



Exploration

(It has a greater impact on medicine than you might think)

J.D. Polk, DO, MS, MMM, CPE, FACOEP, FAsMA

Chief Health and Medical Officer

NASA HQ





JOURNEY TO MARS



HUBBLE

INTERNATIONAL
SPACE STATION

SPACE LAUNCH
SYSTEM (SLS)

ORBITERS

LANDERS

SCIENCE

EXPLORATION

TECHNOLOGY

COMMERCIAL
CARGO AND CREW

ORION

SOLAR
ELECTRIC
PROPULSION

ASTEROID
REDIRECT
MISSION

IN-SPACE
HABITAT

MARS
TRANSFER
SPACECRAFT

PHOBOS
DEIMOS

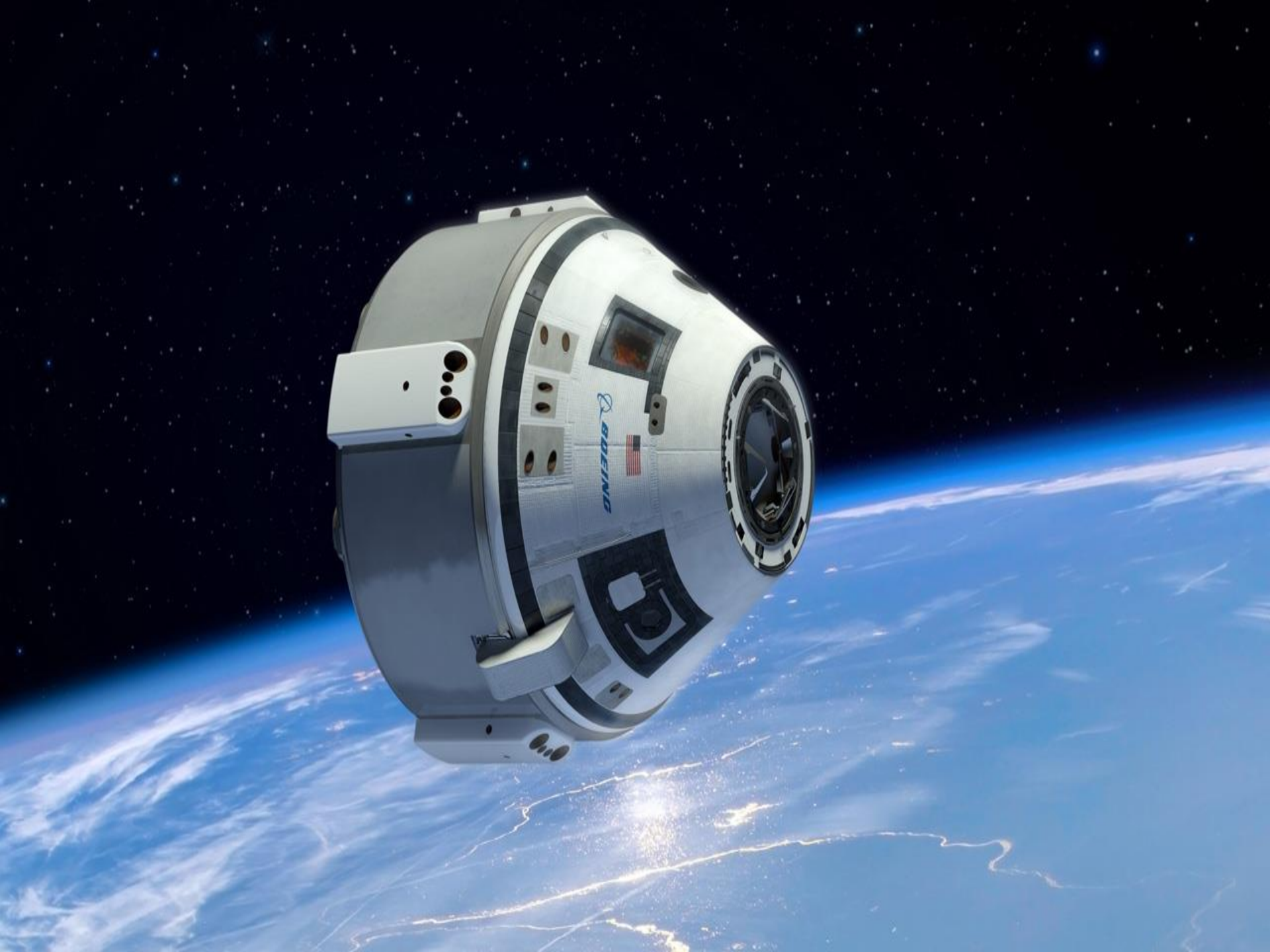


UNCLASSIFIED



SPACEX

DRAGON





Sierra Nevada Dream Chaser
Photo Art by Space News



Bigelow Inflatable Modules

UNCLASSIFIED



www.nasa.gov

NASA's New Spacecraft: The SLS and Orion



EXPLORATION TEST FLIGHTS



PHASE 1



May 2010
PA-1



Dec. 2014
EFT-1



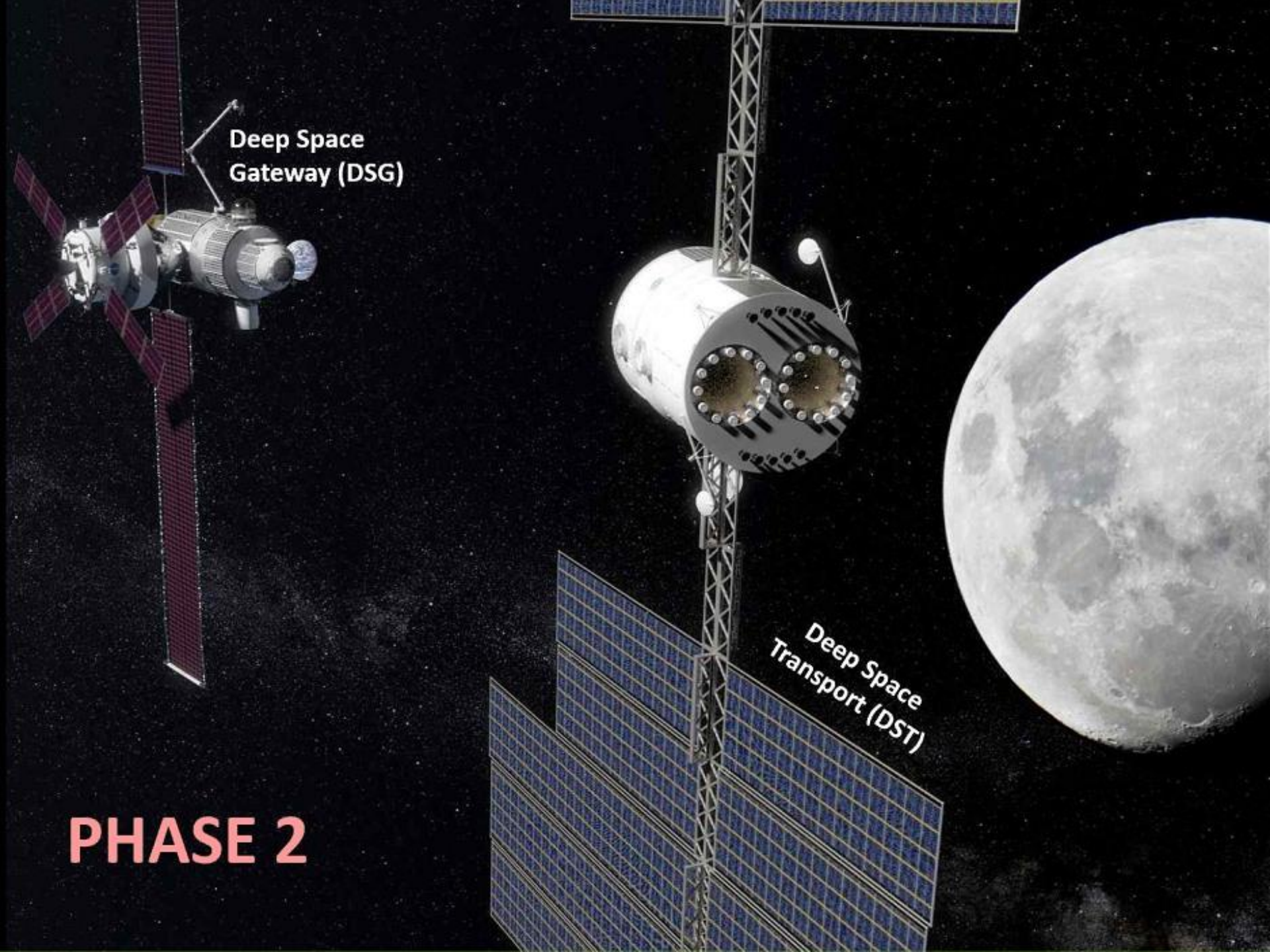
EM-1



AA2



EM-2

An illustration of a spacecraft in deep space. The spacecraft is white with a cylindrical body and a conical nose. It has four large, rectangular solar panels extending from its sides. The background is a dark, starry space with a large, bright moon on the right side. Labels with leader lines point to the spacecraft and the transport vehicle. The text 'PHASE 2' is in the bottom left corner.

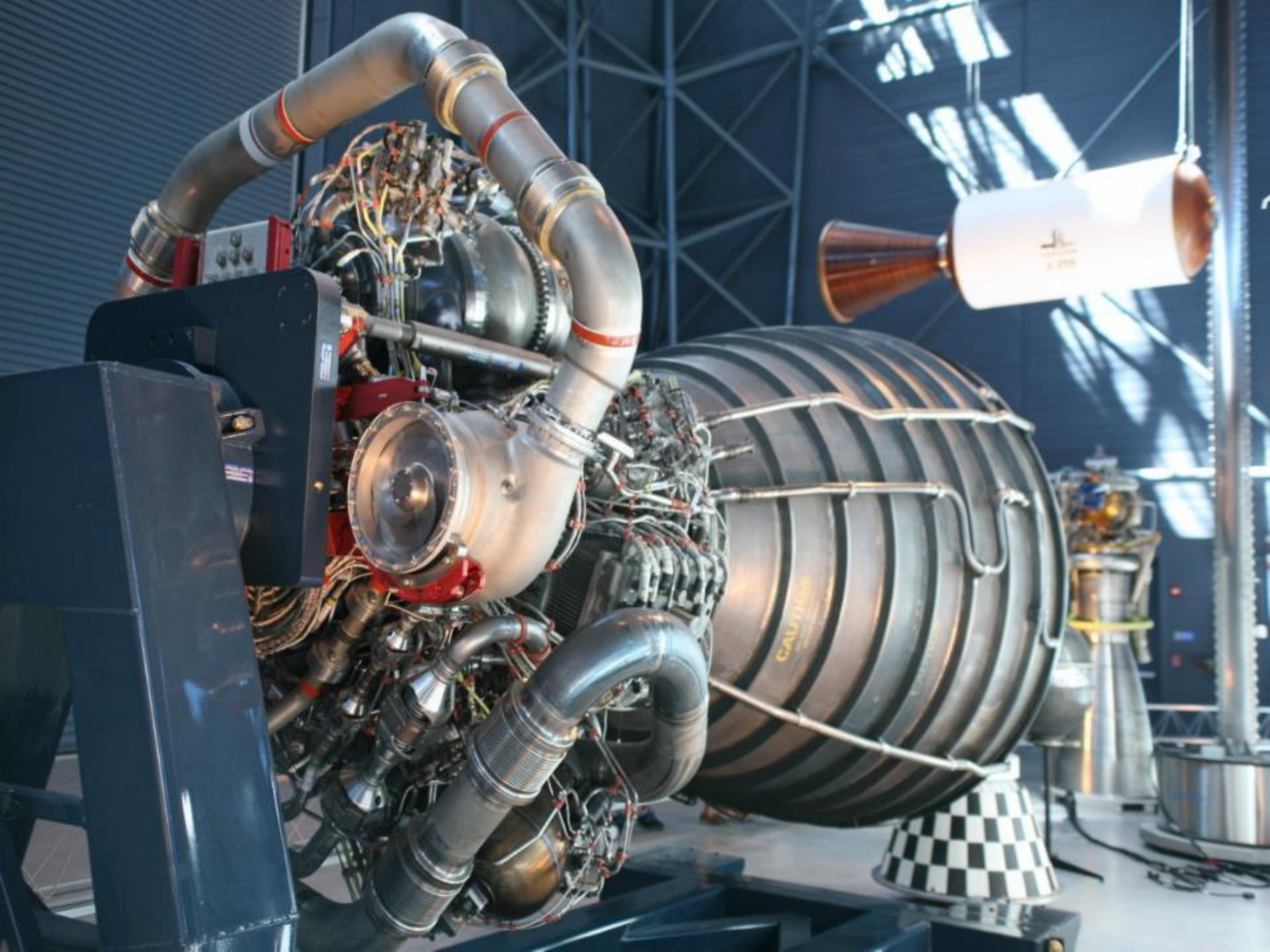
Deep Space
Gateway (DSG)

Deep Space
Transport (DST)

