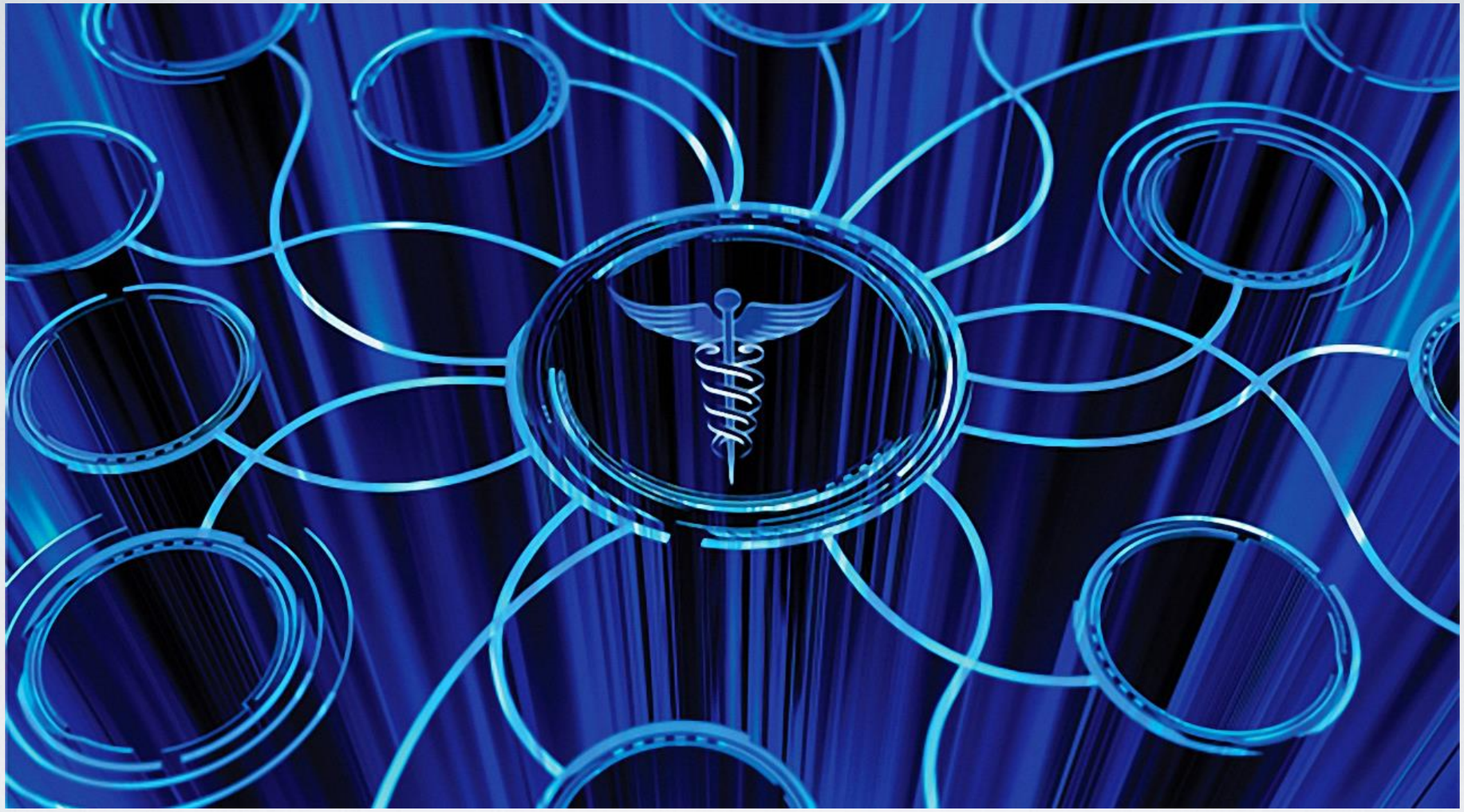


BIOENGINEERING FOR ONE HEALTH

Loinda Rugay Baldrias

DVM, MVS, PhD
Professor and Former Dean
College of Veterinary Medicine
University of the Philippines Los Baños

OUTLINE

- What is One Health?
- Why One Health?
- Bioengineering
- Biomedical Devices
- Why Bioengineering in One Health?

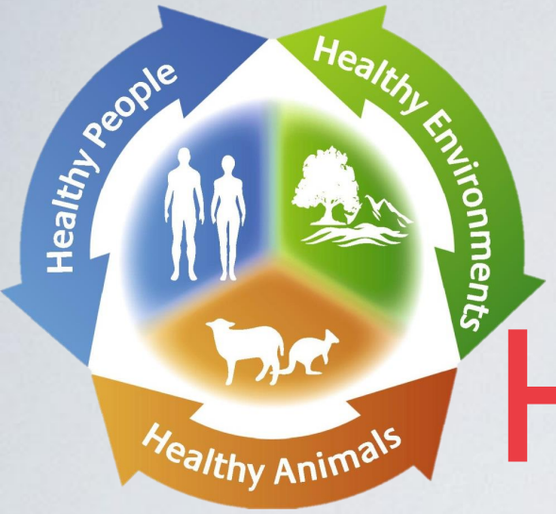
WHAT IS ONE HEALTH?

