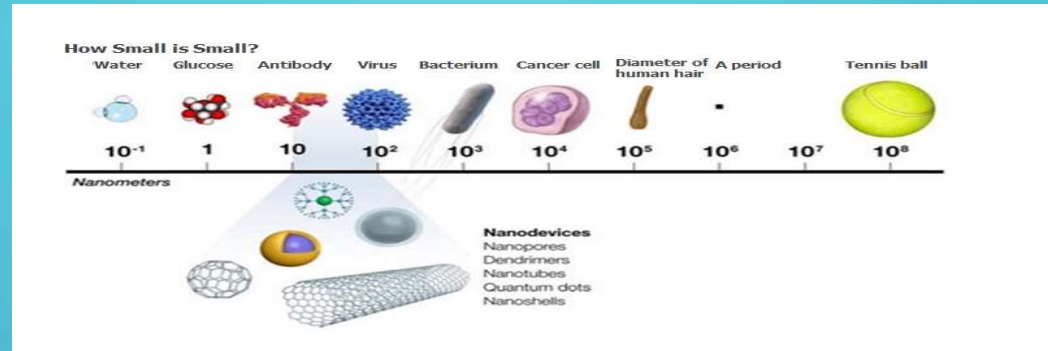
# 4/ SYNTHETIC BIOLOGY & NANOMEDICINE



# SYNTHESIS OF BIOMOLECULES

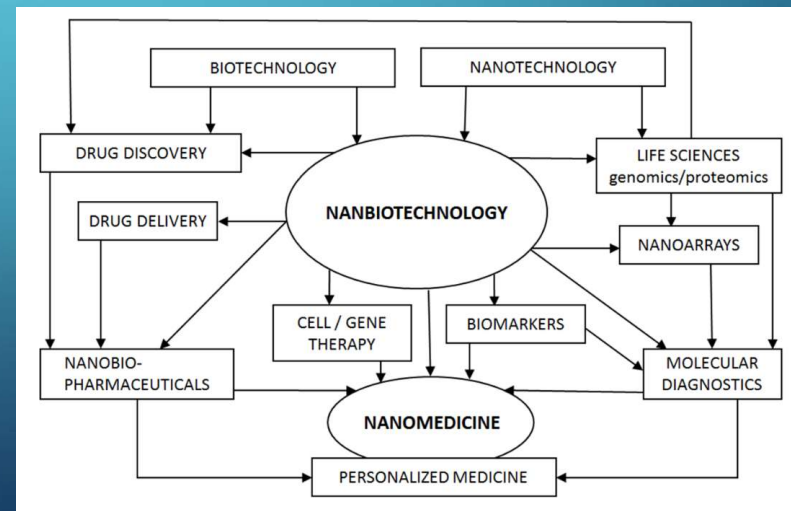


# NANOMEDICINE



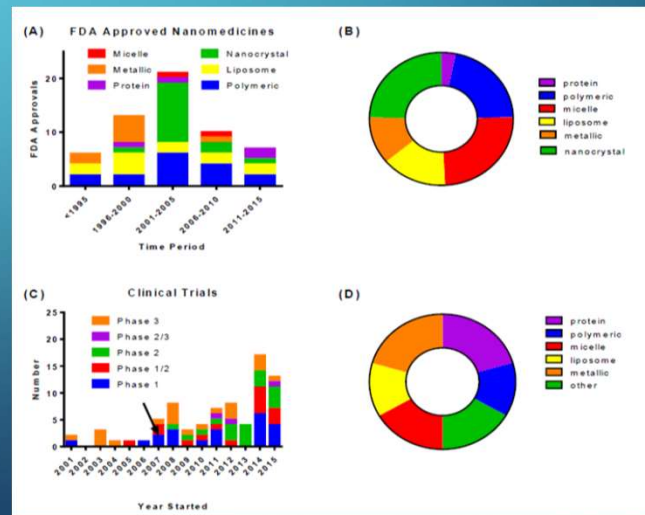
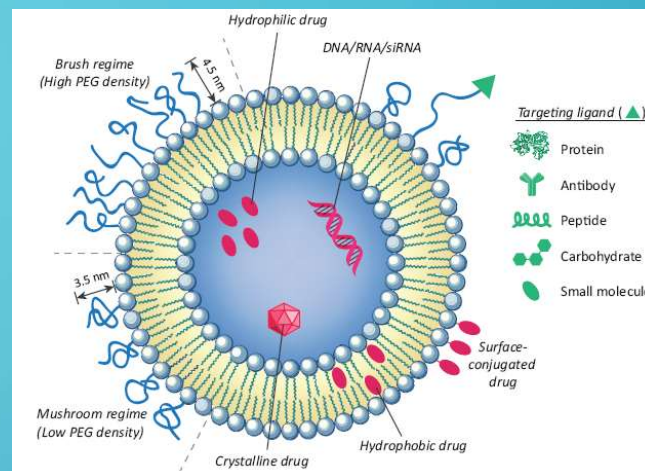
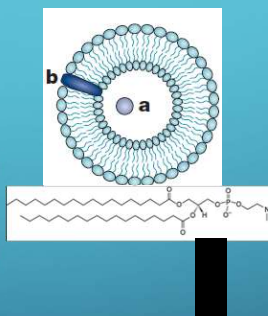
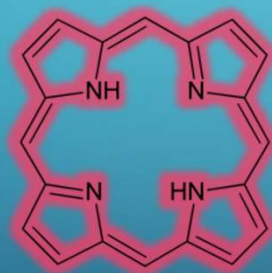
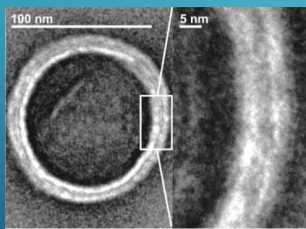
Nanomaterials, Biological Devices, Nanoelectronic Biosensors, Nanobots