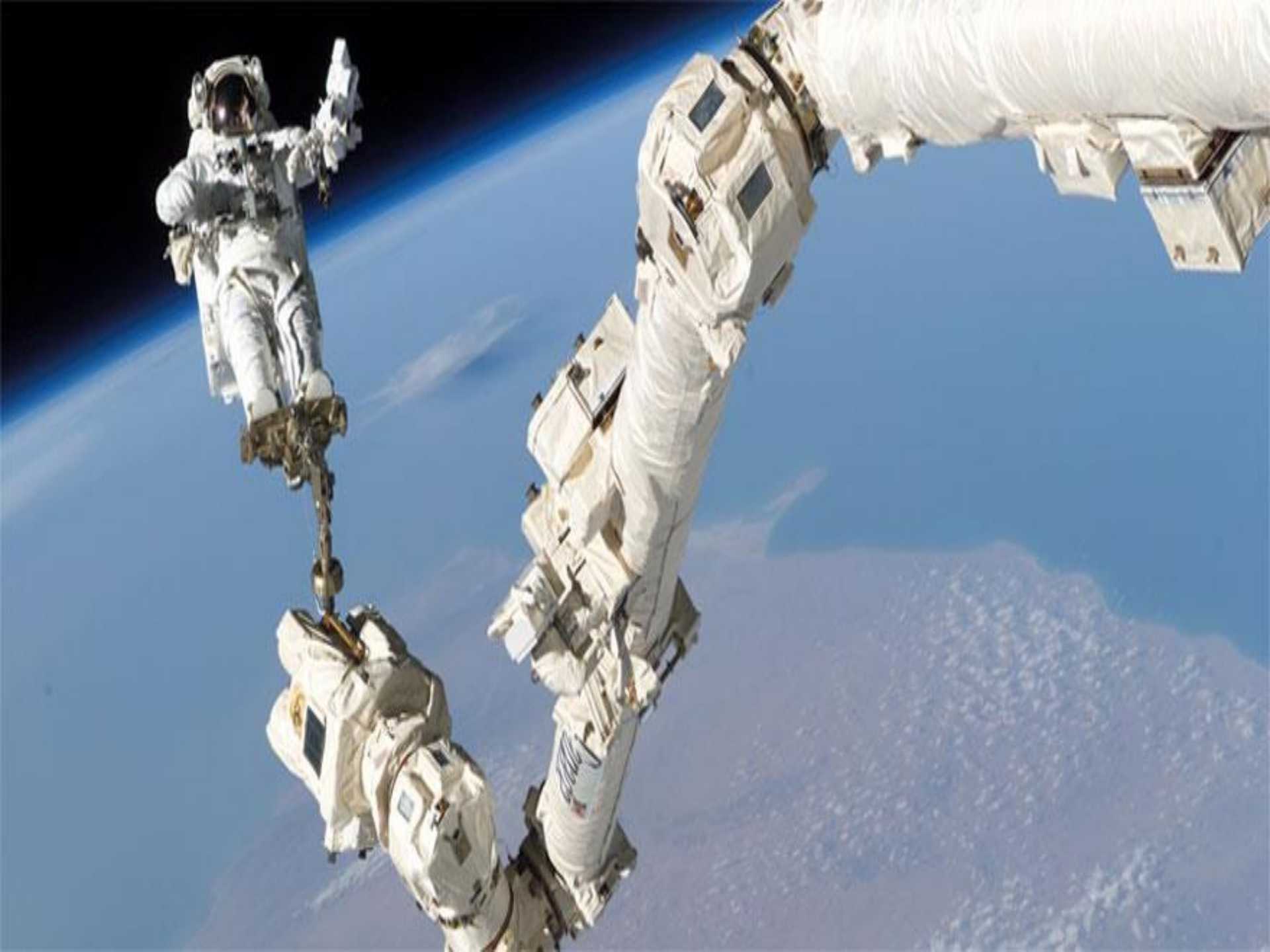
PHASE 2



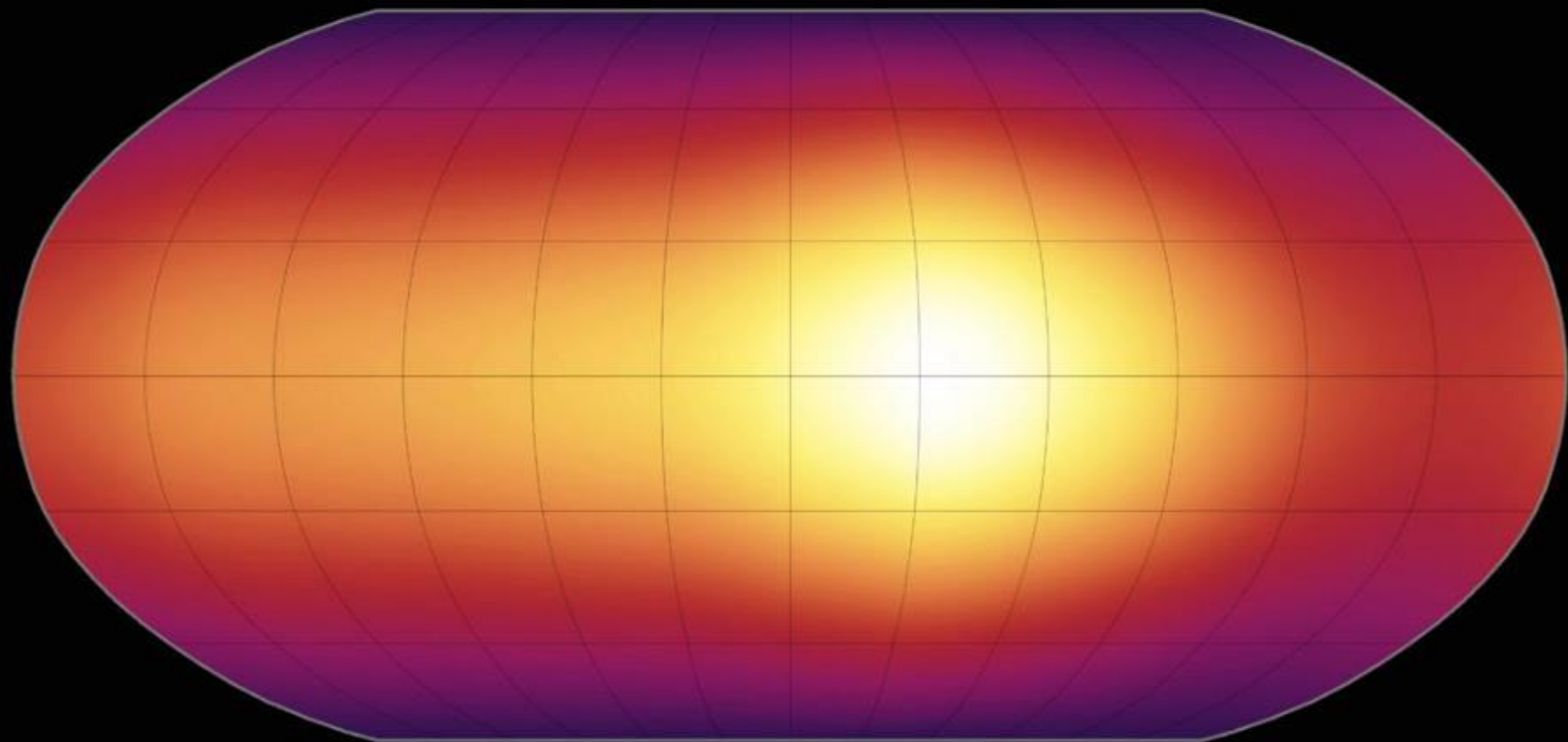
250 nm, 17,500 mph, 26 countries, 16 years and counting...











Sun-Facing Longitude

[Grid Spacing: 30°]

Global Temperature Map for Exoplanet HD189733b
NASA / JPL-Caltech / H. Knutson (Harvard-Smithsonian CfA)

Spitzer Space Telescope • IRAC
ssc2007-09a











Canada

Endeavour



ENDEAVOUR
DOCKED

YEAR: 2007
MISSION: STS-118
TARGET: EARTH

Space Shuttle Endeavour, docked to the Destiny laboratory of the International Space Station.