ONE MEDICINE

"Between animal and human medicine, there is no dividing line, nor should there be. The object is different, but the experience obtained constitutes the basis of all medicine."

- Rudolf Virchow (1821-1902), a physician; Father of Comparative Biology and Cellular Pathology

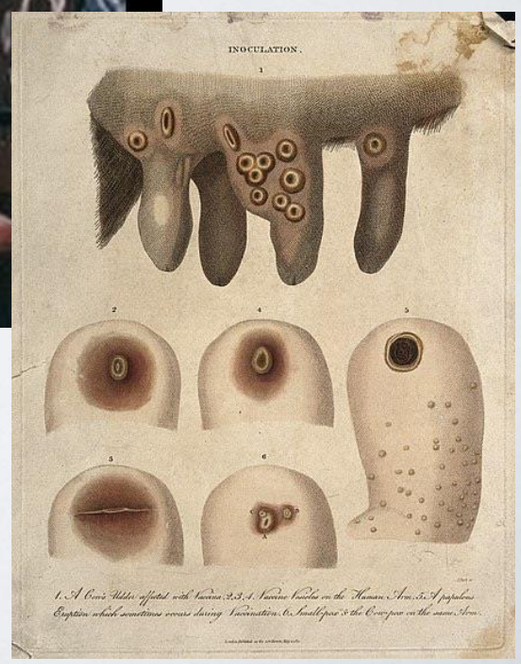
Rudolf Virchow
Coined the term
"ZOONOSIS"



ONE HEALTH

unvaccinated vaccinated

1st human VACCINE against smallpox comes from the cow ("VACA") infected with cowpox



ONE MEDICINE

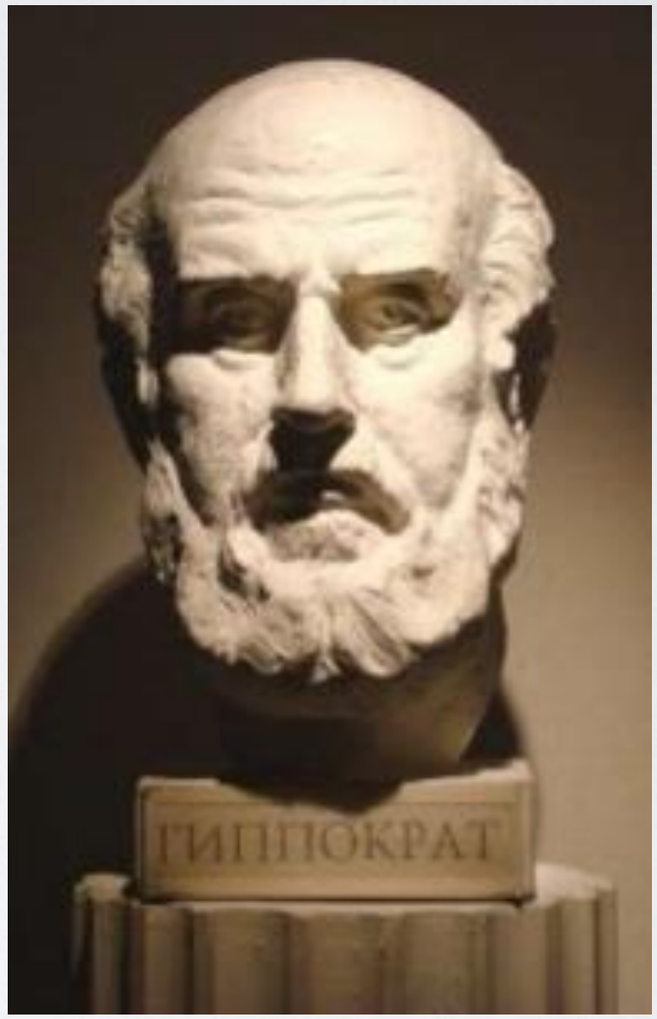
"There is no difference of paradigm between human and veterinary medicine. Both sciences share a common body of knowledge in anatomy, physiology, pathology on the origins in all species."

- Schwabe C., 1984, Veterinarian
Father of Veterinary
Epidemiology

Dr. Calvin Schwabe
Coined the term
"ONE Medicine"

ONE HEALTH
AND ITS RELEVANCE

- One Health recognizes that the health of people is connected to the health of animals and the environment