- Drug Delivery
- Teranostics
- Nanobiosensors
- Nanobots



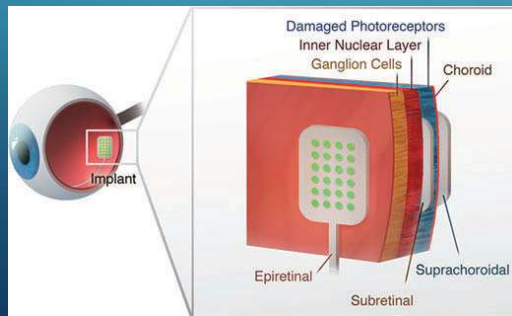
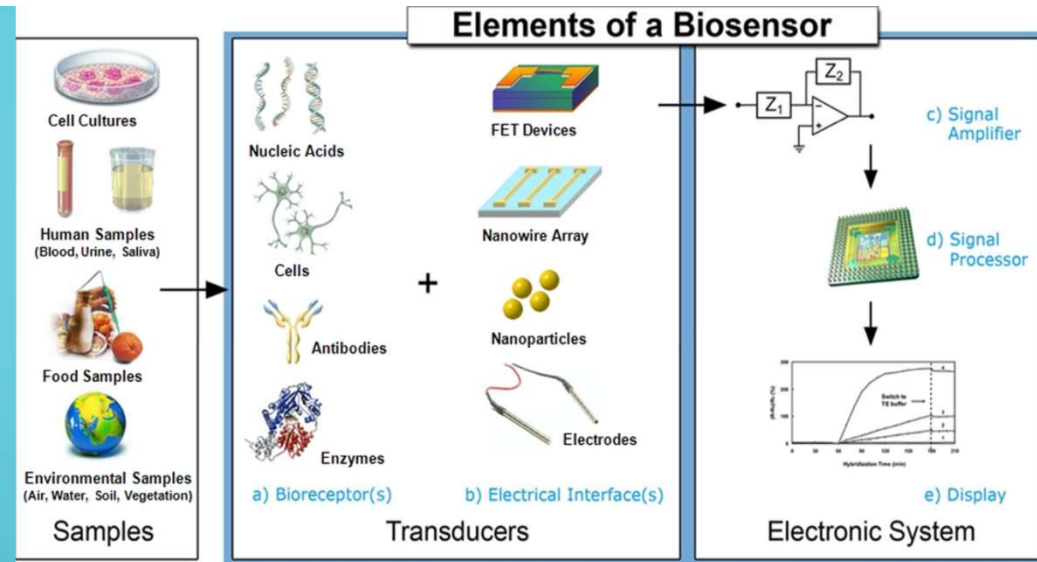
# TARGETED DRUG DELIVERY