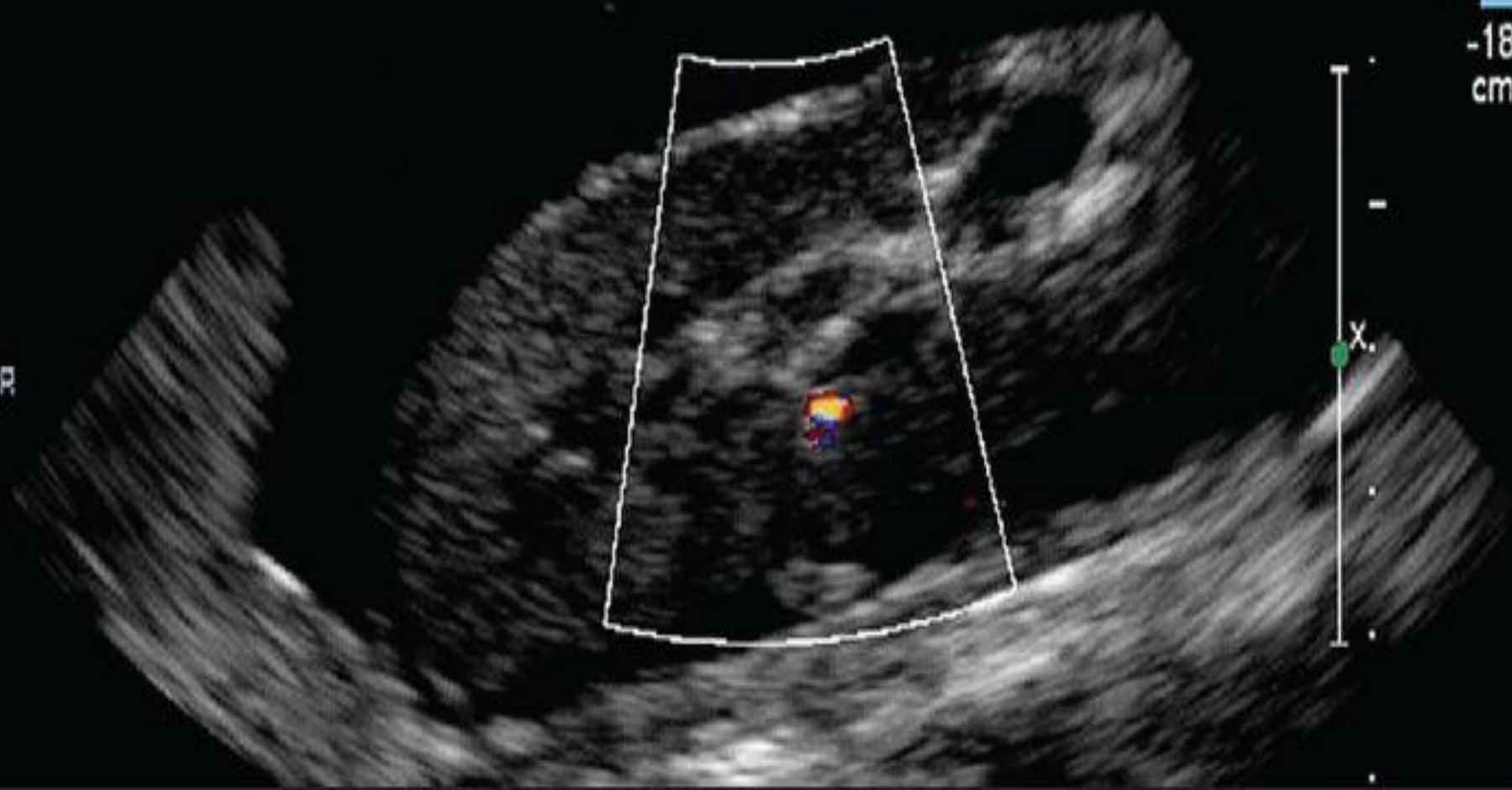






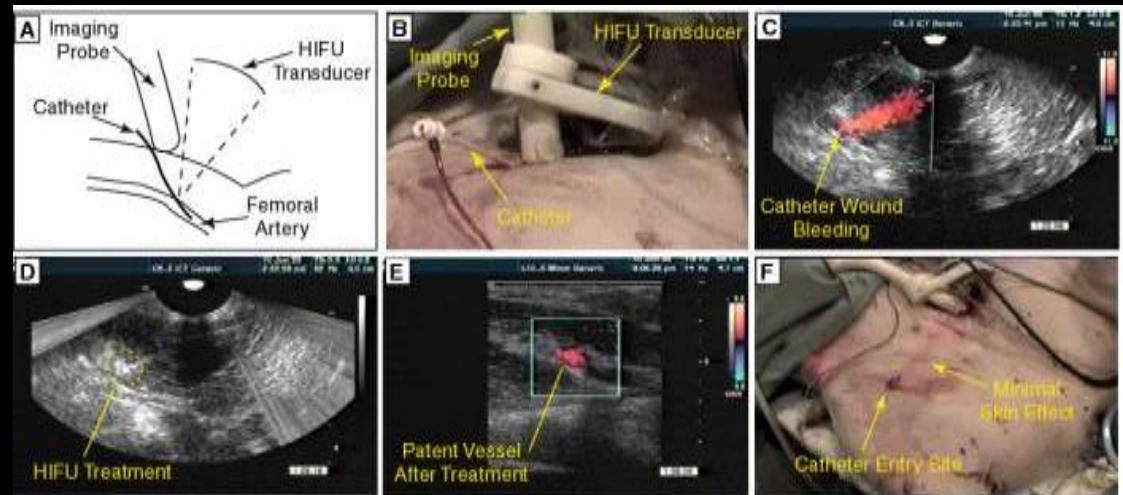
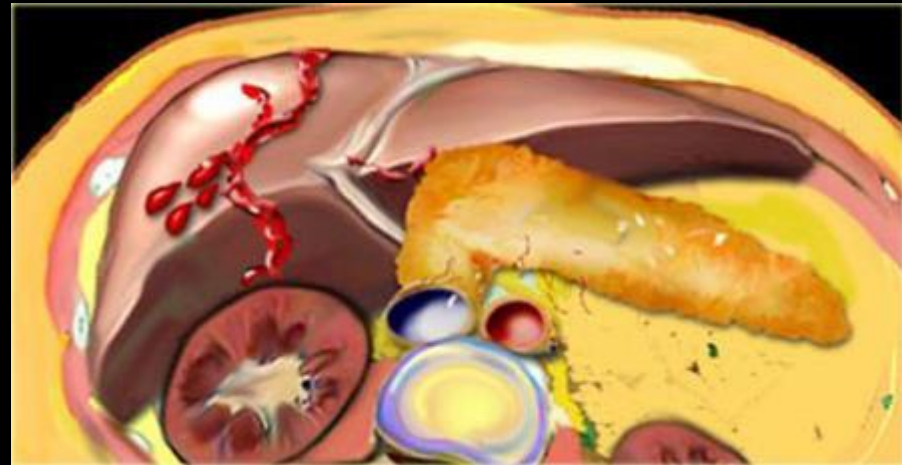
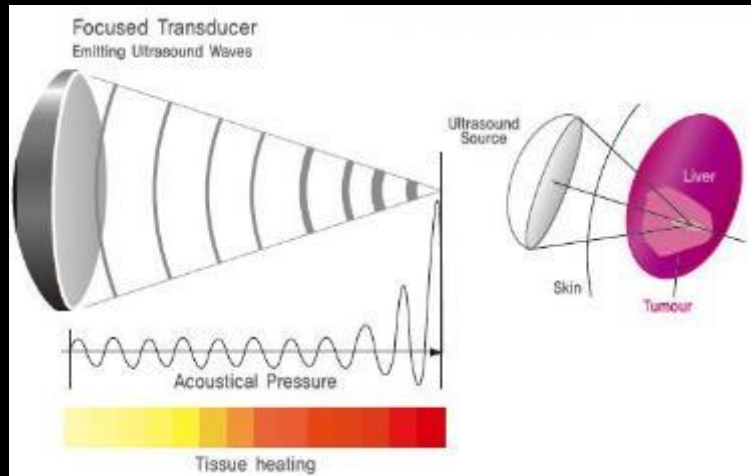
42%
50
Low
Gen
F
75%
0MHz
WF Med
led

Small stone with twinkling

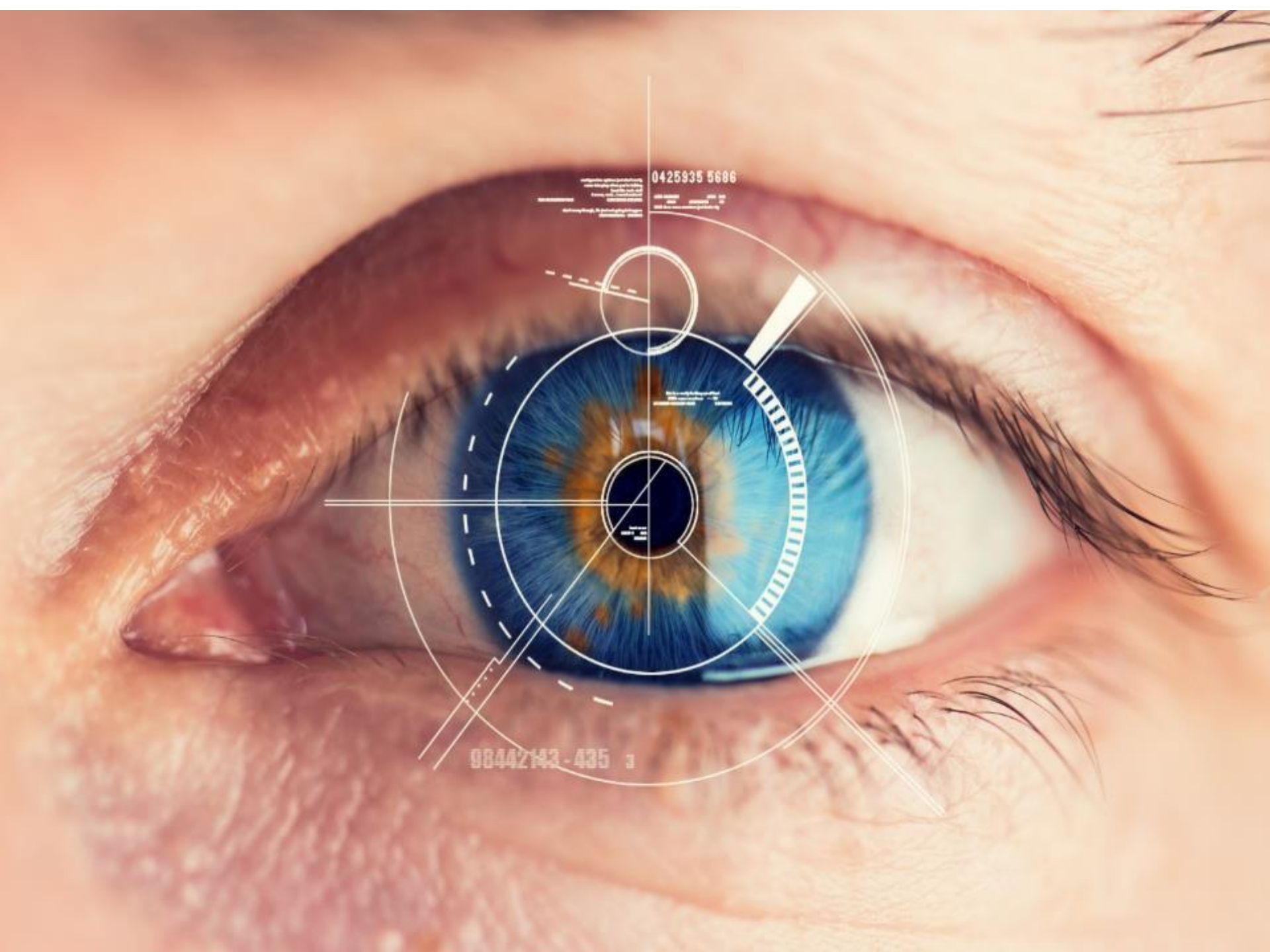


-18
cm

High Intensity Focused Ultrasound







0425935 5686

08442143 - 435 3



Final Osmosis Bag

999 1027-M-2001-00



STATUS

CURRENT TREATMENT		LIV WITH		CURRENT PRESCRIPTION	
Flow:	200 ml/hr	Flow:	20 ml/hr	Flow:	100 ml/hr
Pressure:	150 mmHg	Pressure:	150 mmHg	Pressure:	150 mmHg
Temp:	37.0°C	Temp:	37.0°C	Temp:	37.0°C
pH:	7.35	pH:	7.35	pH:	7.35
CO ₂ :	35 mmHg	CO ₂ :	35 mmHg	CO ₂ :	35 mmHg
O ₂ :	100 mmHg	O ₂ :	100 mmHg	O ₂ :	100 mmHg
Na:	135 mmol/L	Na:	135 mmol/L	Na:	135 mmol/L
K:	4.0 mmol/L	K:	4.0 mmol/L	K:	4.0 mmol/L
Ca:	1.0 mmol/L	Ca:	1.0 mmol/L	Ca:	1.0 mmol/L
Mg:	0.8 mmol/L	Mg:	0.8 mmol/L	Mg:	0.8 mmol/L
BUN:	10 mg/dL	BUN:	10 mg/dL	BUN:	10 mg/dL
Cr:	1.0 mg/dL	Cr:	1.0 mg/dL	Cr:	1.0 mg/dL

Next scheduled flow in 1 hour: 1 hr 00 min
 Run to: End of run / Stop

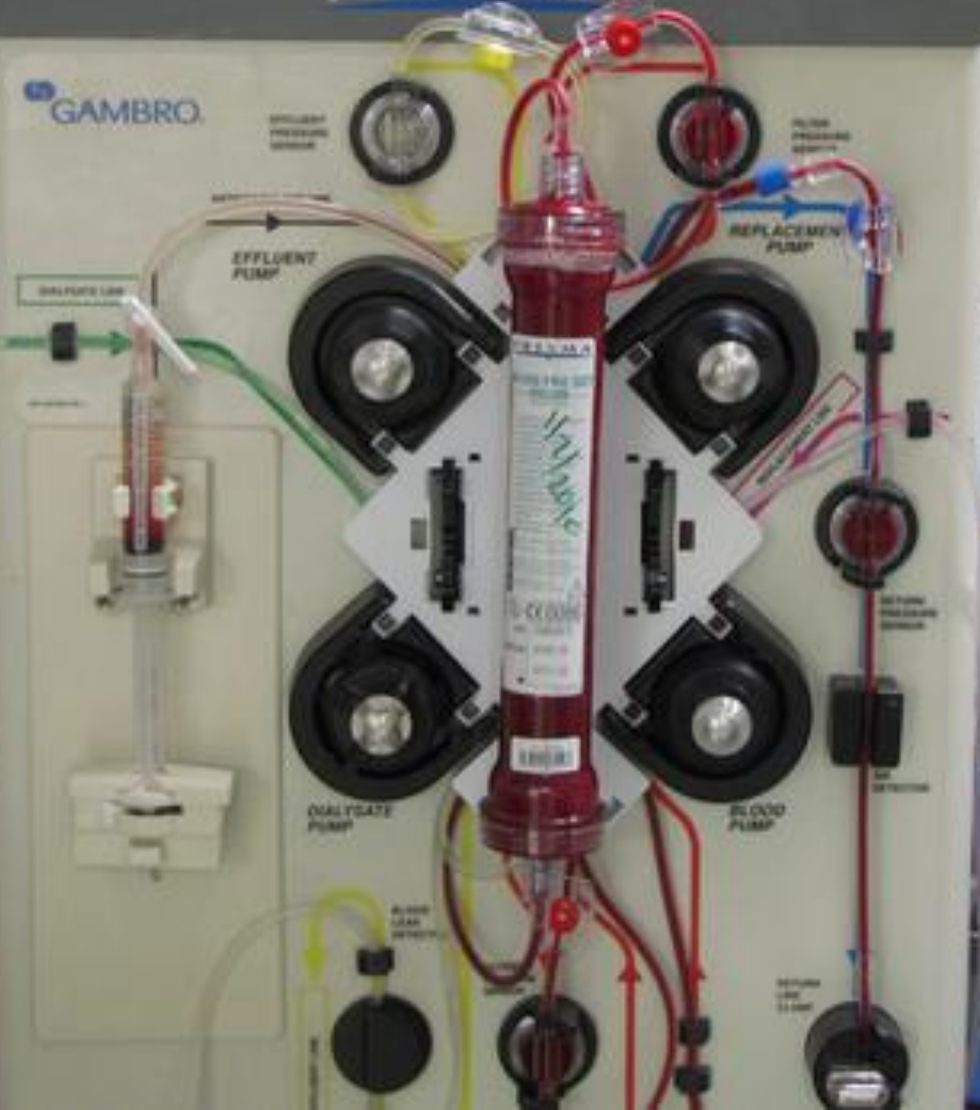
UNIT	UNIT	UNIT	UNIT	UNIT
100%	100%	100%	100%	100%
100%	100%	100%	100%	100%