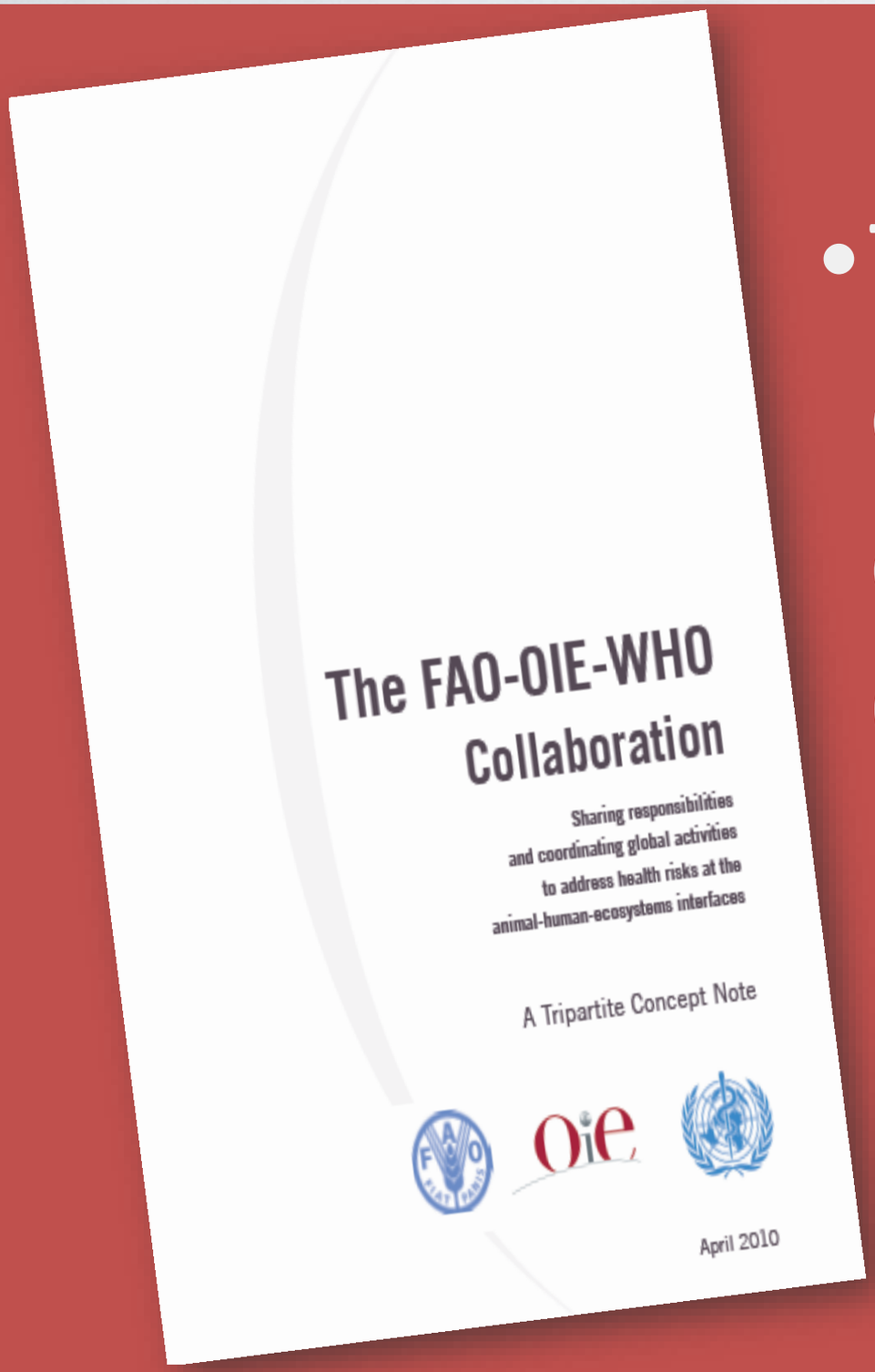
Hippocrates (Greek Physician)
"*On Airs, Waters, and Place*" promoted the concept that public health depended on a clean environment.

One Health initiative will unite human and veterinary medicine

www.onehealthinitiative.com

Collaborative, multisectoral efforts of **multiple disciplines** working **locally, nationally, and globally** to attain the best of health for **people** and other **animals**, **plants** and our **environment**.

FAO-OIE-WHO: An Intersectoral Global Strategy for "One Health"



- To address the health risks of human-animal-environment, the FAO-OIE-WHO framework have been applying **"One Health"** Approach.