- Lyposomes
- Polymeres
- glycans



# NANOBIOSENSORS

- Chemical, physical, biological
- Molecules (incl nuc ac)
- Closed loop

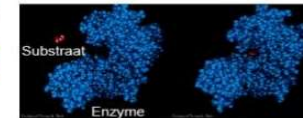


## Biosensor classification (receptor-based)

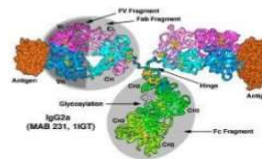
### DNA-sensor



### Enzyme sensor



### Immuno-sensor

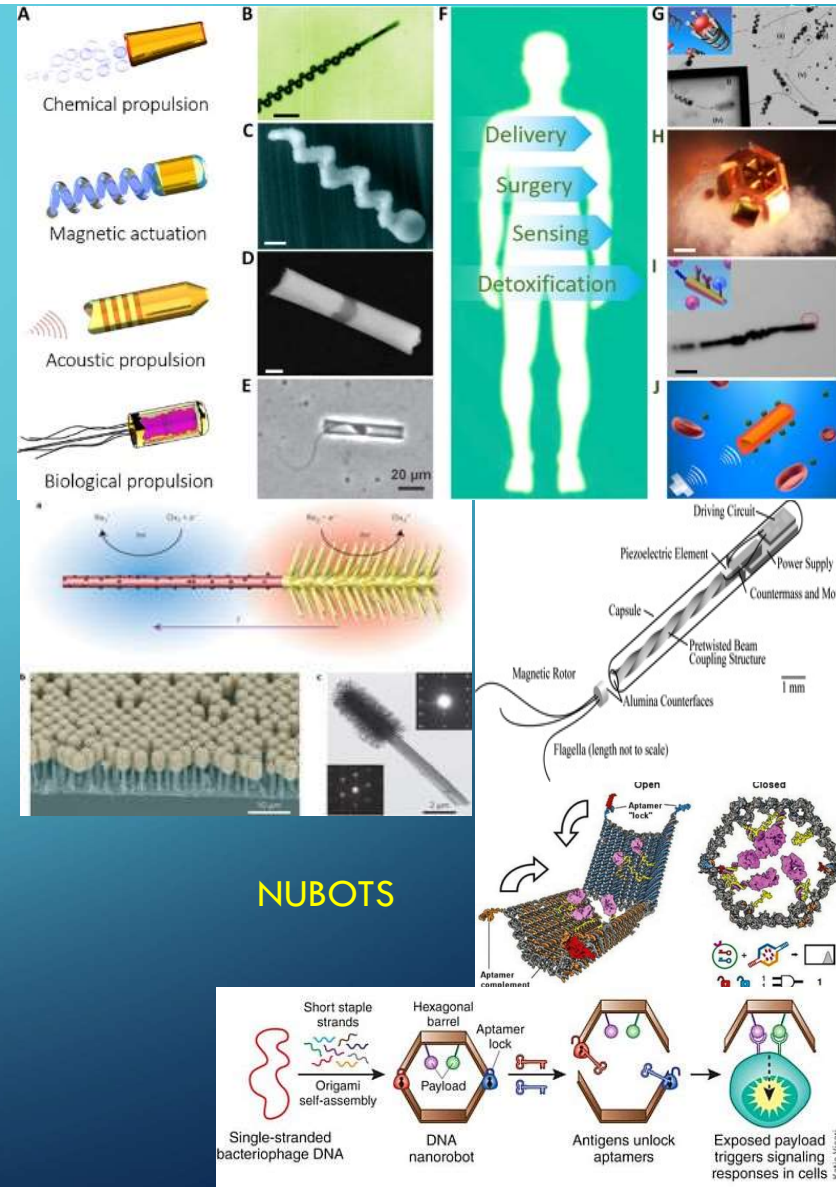


### Whole-cell biosensor

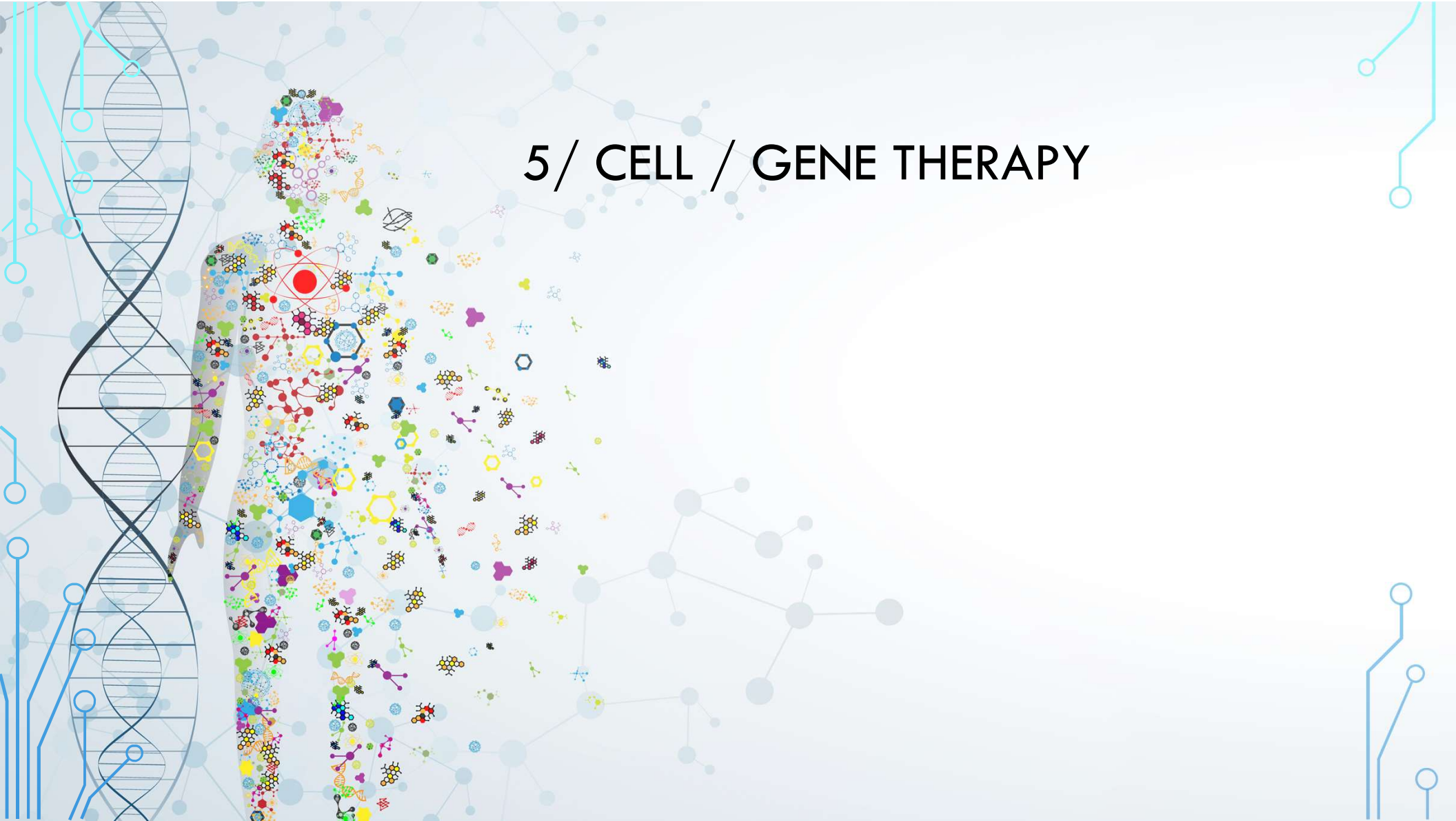


# NANOBOTS

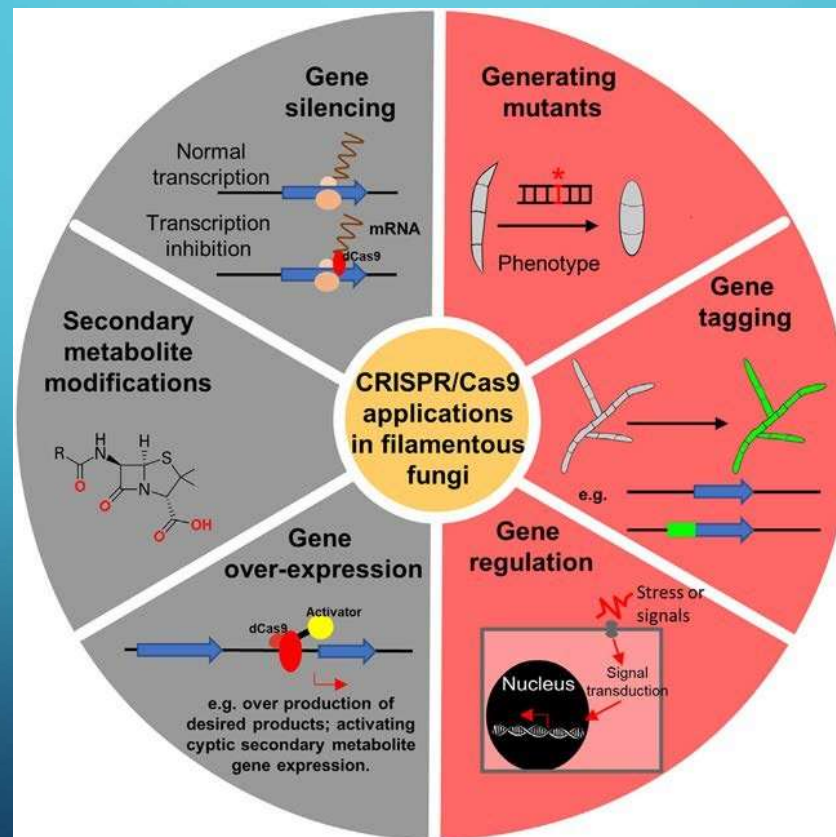
- robots that carry out a very specific function and are ~50–100 nm wide.
- They can be used very effectively for drug delivery.
- Nanoelectronics, photolithography, and new biomaterials