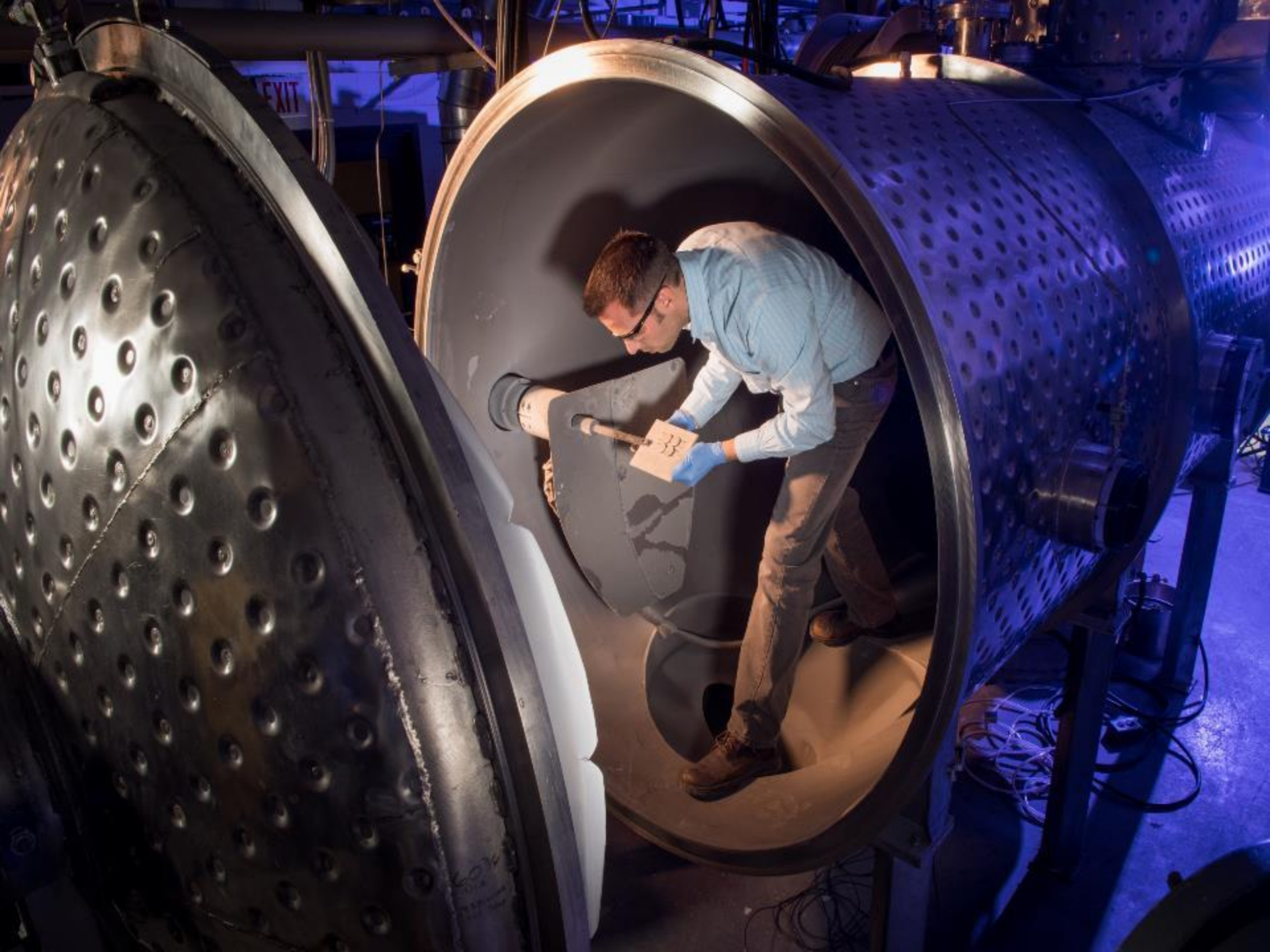
WARNING

Do not touch the dialyzer. The dialyzer is hot. To avoid burns, do not touch the dialyzer. Do not touch the dialyzer. Do not touch the dialyzer.

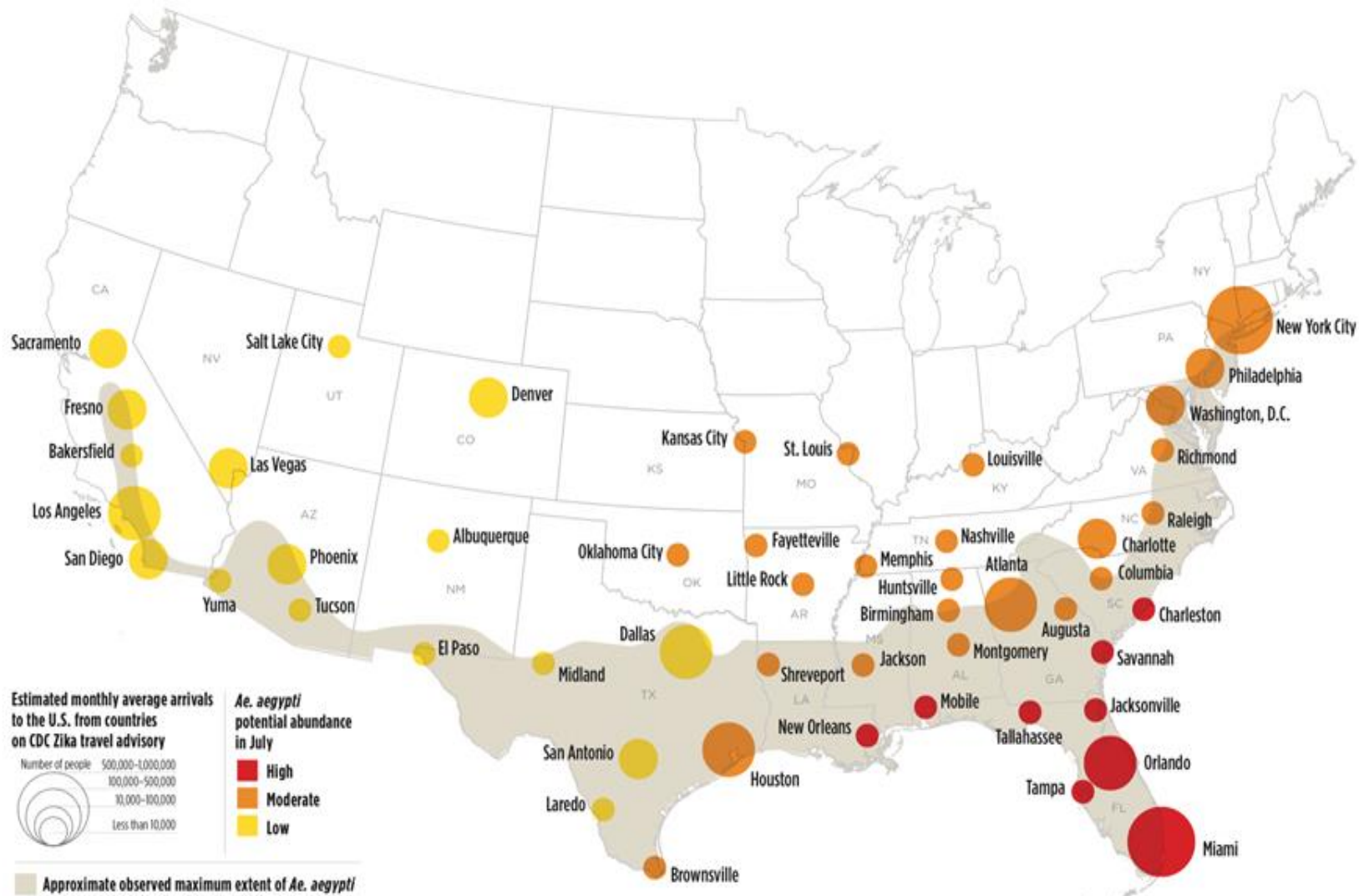
PRISMA

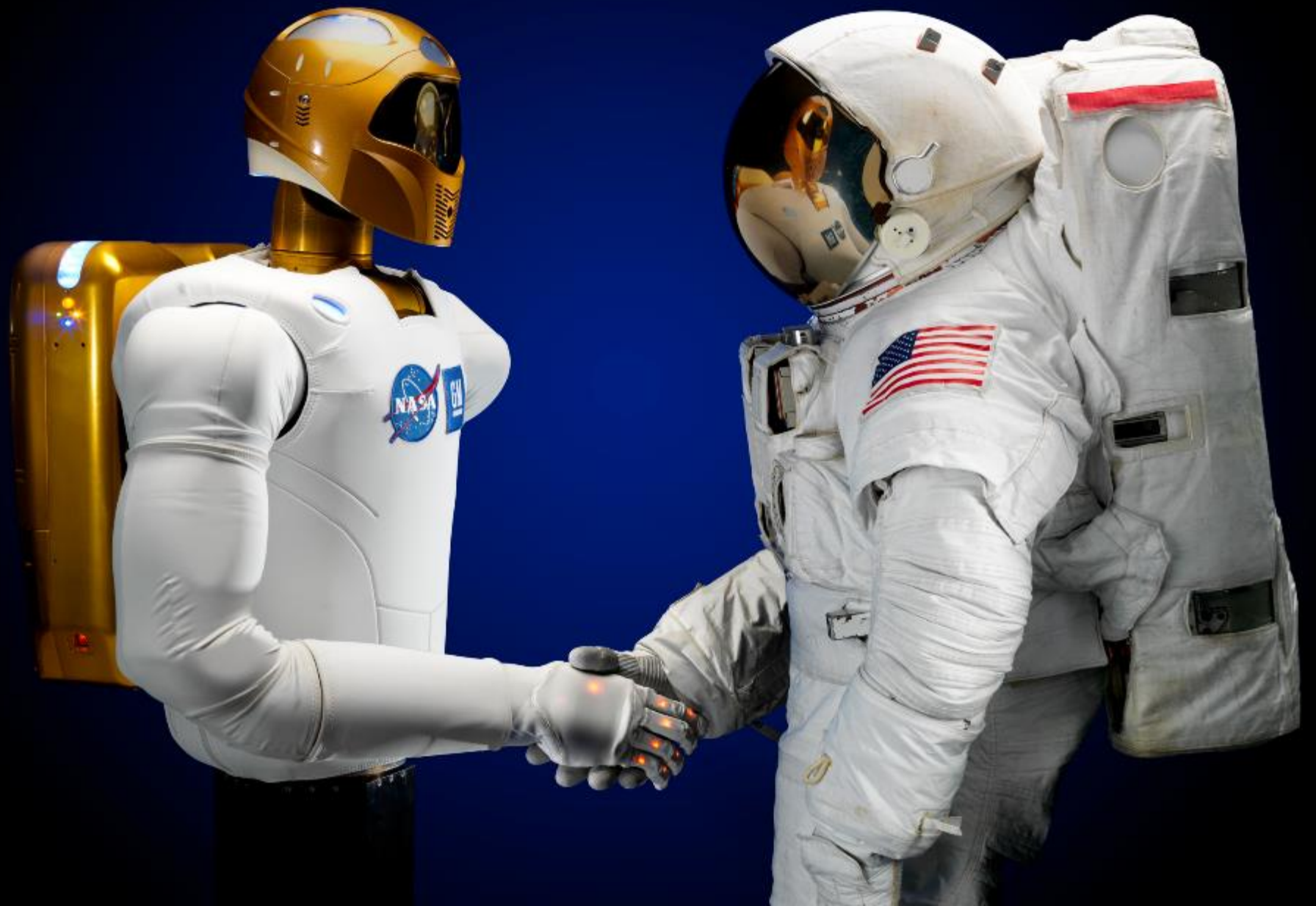
GAMBRO



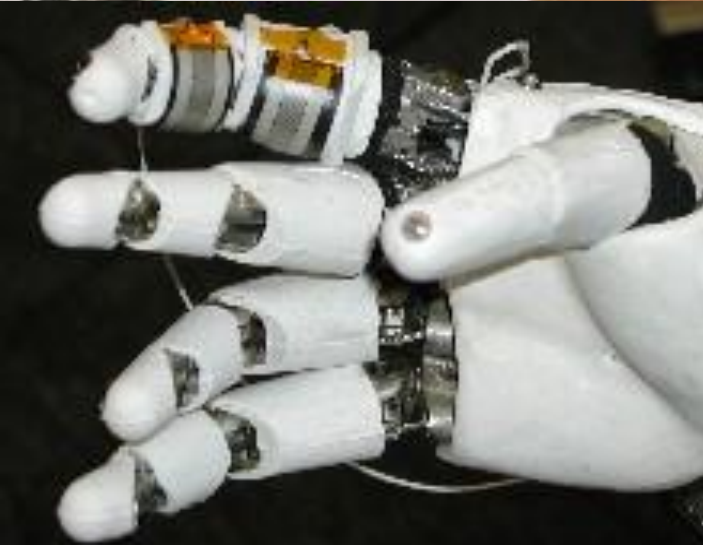
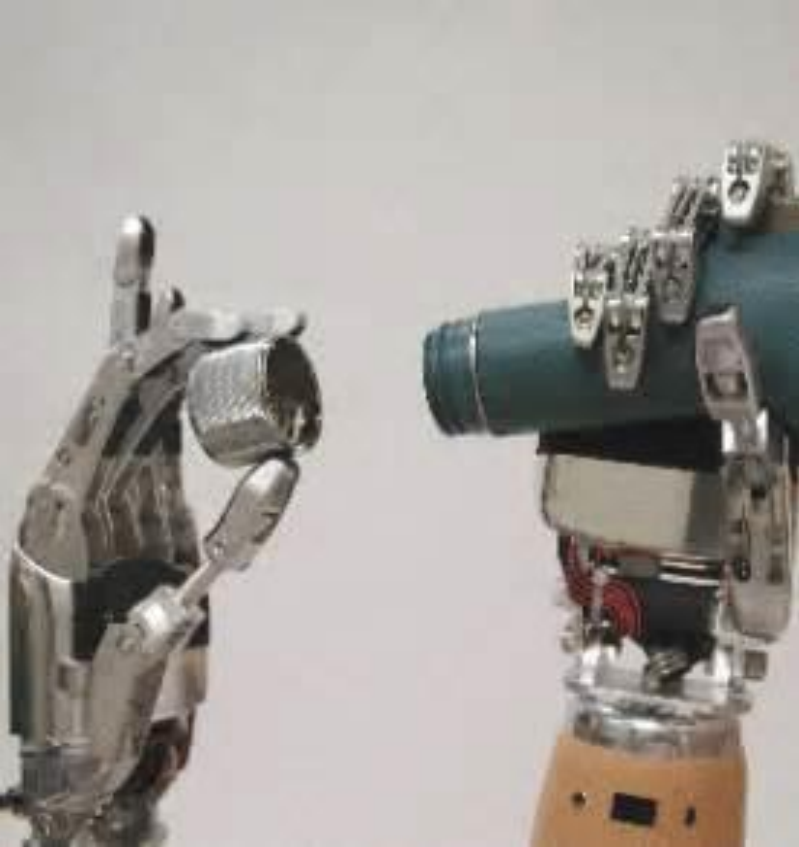












www.nasa.gov



DUND WARRIOR
PROJECT



Galileo - Smart Prosthetics Control App
Orthocare Innovations LLC, Galileo Prosthetics Control Support LLC.