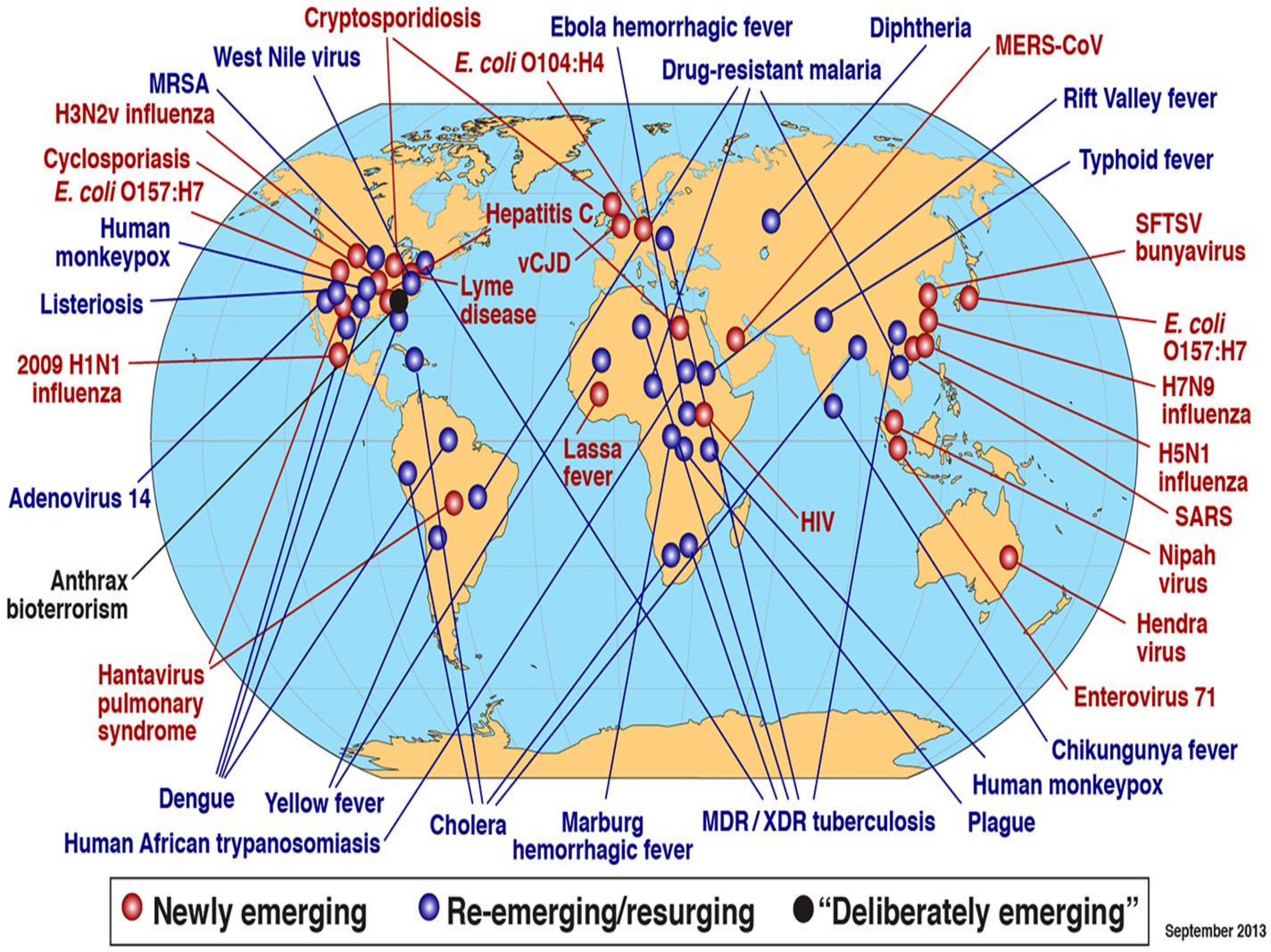
ONE HEALTH

Enhances the teamwork of physicians, veterinarians, animal scientists and other scientific health and environmental professionals, engineers for the optimal utilization of their expertise

WHY ONE HEALTH?

WHY ONE HEALTH?

- OH advances technologies and science-based evidence to increase the awareness, knowledge, and understanding of the interdependency of the health of humans, animals, and the environment


Cryptosporidiosis
Ebola hemorrhagic fever
Diphtheria
MERS-CoV
West Nile virus
E. coli O104:H4
Drug-resistant malaria
MRSA
H3N2v influenza
Rift Valley fever
Cyclosporiasis
E. coli O157:H7
Typhoid fever
Hepatitis C
SFTSV bunyavirus
Human monkeypox
vCJD
Lyme disease
Listeriosis
E. coli O157:H7
2009 H1N1 influenza
H7N9 influenza
Lassa fever
H5N1 influenza
Adenovirus 14
HIV
SARS
Nipah virus
Anthrax bioterrorism
Hendra virus
Hantavirus pulmonary syndrome
Enterovirus 71
Chikungunya fever
Human monkeypox
Dengue
Yellow fever
Plague
Cholera
MDR / XDR tuberculosis
Human African trypanosomiasis
Marburg hemorrhagic fever
Newly emerging
Re-emerging/resurging
"Deliberately emerging"
September 2013