# 5 / CELL / GENE THERAPY

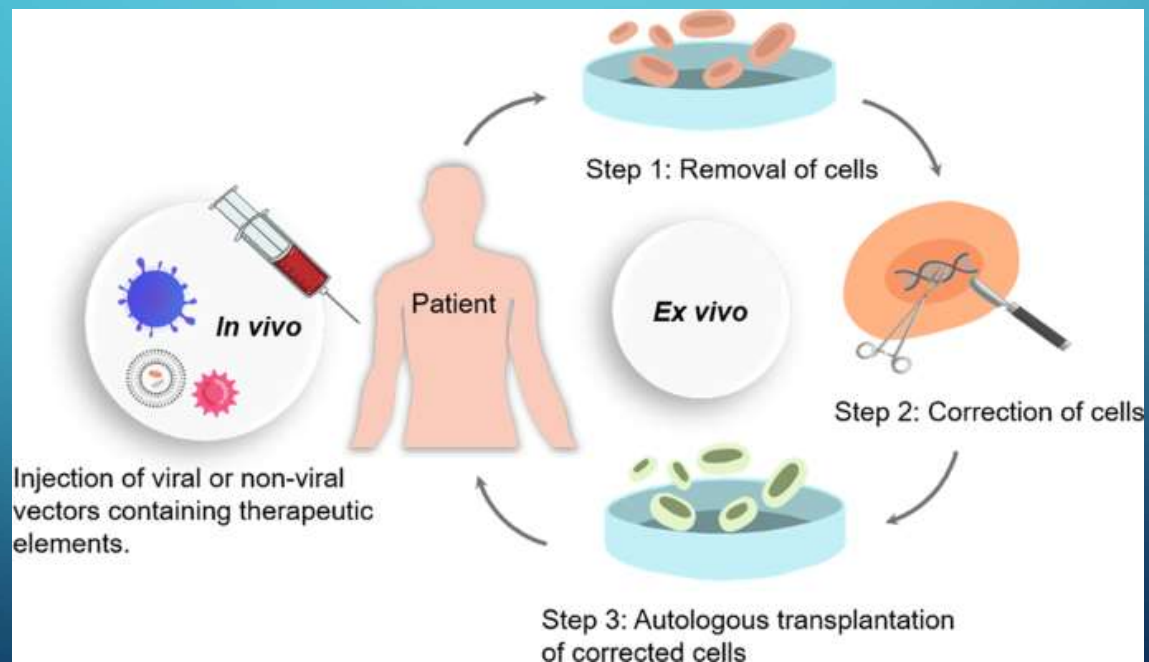


# CELL THERAPY / GENE-EDITING













































# THE TECHNOLOGY

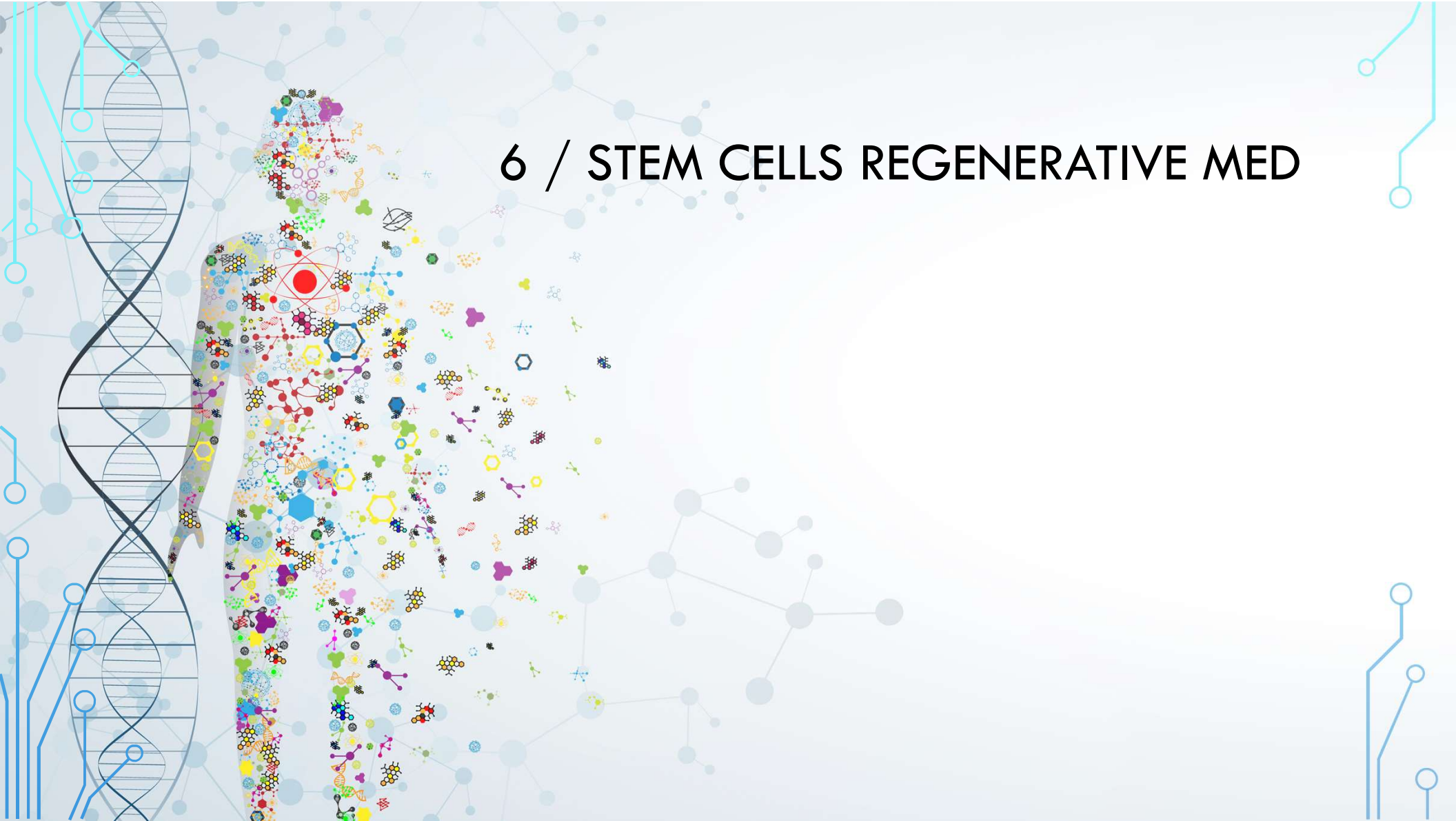


**Gene Editing Business Development Deals**

Date/s	Companies	Agreement Details	# of Indications	Type	Upfront	Milestones
2021	AbbVie - Caribou  	Discover and develop allogeneic CAR-T cell therapies using Caribou's Cas12a CRISPR hybrid chRNA	4	Allo-CAR T	\$40M	\$300M
2021	Apellis - Beam  	Discover novel therapies for complement-driven diseases using base editing	6	C3, Eye, Liver, Brain	\$75M	u/d
2022	Bayer - Mammoth  	Discover and develop in vivo CRISPR-based gene editing therapies	5	Liver-targeted	\$40M	\$1B
2021	Biogen - Scribe  	Discover and develop CRISPR-based genetic medicines for neurological diseases	2	ALS, Neuro	\$15M	\$400M
2015, 2019	BMS - Editas  	Develop and commercialize autologous and allogeneic T-cell therapies for cancer and autoimmune diseases	-	Alpha-Beta T cells	\$25M + \$70M	\$22M
Jul-05	CRISPR - ViaCyte  	Discovery, development, commercialization of gene-edited stem cell therapies for diabetes	1	diabetes	\$15M	\$10M
2021	Epsilen Bio - Chroma Medicine  	Chroma acquires Epsilen Bio for epigenetic editing	-	-	u/d	N/A
2020	LifeEDIT - ElevateBio  	ElevateBio acquires LifeEDIT for its next-generation gene-editing platform	-	-	u/d	N/A
2022	Pfizer - Beam  	Discover and develop in vivo base-editing therapies	3	Liver, muscle, CNS	\$300M	\$1.05B
2021	Moderna - Metagenomi  	Discover and develop next-generation in vivo gene-editing therapeutics	u/d	u/d	u/d	u/d
2021	Nkarta - CRISPR  	Develop and commercialize gene-edited cell therapies for cancer	7	CD70 tumor antigen	u/d	u/d
2015 - 2019	Novartis - Intellia  	Discover and develop CRISPR-based therapies using CAR Ts and HSCs	u/d	eye disorders	\$6M + \$10M	u/d
2016, 2020	Regeneron - Intellia  	Discover and develop in vivo and ex-vivo CRISPR-based therapies for up to 10 targets including hemophilia A and B	15	Hemophilia A and B	\$75M + \$70M	\$50M
2022	Rewrite - Intellia  	Intellia acquired Rewrite to obtain its proprietary DNA writing platform	-	-	\$200M	N/A
2021	Sana - Beam  	Sana licenses Beam's CRISPR Cas12b gene-editing technology to enable engineered cell programs	u/d	Cancer, diabetes, cardio	\$50M	u/d
2018, 2021	Vertex - Arbor Bio  	Develop ex vivo cell therapies using Arbor's CRISPR gene-editing technology	u/d	T1 diabetes, SCD, BT	\$30M	\$1.2B
2015, 2019, 2021	Vertex - CRISPR  	Discover and develop CRISPR-based therapies with amendment toward manufacturing and commercialization of CTX001 in SCD and BT; DMD, DM1	4	SCD, BT, DMD, DM1	\$105M + \$171M + \$900M	\$200M
2015, 2022	Vertex - Exonics Therapeutics  	Vertex acquires Exonics Therapeutics to enhance its gene-editing capabilities for DMD and DM1	2	DMD, DM1	\$254M	Up to \$1B
2021	Vertex - Mammoth  	Discovery and develop in vivo gene-editing therapies	2	u/d	\$41M	\$650M
2021	Verve - Beam  	Discover and develop gene-editing therapies for heart disease	2	HeFH, HoFH	u/d	u/d