SILS

(Single Incision Laparoscopic Surgery)



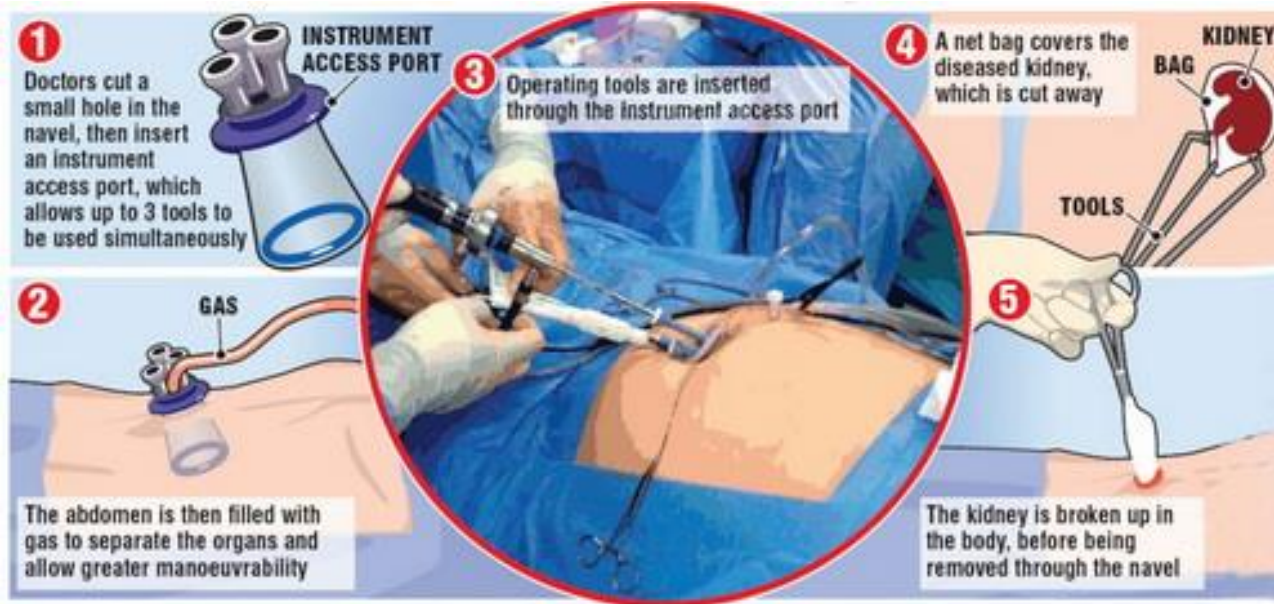
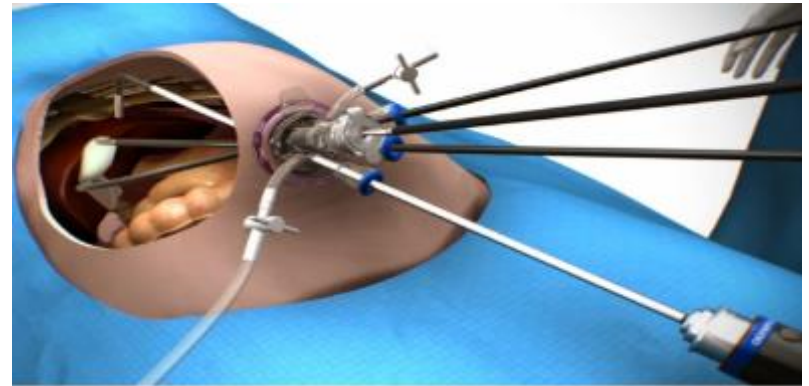
Traditional open gallbladder surgery scars



Multi-port lap gallbladder surgery scars



SILS gallbladder surgery
No visible scars





NASA Valkyrie
Robot





Ford, O. *Robotic Exoskeleton. The Future is Now.* Medical Device Daily, Aug 24, 2014.

3D Printing for skin and flesh tones

Scan of remaining eye to create exact duplicate eye with 3-D printer

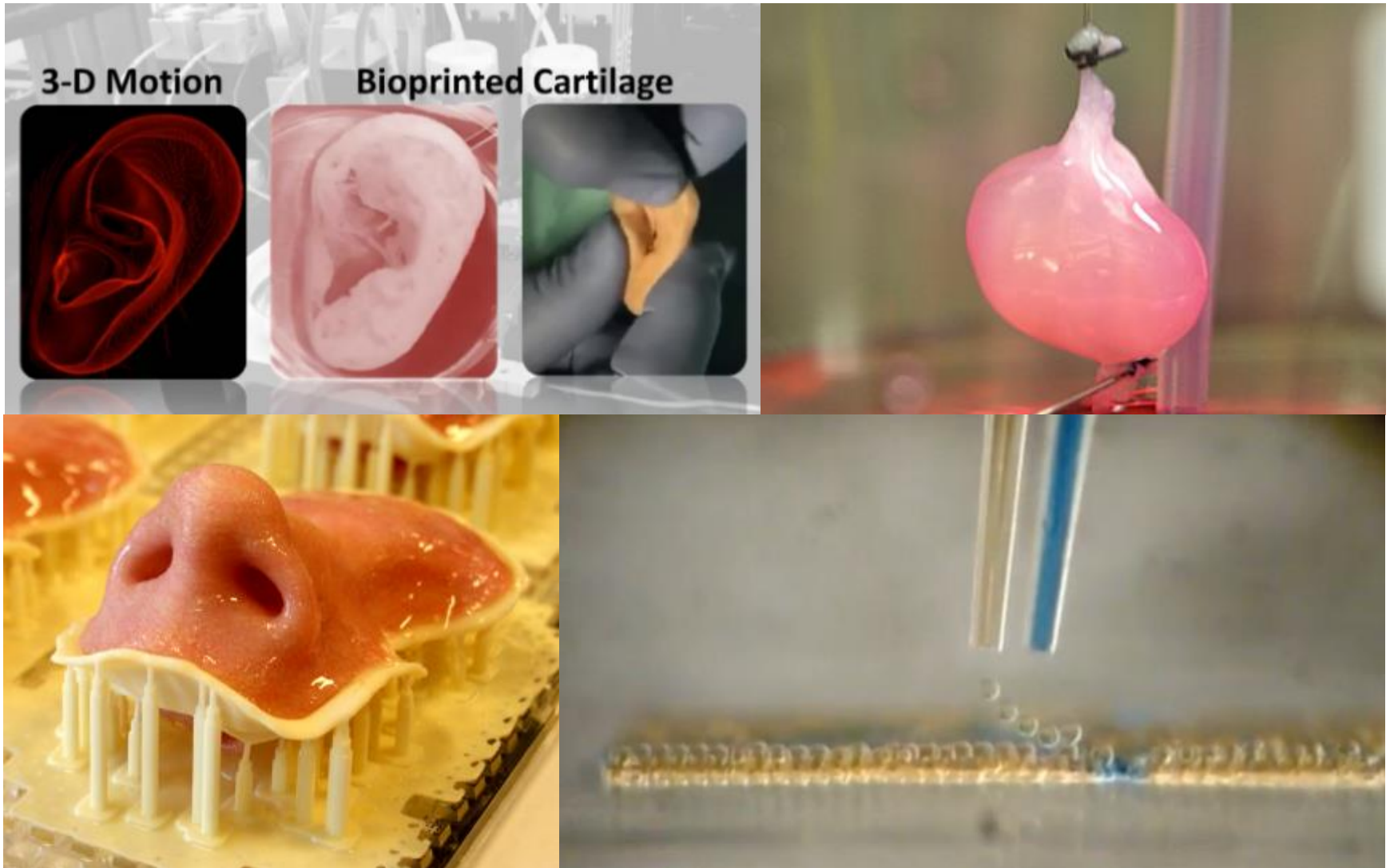


Computer scanned, then flipped images of remaining limb to create “3-d duplicate”

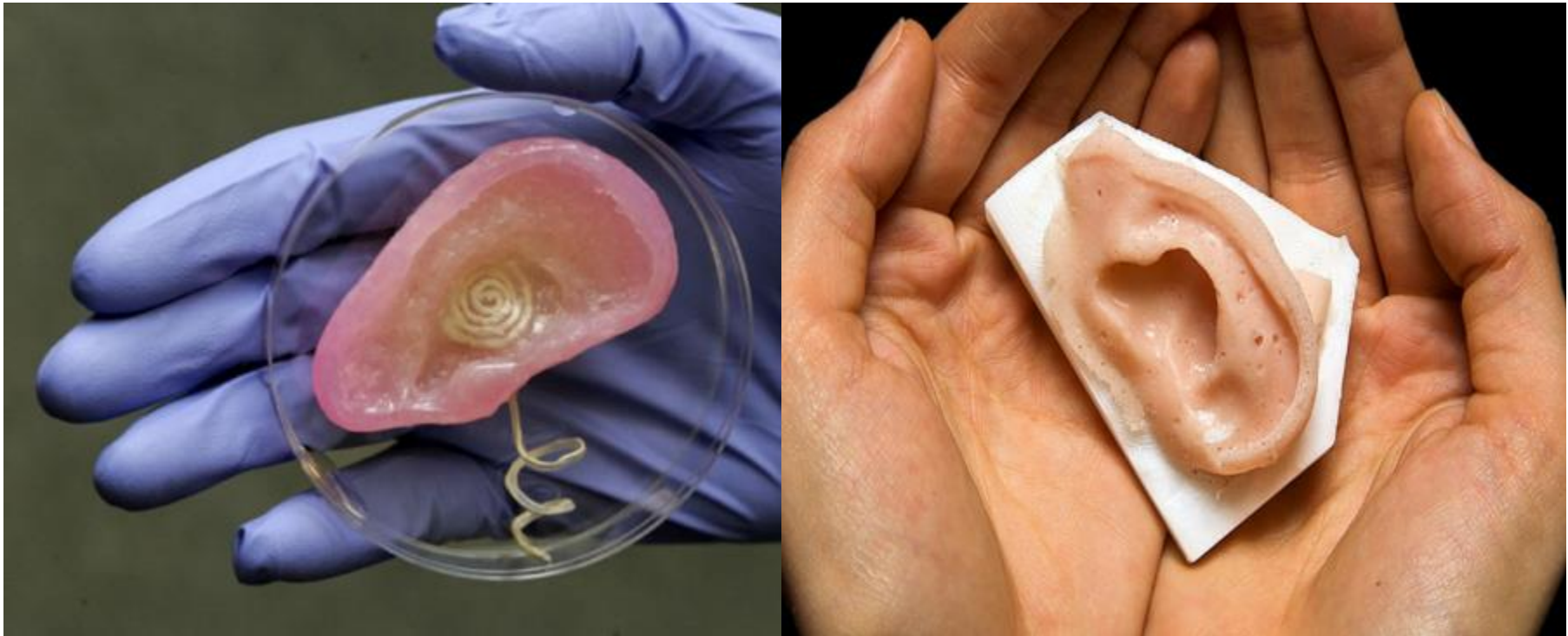


Wake Forest University: Printing skin directly onto the burned limb.

3D Printers and Human Tissue

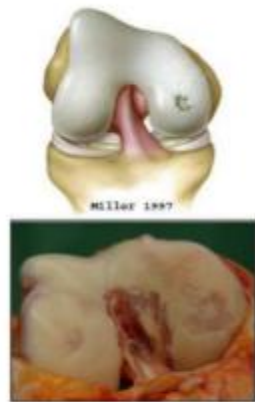
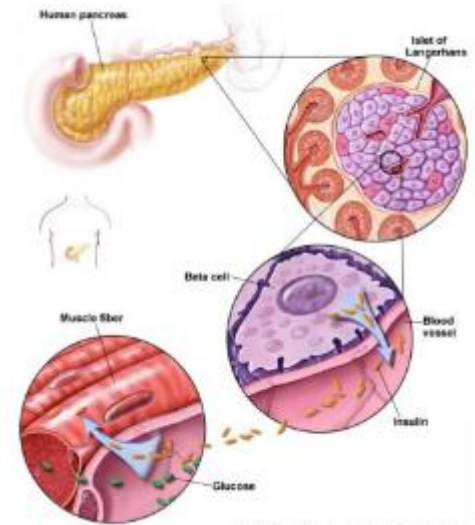
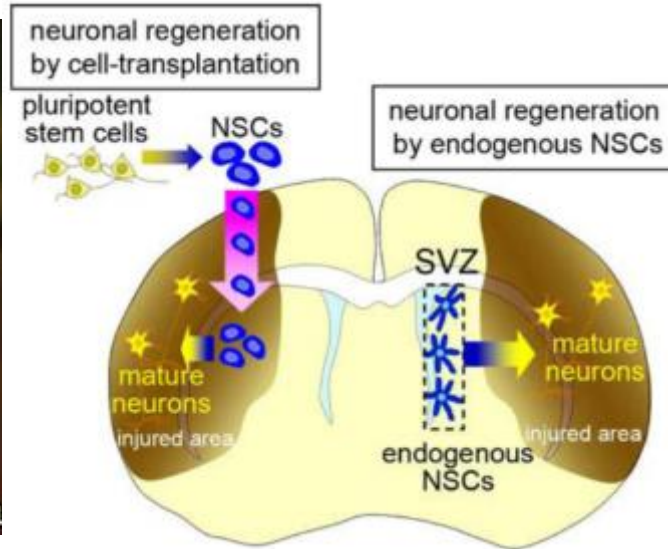


3-D printed ears that can hear...