PCARI- IHITM

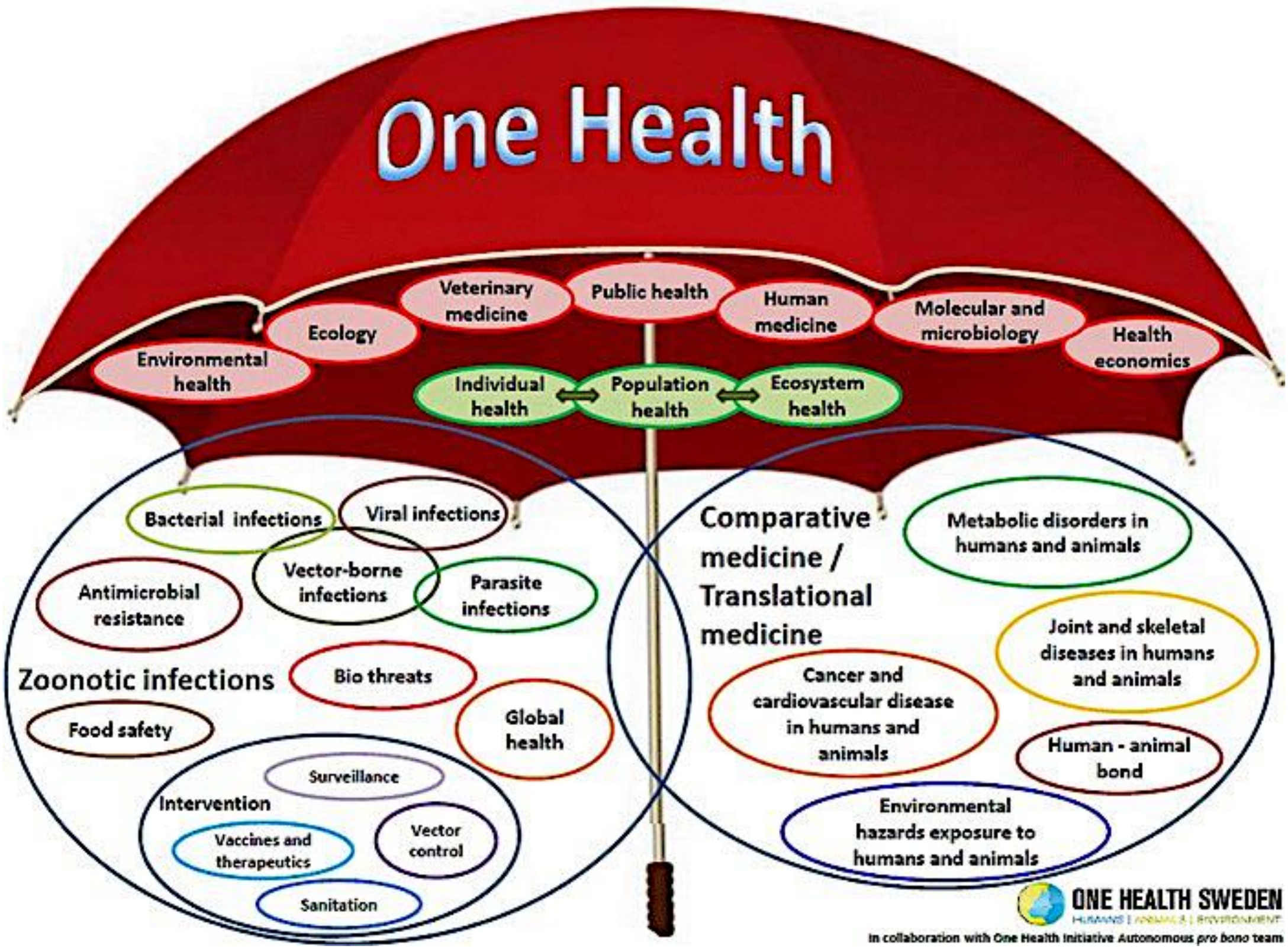
ONE HEALTH PROJECT:

Innovations in Early Detection and Interventions in Human, Animal, and Plant health

oneHEALTH

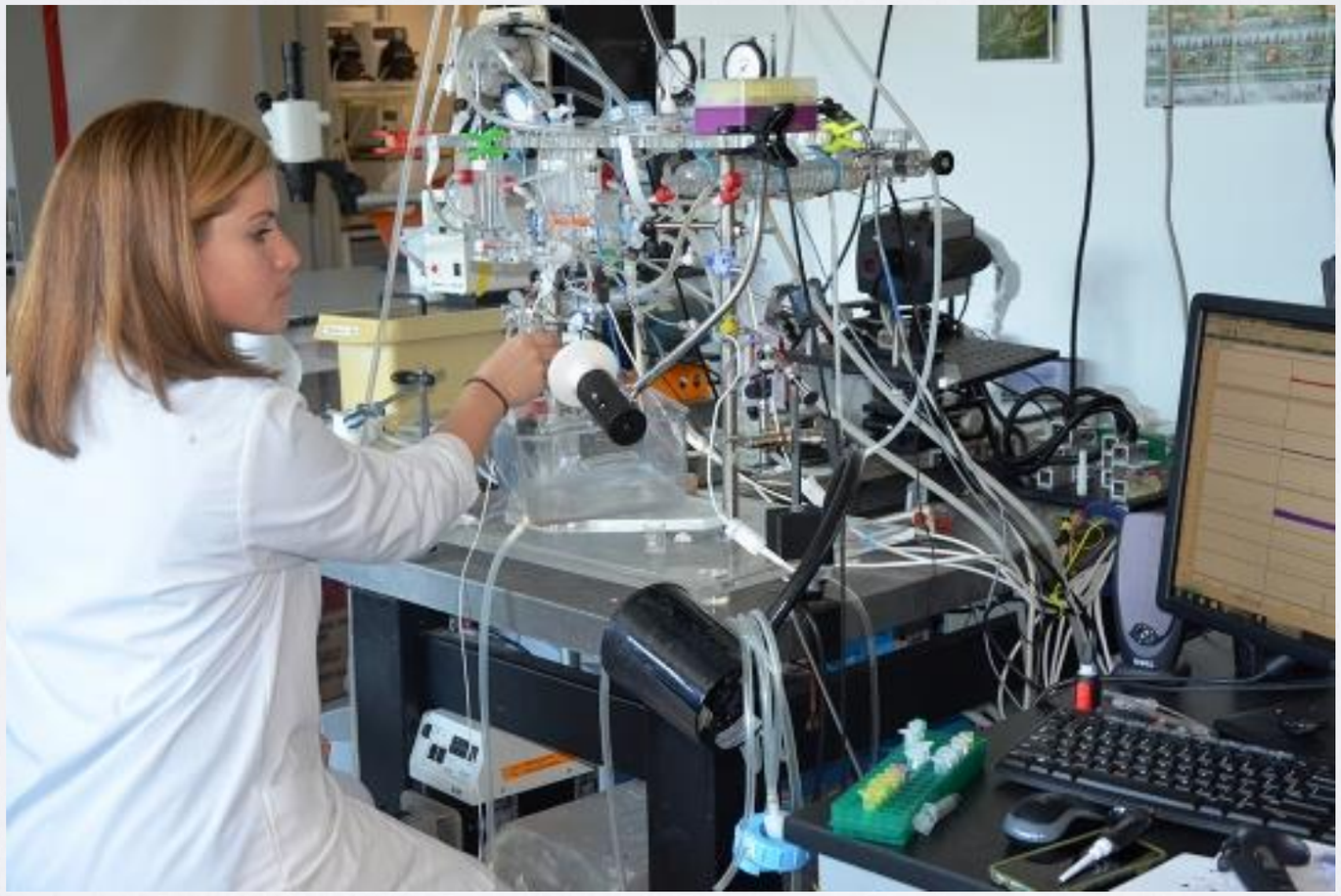
One Health Worker:
Last Sync: 3/23/19, 7:28 PM