Source: Company reports; William Blair Equity Research

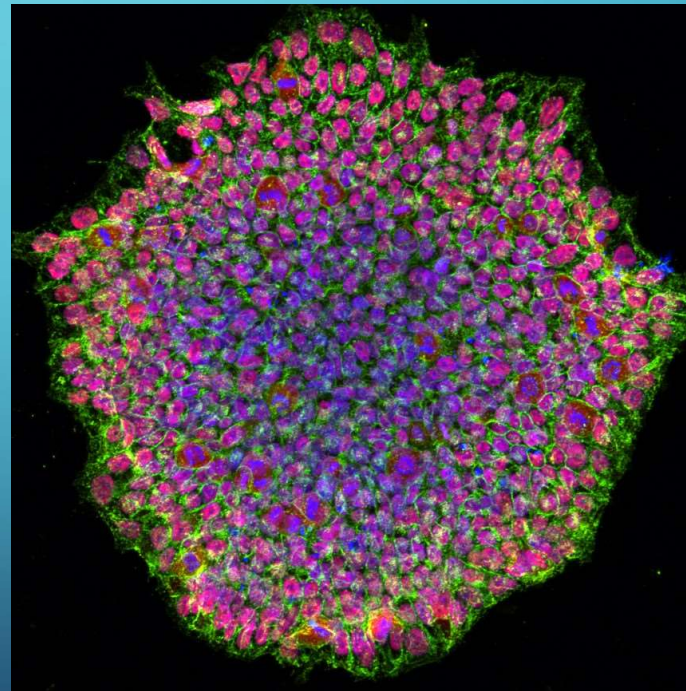
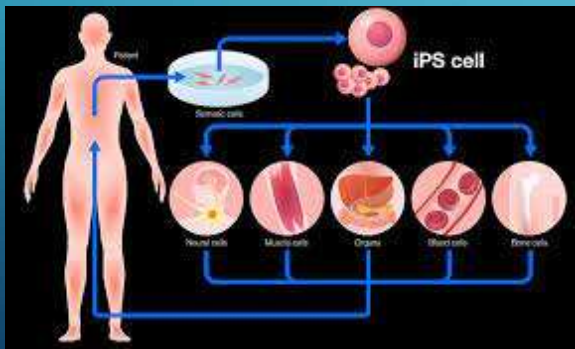
# 6 / STEM CELLS REGENERATIVE MED