- Princeton 3-D printed ear with acoustic ear coil transmission.

Insertion of Progenitor Cell Lines



Cartilage lesions

Transferred cells

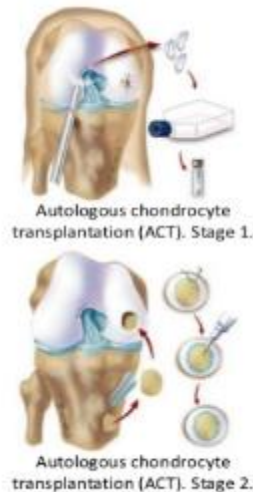
↓

Cultured cells

↓

Cells in biomaterials

Strategies for cartilage repair.



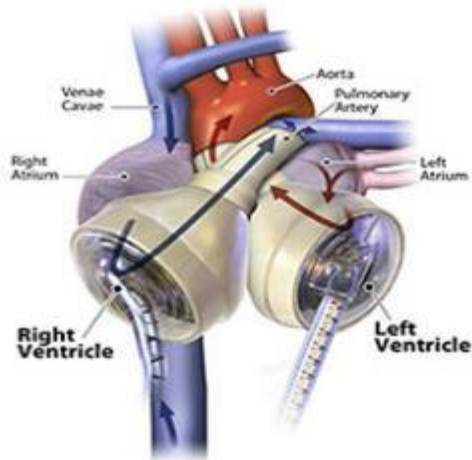
First Use of 3D printed tissue to make Trachea

University of Michigan implants first 3-D printed tissue into infant

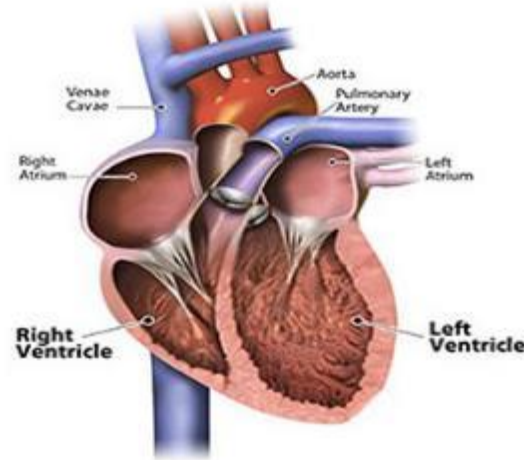


<http://www.uofmhealth.org/news/archive/201403/babys-life-saved-after-3d-printed-devices-were-implanted-u>

Artificial Heart



Total Artificial Heart



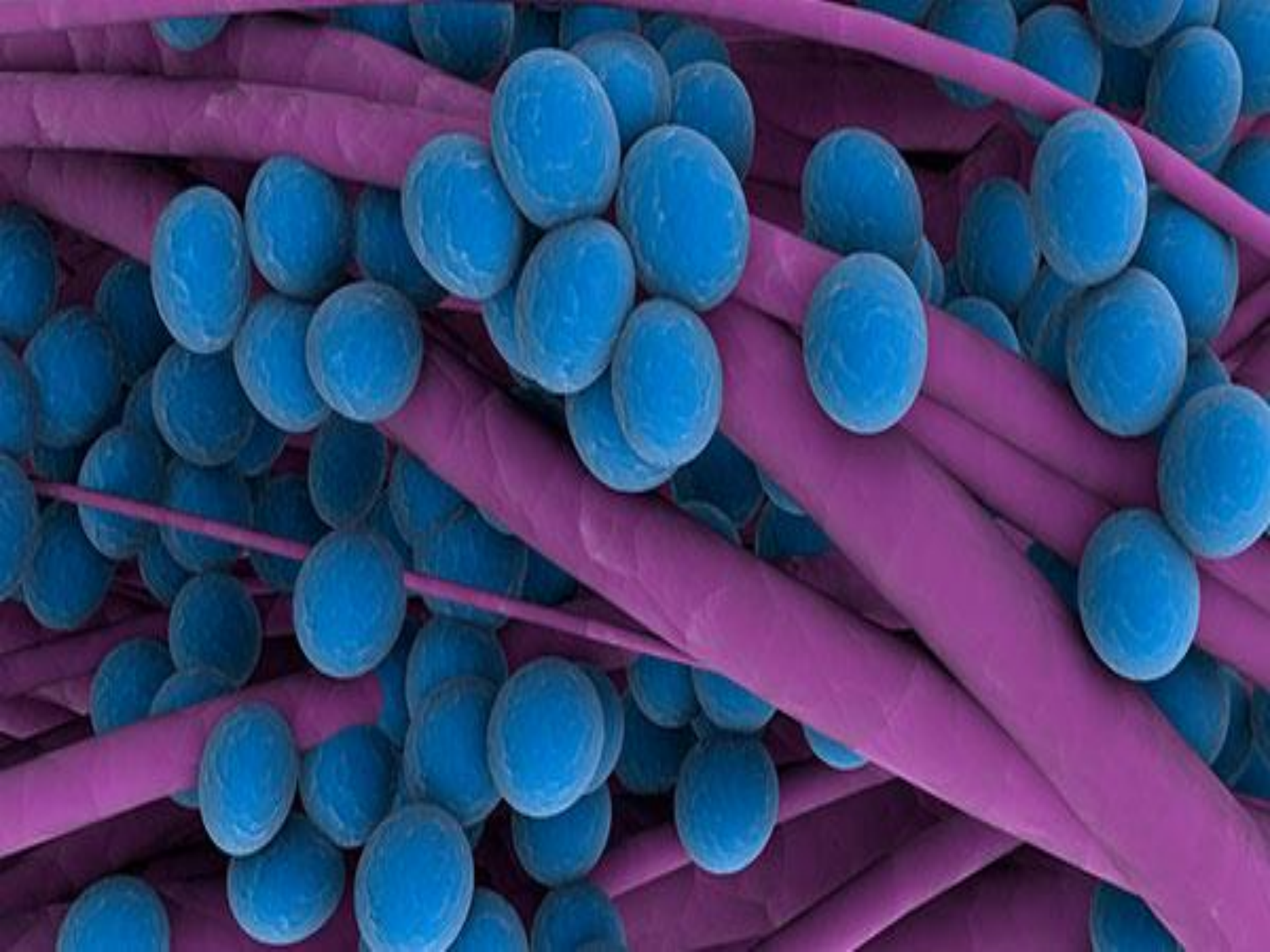
Human Heart

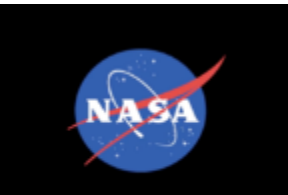
Wake Forest Institute for
Regenerative Medicine, 3-D
printed beating cardiac cells

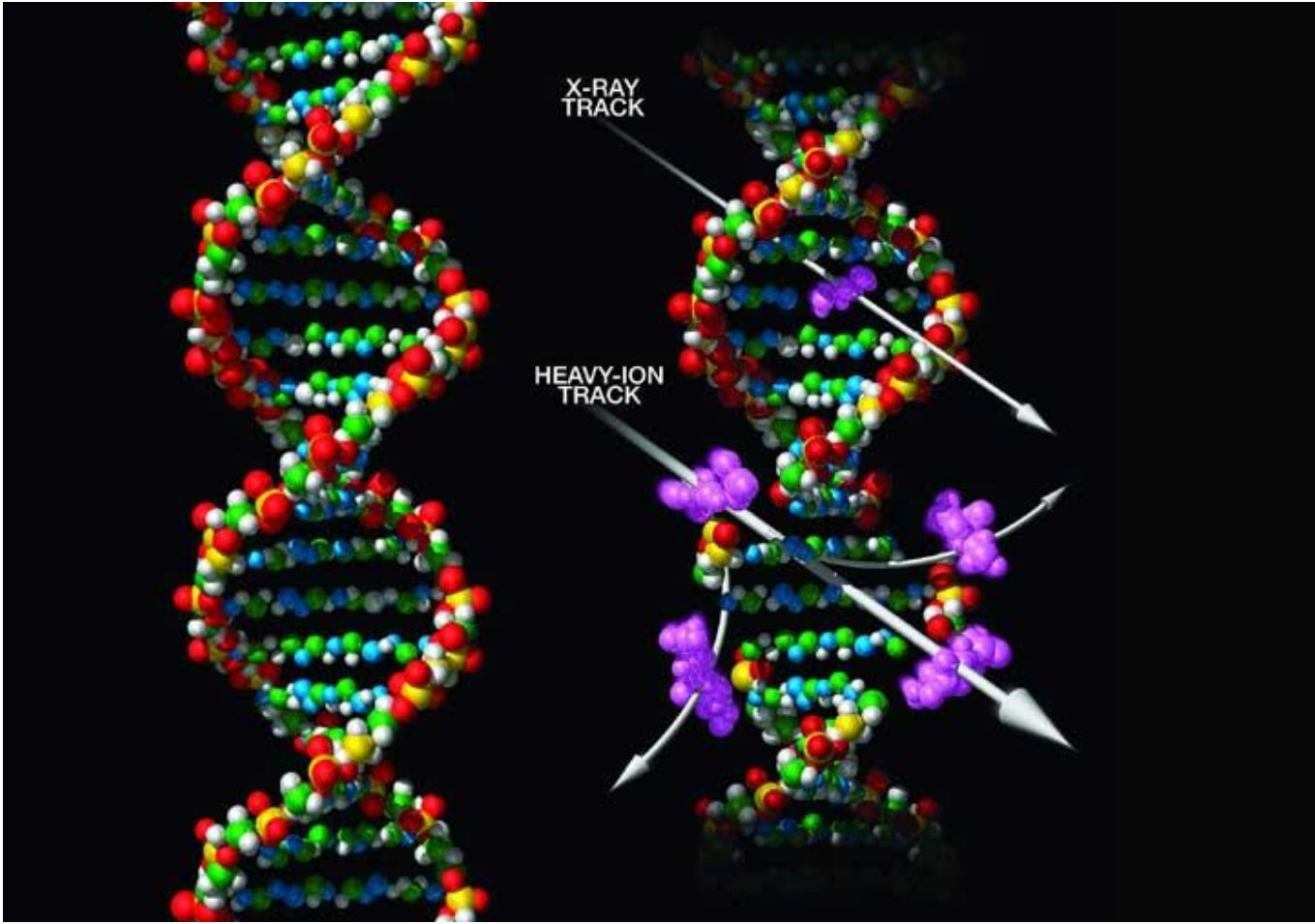




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Futuristic?