Community Env. Screening	Routine Surveil-lance	Human Health Event
Human Bite/ Scratch	Human Pregnancy	Animal Health Event
Plant Health Event	Household/ Member Registra-tion	eSignature/ Incomplete Cases



Collaborative, multisectoral efforts of multiple disciplines working together for the promotion of health

BIOMEDICAL ENGINEERING



WHAT IS BIOMEDICAL ENGINEERING?

Multidisciplinary STEM field that combines biology and engineering, applying engineering principles and materials to medicine and healthcare

WHAT IS BIOMEDICAL ENGINEERING?

- Combines engineering principles with biological knowledge to address medical needs
- Contributes to the development of revolutionary and life-saving concepts such as:
  - Artificial organs
  - Surgical robots
  - Advanced prosthetics
  - New pharmaceutical drugs
  - Kidney dialysis

SOME SUBDIVISIONS OF BIOMEDICAL ENGINEERING:

- Biomedical Electronics
- Biomaterials
- Computational Biology
- Cellular, Tissue, and Genetic Engineering
- Medical Imaging
- Orthopedic Bioengineering
- Bionanotechnology

SPECIALTY AREAS WITHIN THE FIELD OF BIOMEDICAL ENGINEERING

- Bioinstrumentation
  - Using electronics, computer science, and measurement principles to develop instruments to diagnose and treat medical problems
- Biomaterials
  - Study of naturally occurring or laboratory-designed materials used in medical devices or as implantation materials

SPECIALTY AREAS WITHIN THE FIELD OF BIOMEDICAL ENGINEERING

- Biomechanics
  - Study of mechanics, such as thermodynamics, to solve biological or medical problems
- Clinical engineering
  - Applying medical technology to optimize healthcare delivery

SPECIALTY AREAS WITHIN THE FIELD OF BIOMEDICAL ENGINEERING

- Rehabilitation engineering
  - Study of engineering and computer science to develop devices that assist individuals recovering from or adapting to physical and cognitive impairments
- Systems physiology
  - Using engineering tools to understand how systems within living organisms, from bacteria to humans, function and respond to changes in their environment

IMPORTANT QUALITIES FOR BIOMEDICAL ENGINEERS

- Analytical skills

  - Analyzes the needs of patients and customers to design appropriate solutions

IMPORTANT QUALITIES FOR BIOMEDICAL ENGINEERS

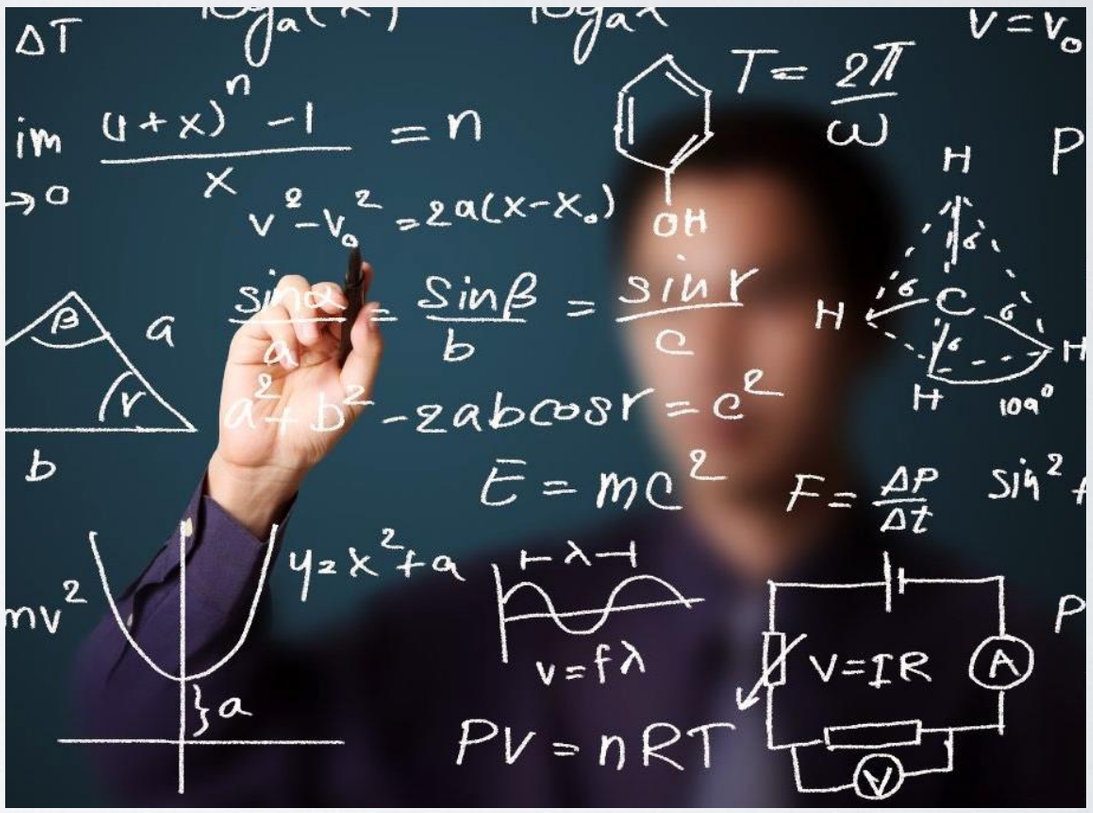
- Communication skills
  - Expresses their ideas clearly
  - Seeks others' ideas and incorporates those ideas into the problem-solving process