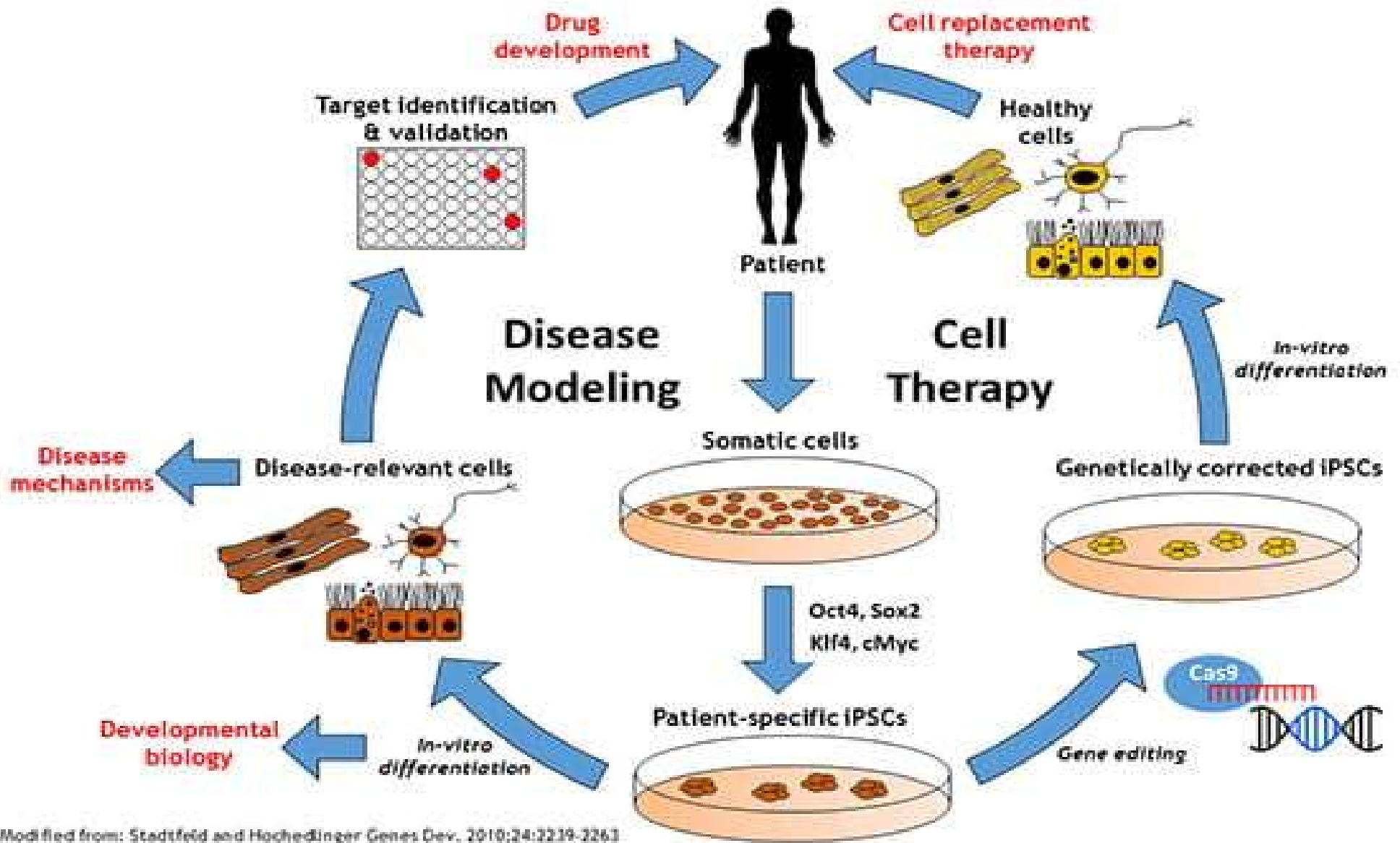


# STEM CELLS & REG MED

## IPSC

### Induced Pluripotent Stem Cells

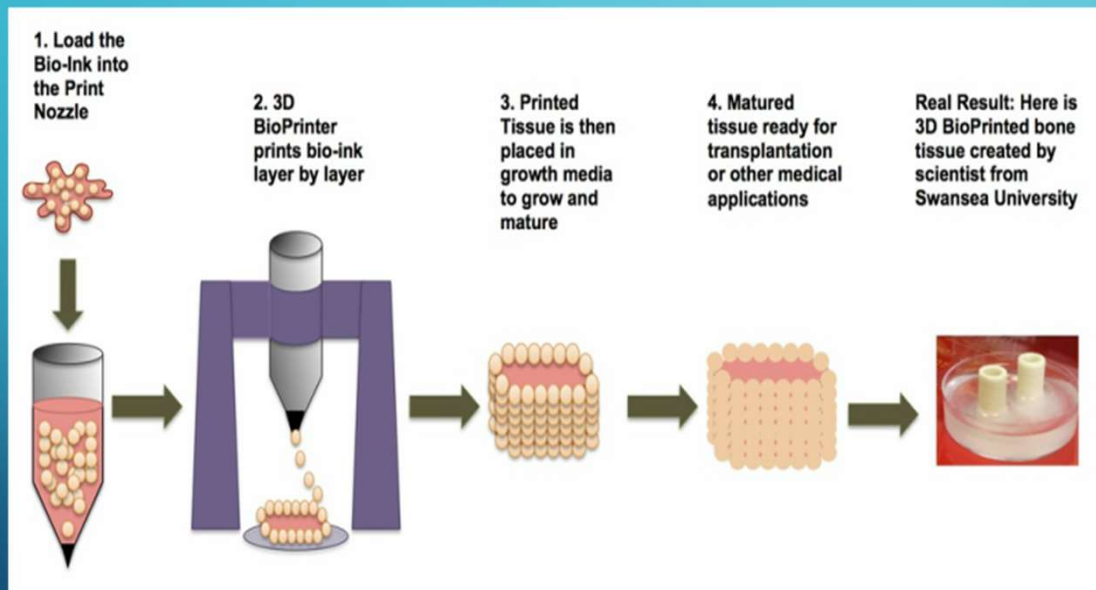




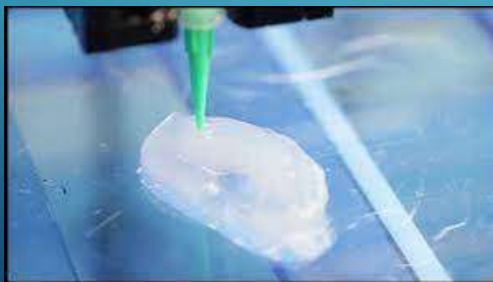
# 7/ BIOPRINTING



# 3D BIOPRINTING



# BIOPRINTED TISSUES



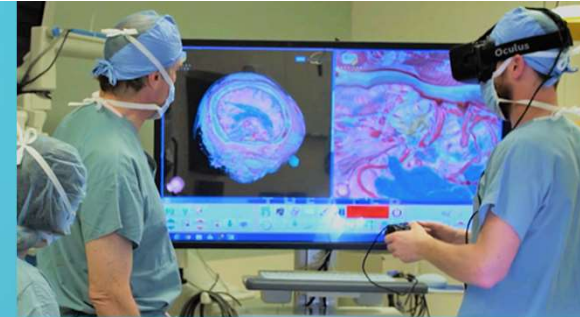


# 8/ ADVANCED IMAGING

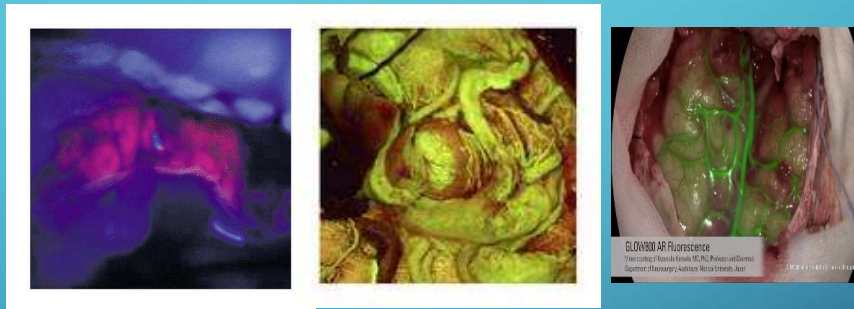


# VIRTUAL/AUGMENTED REALITY

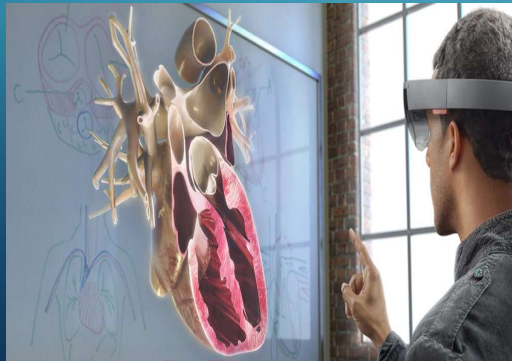
Accuvein



## Augmented-reality surgical procedures



## VR imaging



## Augmented-reality surgical navigation



# MEDICAL HOLOGRAPHY



## MEDICAL HOLOGRAPHY MARKET ANALYSIS

### Market Taxonomy :

#### By Technique

- X-ray Holography
- Endoscopic Holography
- Hologram Recording Endoscope
- Multiplexed Holography
- Light-in-flight Holography

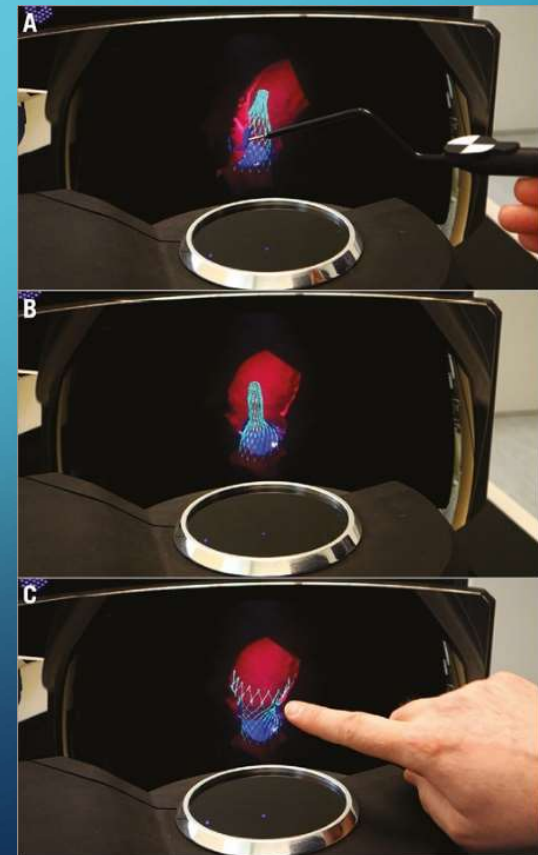
#### By Hologram Type

- Reflection Hologram
- Transmission Hologram
- Hybrid Hologram
  - Embossed Holograms
  - Integral Holograms
  - Holographic Interferometry
  - Multichannel Holograms
  - Computer-generated Holograms