CPD, NASA AMES

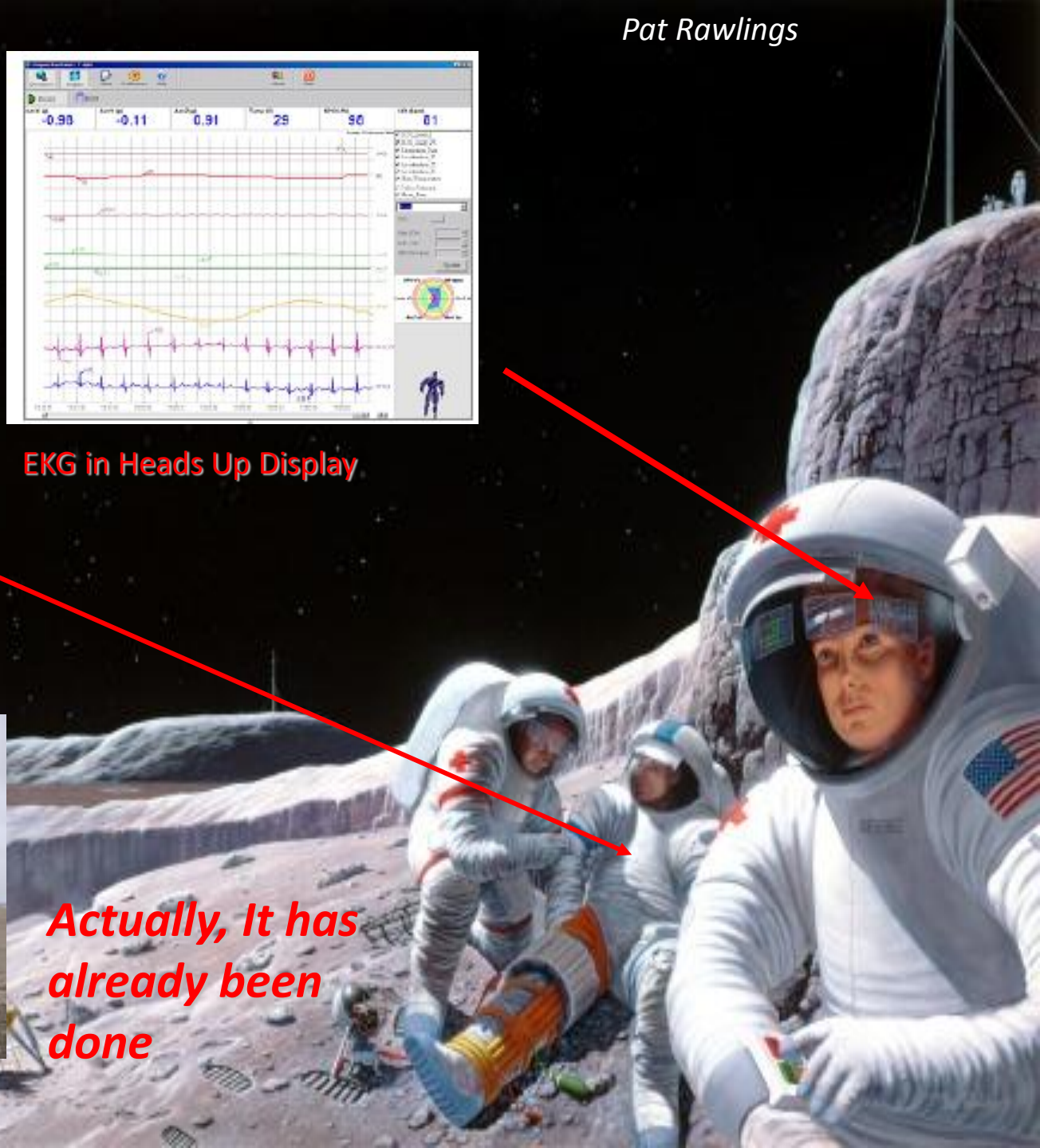


EKG in Heads Up Display

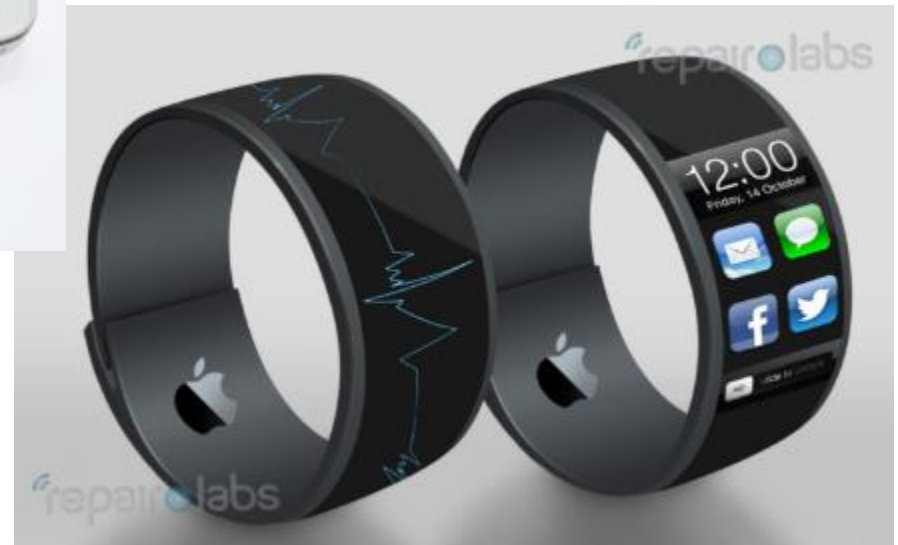


NASA Houghton Mars Project

*Actually, It has
already been
done*



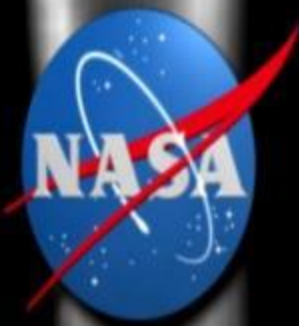
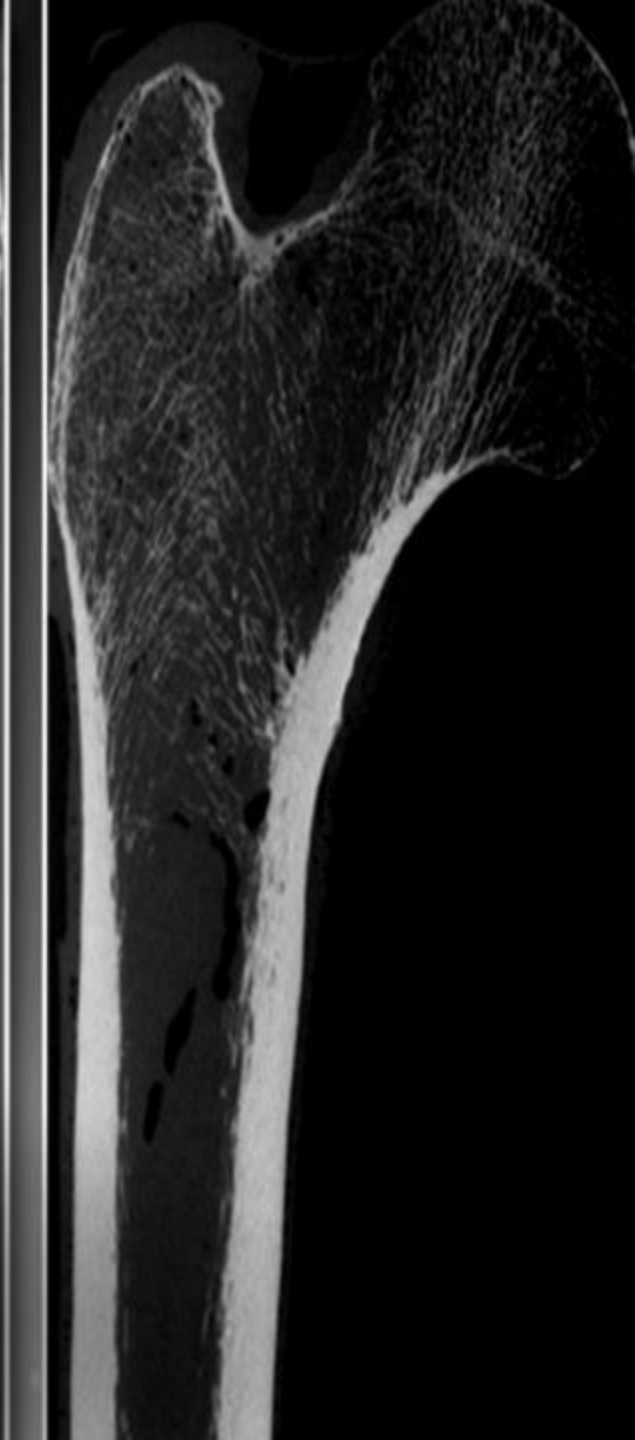
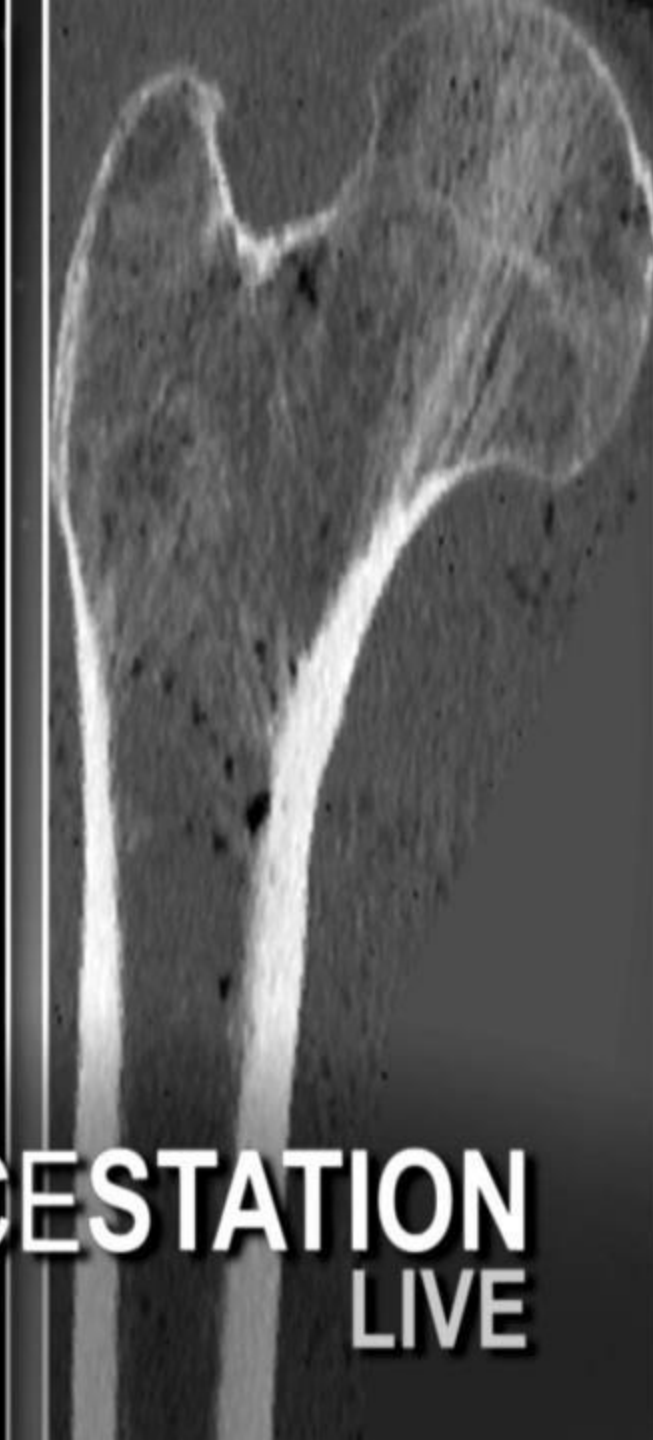
Wearable Technologies and Data



<http://www.forbes.com/sites/robertglatter/2014/11/20/wearable-technology-and-digital-healthcare-strategies-should-shift-focus-to-chronic-medical-illness/>



Happy



**SPACESTATION
LIVE**











OMICS

National Aeronautics and
Space Administration



A Circular
Genome
Visualization

Human Cell

Telomere

Chromosome

Chromatin

DNA

Methyl
Groups

Telomere

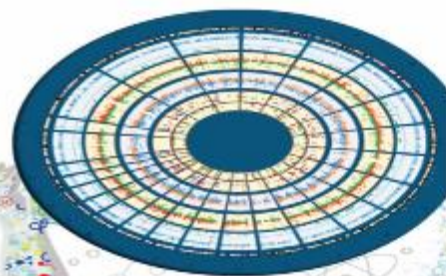
Metabolites

Proteins

RNA

Telomere

A Journey to See More
Than Ever Before



OMICS

Exploring Space Through You



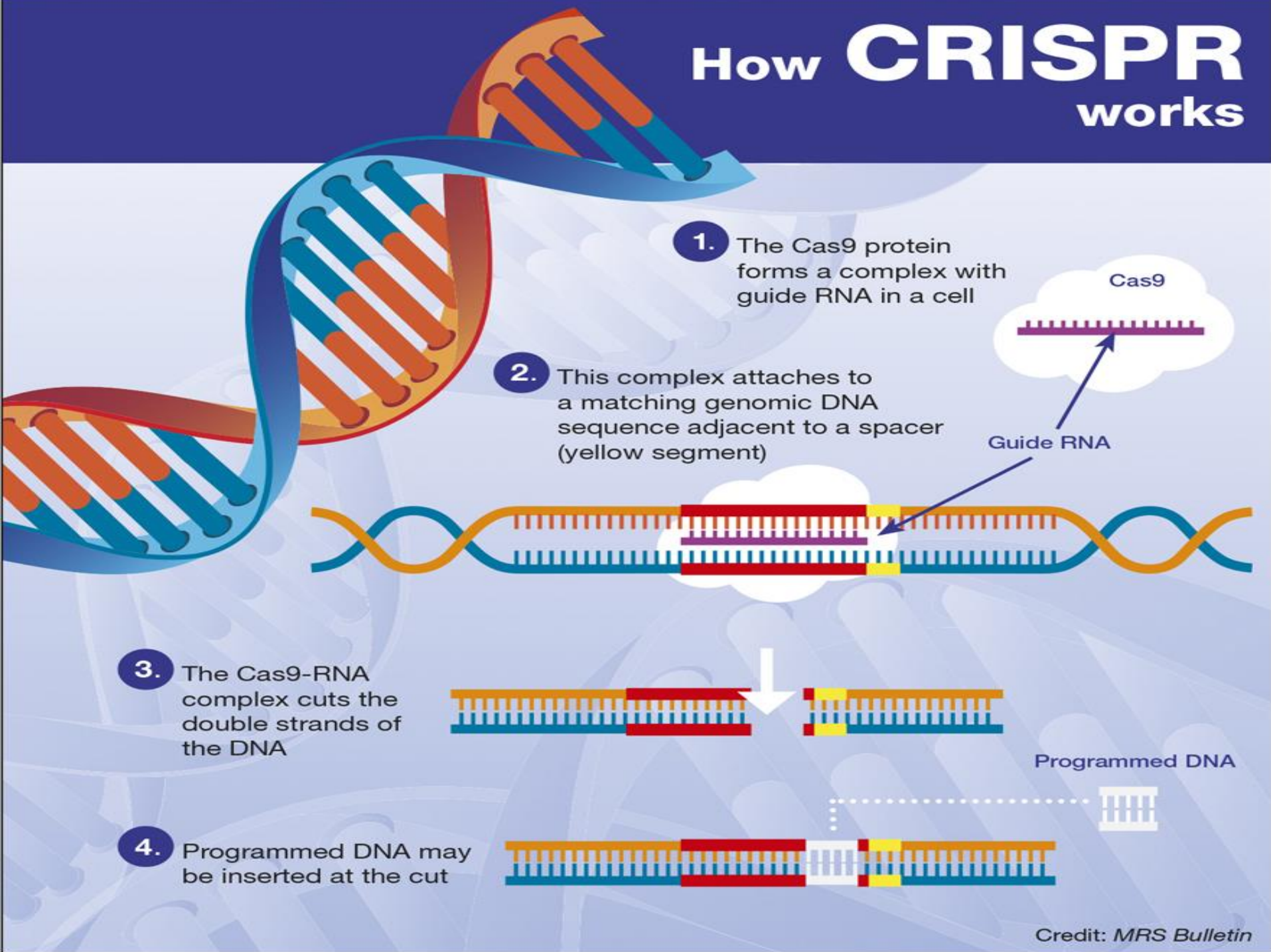
VOCABULARY

1. _____ OMICS
2. _____ GENOMICS
3. _____ TRANSCRIPTOMICS
4. _____ PROTEOMICS
5. _____ EPIGENOMICS
6. _____ METABOLOMICS
7. _____ MICROBIOMICS

- a. The study of the genetic ecosystem in our body including bacteria, viruses, fungi, etc. that keep our body healthy or give our body diseases
- b. The study of the complete set of DNA within a single cell of an organism
- c. The study of all RNA that was produced from a genome
- d. The study of all proteins in an organism that enables scientists to find and target diseases within that organism
- e. An integrative field of study that helps scientists determine what each part of someone's genetic instruction does, how it relates to the other parts, and how each part is expressed
- f. The study of the chemical processes that happen in a cell, tissue, organ, or organism to help maintain life and help stop diseases by monitoring those processes
- g. The study of how an organism's environment influences changes in the expression of the gene without changing the actual DNA sequence

Journey into the vastness of the human body and explore the endless possibilities of omics on Earth and in space. Omics integrates fields of study of biomolecules allowing researchers to investigate and see more than ever before. On the front of this poster is a depiction of the interrelation of Earth, humans and space. This graph surrounding Earth shows a genomic circular visualization used by scientists to analyze data representative of human biomolecules. Biomolecules are shown flowing through an astronaut to demonstrate the massiveness of the human body. The unwinding DNA within the chromosome represents the journey from Earth to Mars and deep space and is analogous to the dual missions of protecting astronaut health to ensure a successful journey to Mars and beyond. The NASA Twins Study enables researchers to compare identical twin Chak to discover molecular changes within the human body. Join us on this exciting adventure at www.nasa.gov/hrp.