IMPORTANT QUALITIES FOR BIOMEDICAL ENGINEERS

- Creativity
  - Think up innovative and integrative advances in healthcare equipment and devices

IMPORTANT QUALITIES FOR BIOMEDICAL ENGINEERS

- Math skills
  - Using principles in calculus and other advanced topics in math and statistics to analyze, design, and troubleshoot their work



IMPORTANT QUALITIES FOR BIOMEDICAL ENGINEERS

- Problem-solving skills
  - Dealing with and solving problems in complex biological systems

HOW MUCH CAN YOU EARN AS A BIOMEDICAL ENGINEER?

- United States Department of Labor:
  - The mean annual wage for a biomedical engineer is $95,090
  - The highest ten percent of biomedical engineers can earn more than $144,350

BIOMEDICAL DEVICES

- Need to be constructed, assembled and processed in such a manner that they

  - Are Biocompatible
  - Can assume the mechanical and functional roles of the components they are replacing

WHAT DO **BIOMEDICAL ENGINEERS** TYPICALLY DO?

- Design biomedical equipment and devices, such as artificial internal organs, replacements for body parts, and machines for diagnosing medical problems

- Install, adjust, maintain, repair, or provide technical support for biomedical equipment

- Evaluate the safety, efficiency, and effectiveness of biomedical equipment

- Train clinicians and other personnel on the proper use of biomedical equipment

DUTIES OF **BIOMEDICAL ENGINEERS**

- Research the engineering aspects of the biological systems of humans and animals with life scientists, chemists, and medical scientists

- Prepare procedures, write technical reports, publish research papers, and make recommendations based on their research findings

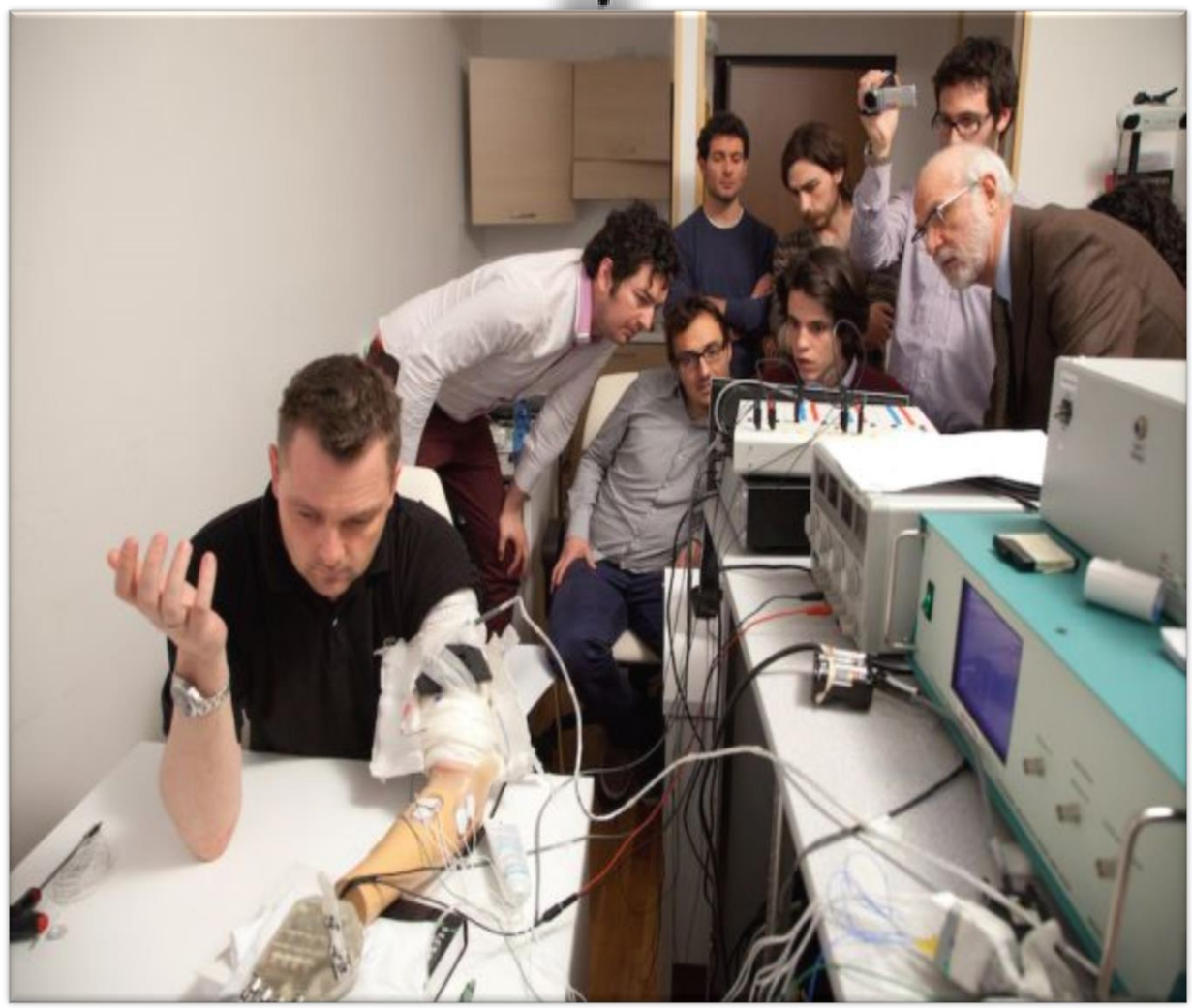
- Present research findings to scientists, nonscientist executives, clinicians, hospital management, engineers, other colleagues, and the public