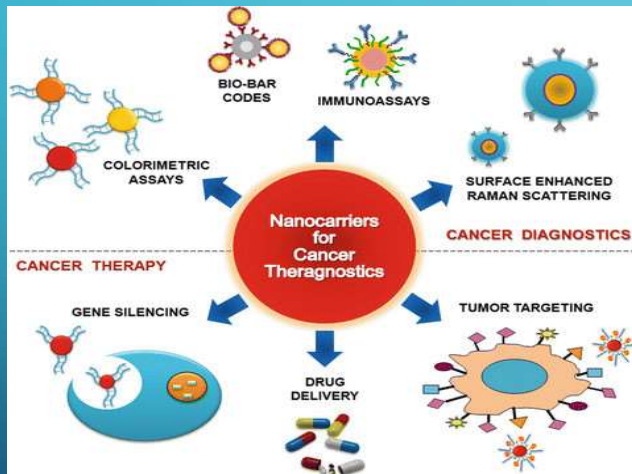
### Major Players Operating :

- |                                |                                |               |
|--------------------------------|--------------------------------|---------------|
| ▶ HoloTech Switzerland AG      | ▶ Lyncee Tec                   | ▶ EON Reality |
| ▶ Hologica Limited             | ▶ EchoPixel                    | ▶ AUGmedics   |
| ▶ RealView Imaging Ltd         | ▶ Zspace                       | ▶ Nanolive SA |
| ▶ Phase Holographic Imaging AB | ▶ Ovizio Imaging Systems NV/SA |               |

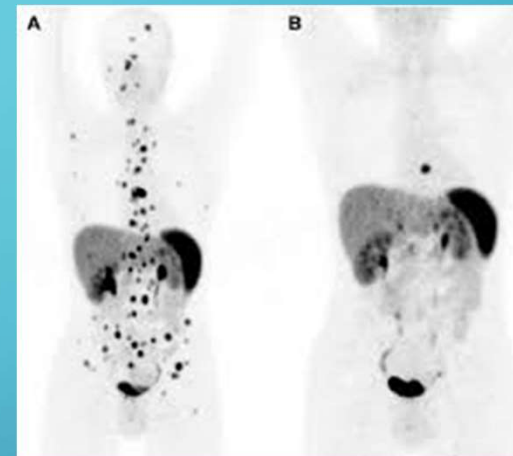
© 2021 Coherent Market Insights Pvt Ltd. All right reservrd.



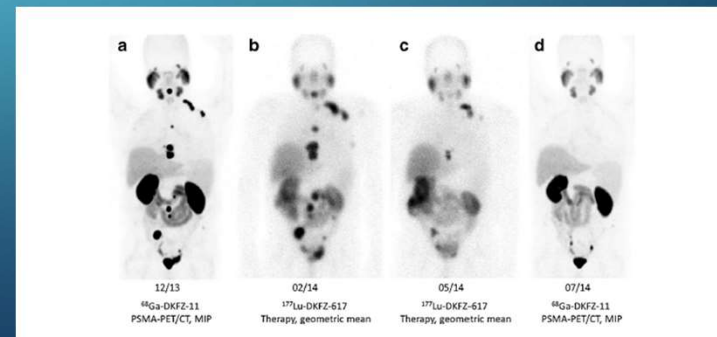
# MOLECULAR IMAGING & TREAT TERANOSTICS



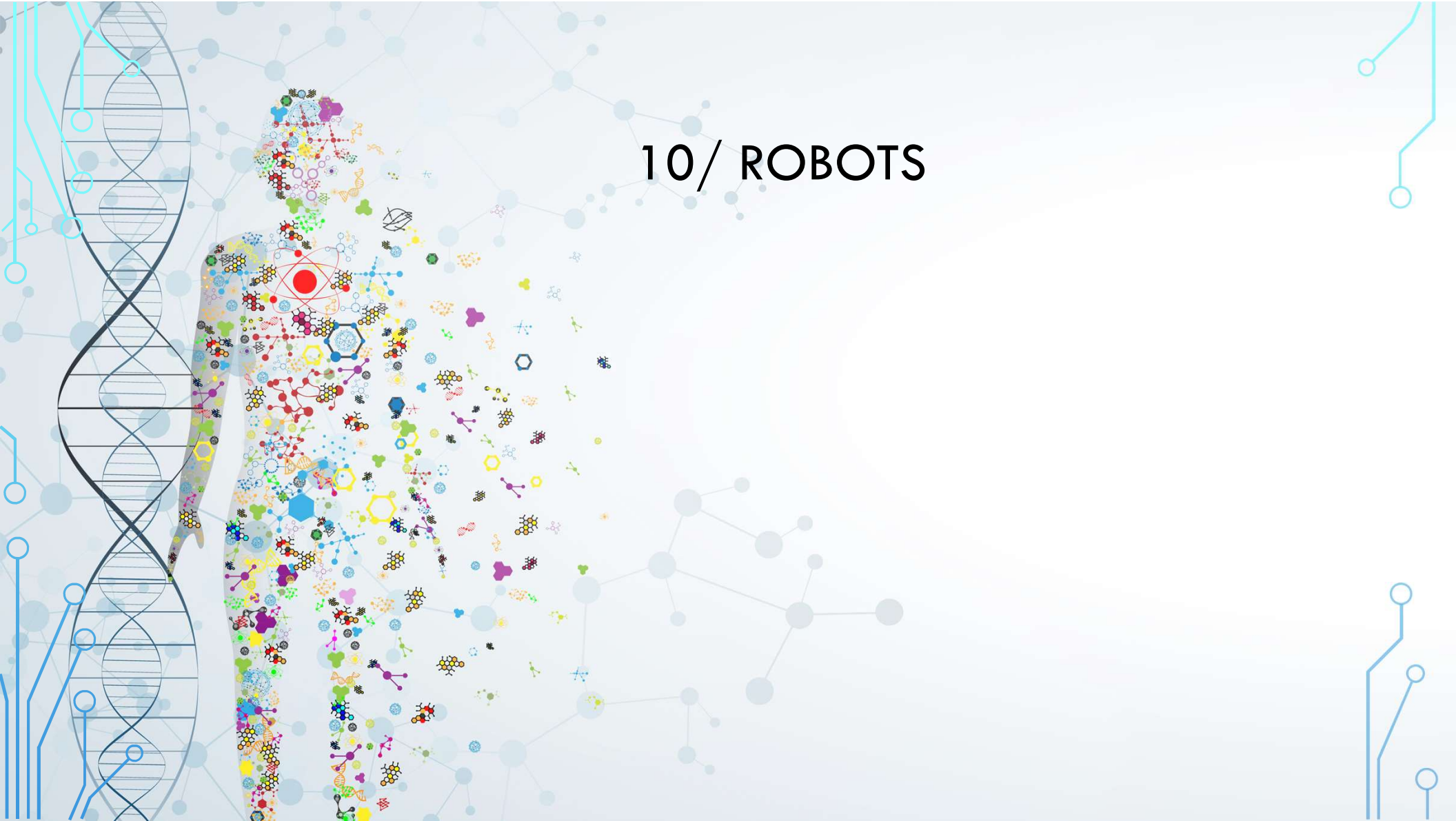
$^{68}\text{Ga}$ -somatostatin receptors