How CRISPR works

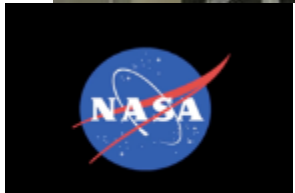
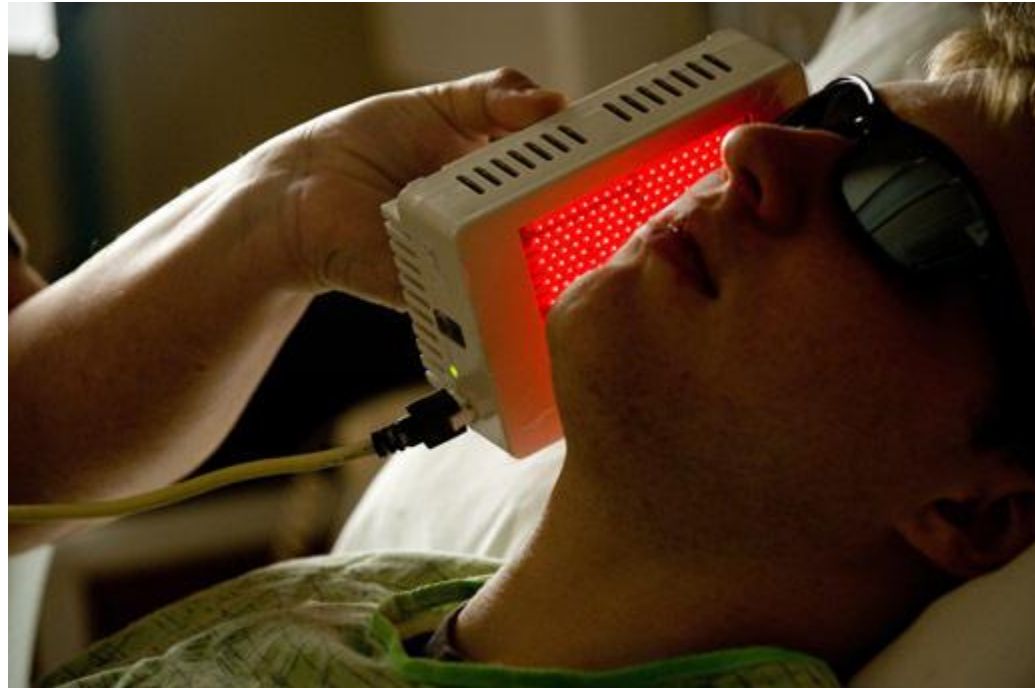
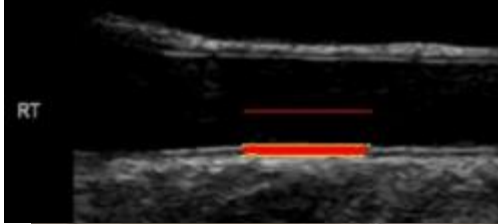


Personalized Genetic Medicine and Pharmacogenomics

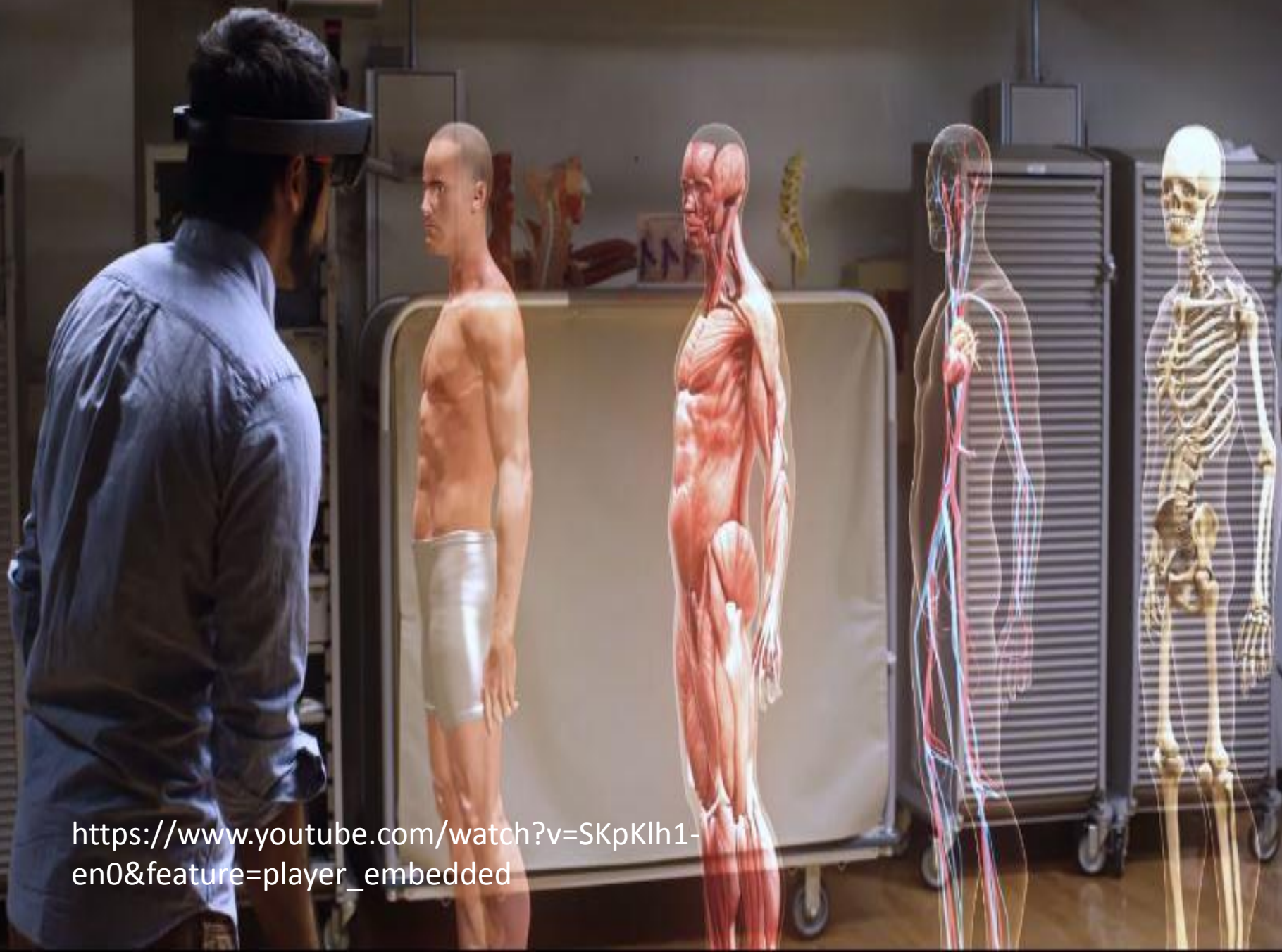
What if your chemotherapy no longer killed all your proliferating cells, but only specific cancer encoded cells?



What if there was a drug that was encoded to only your specific protein markers?







https://www.youtube.com/watch?v=SKpKlh1-en0&feature=player_embedded





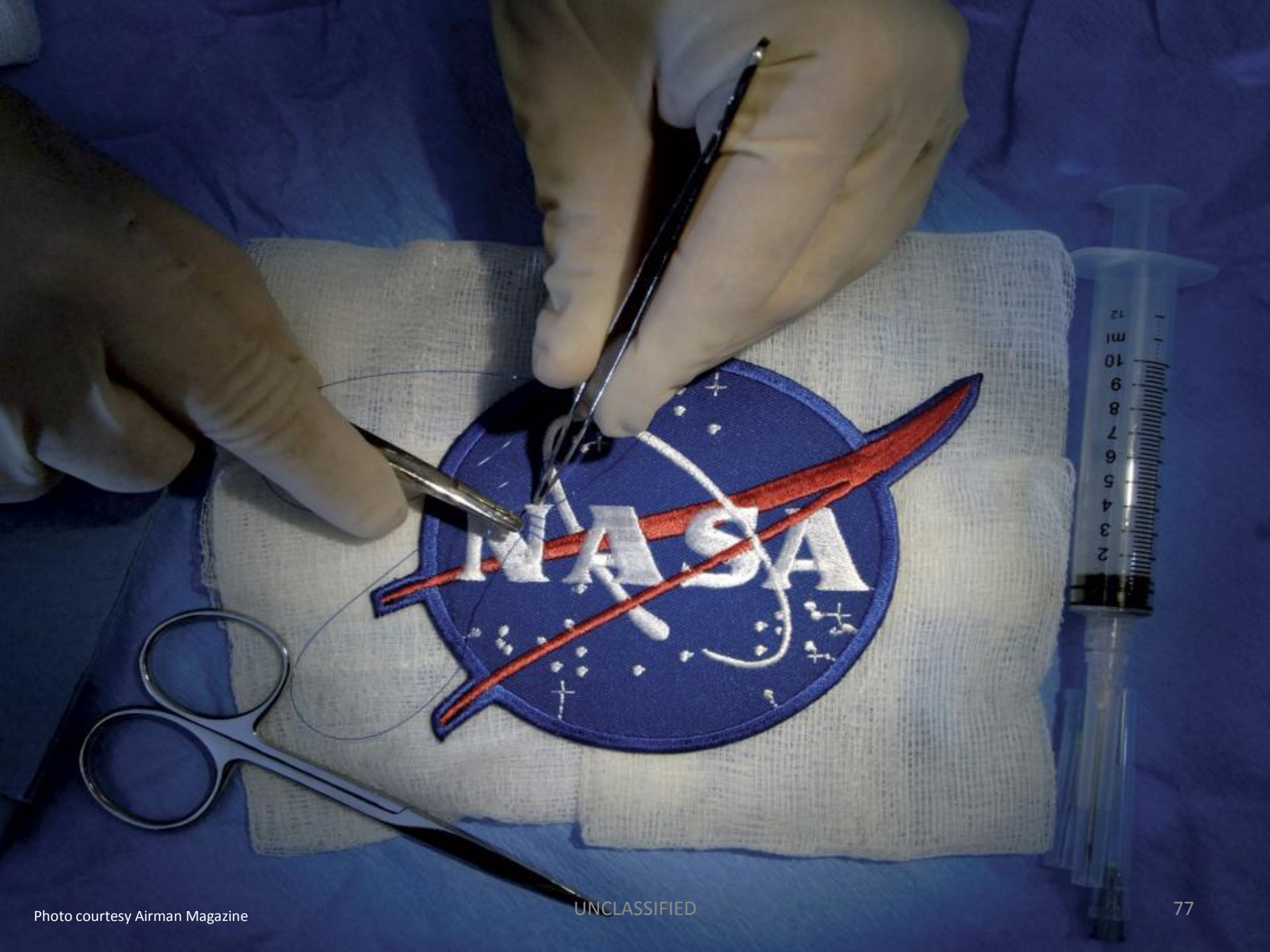




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Summary

- Technology is evolving at a faster rate than ever before in history.
- The half life of medicine is 5 years.
- The half life of technology is 2.4 years and **shortening**.
- Education is no longer confined to the four walls of the institution.
- Medical education can be outsourced and insourced.
- Robotics, Systems Engineering, Team Concepts, Just in Time Training, Bedside Analytics, Heuristics, Watson, Google Glass, MOOC's etc, etc, are all disruptive technologies to both medicine and teaching.
- We used to memorize because the information was not at our fingertips or eyes.
- What students need to know now is vastly different from what we learned.
- **My advice: Don't own a medical bookstore.**