$^{68}\text{Ga}$ -PSMA and therapy with  $^{177}\text{Lu}$ -PSMA



# 10/ ROBOTS



# ROBOTICS

- Unlimited move
- More gentle
- More accurate
- Align to
  - Imaging
  - AR
  - navigation

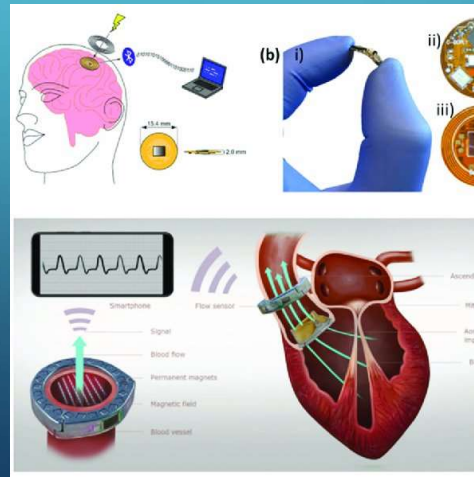
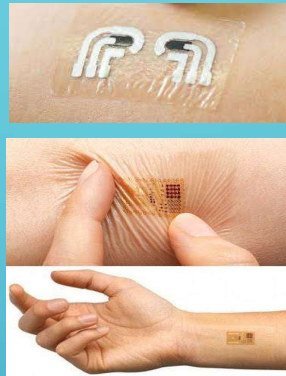


# 9/ SENSORS & MONITORS



# MEDICAL WEARABLES & SENSORS

- Wearable
- Skin
- Implant
- Closed loop





# Envisioning the future of health technology

Technology is the ultimate democratizing force in society. Over time, technology raises lowest common denominators by reducing costs and connecting people across the world. Medical technology is no exception to this trend: previously siloed repositories of information and expensive diagnostic methods are rapidly finding a global reach and enabling both patients and practitioners to make better use of information.

This visualization is an exercise in speculating about which individual technologies are likely to affect the scenario of health in the coming decades. Arranged in six broad areas, the forecast covers a multitude of research and developments that are likely to disrupt the future of healthcare.

**Augmentation**  
 Technological replacements to human features can not only restore senses to those without, but could also enhance conventional attributes into remarkable capabilities.

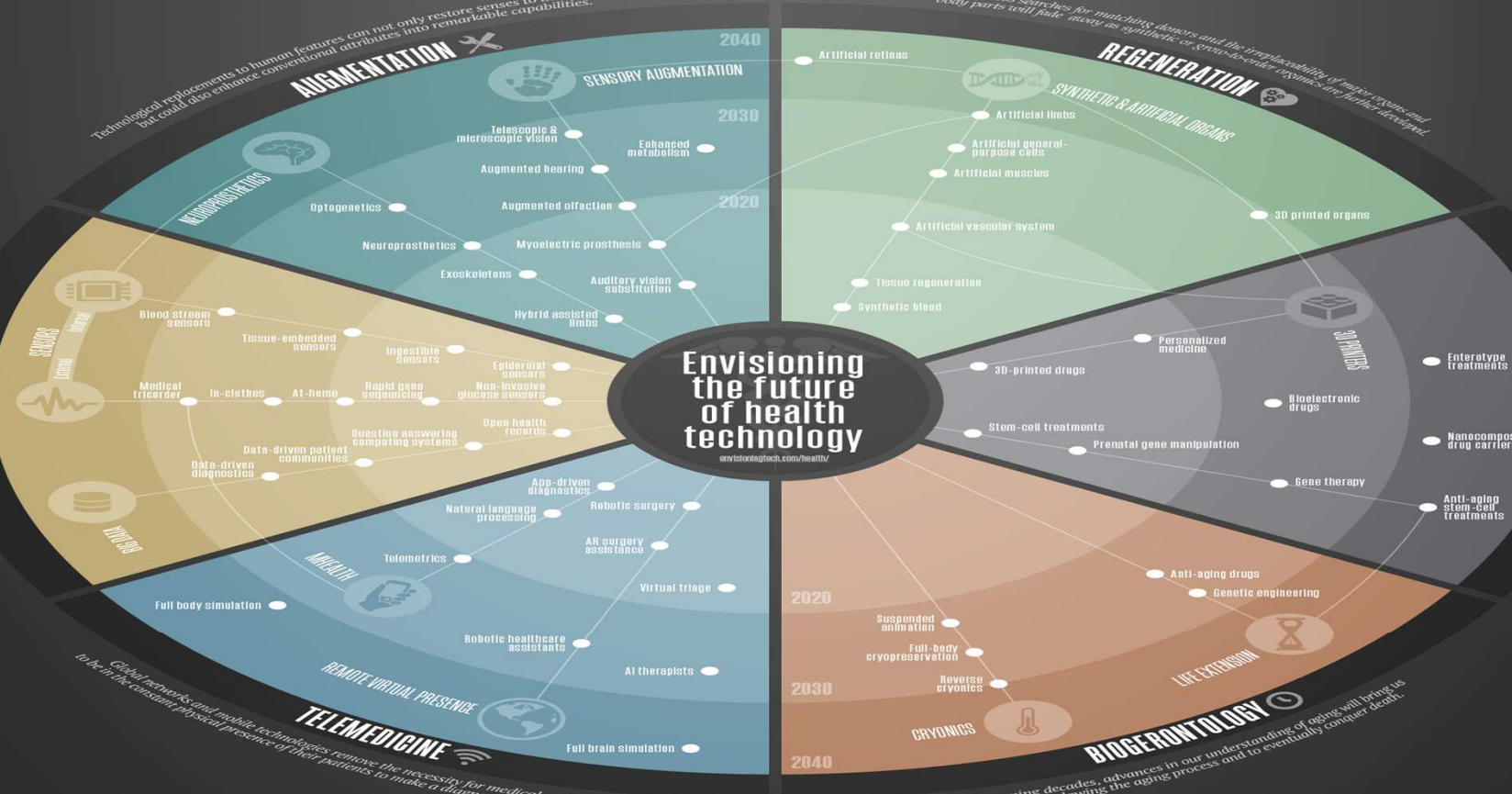
**Regeneration**  
 Hopeless searches for matches, donors and the irreplacability of major organs and body parts will fade away as synthetic or stem-to-ender organs are further developed.

**Treatments**  
 No longer is sufficient to create and manufacture a single, limited drug to cure a population. Customized treatments can be precisely targeted for specific genetic characteristics.

**Telemedicine**  
 Global networks and mobile technologies remove the necessity for medical practitioners to be in the constant physical presence of their patients to make a diagnosis or perform procedures.

**Biogerontology**  
 In coming decades, advances in our understanding of aging will bring us closer to slowing the aging process and to eventually conquer death.

**Envisioning the future of health technology**  
 envisioningtech.com/health/



Updated: September 2012  
 Sources: envisioningtech.com/health/  
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Research & design: **Envisioning Technology**  
 Find out more: [envisioningtech.com/health/](http://envisioningtech.com/health/)





First flight 1903