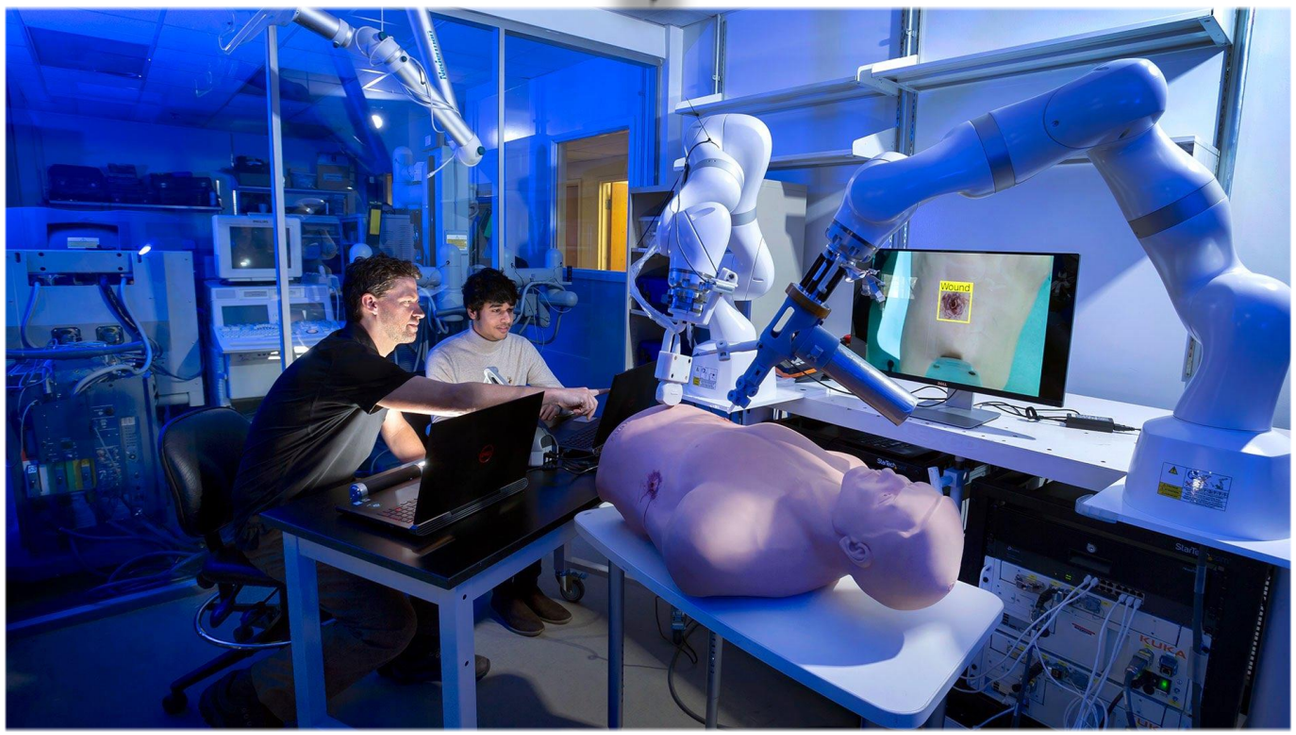
SOME LIFE-ENHANCING AND LIFE-SAVING TECHNOLOGIES DEVELOPED BY BIOMEDICAL ENGINEERS

Prosthetics

Dentures

Artificial limb replacements





Surgical devices and systems

Robotic and laser surgery

da Vinci surgical system used by doctors in performing robotic-assisted minimally invasive surgery

Systems to monitor vital signs and blood chemistry

CloudDX of Canada

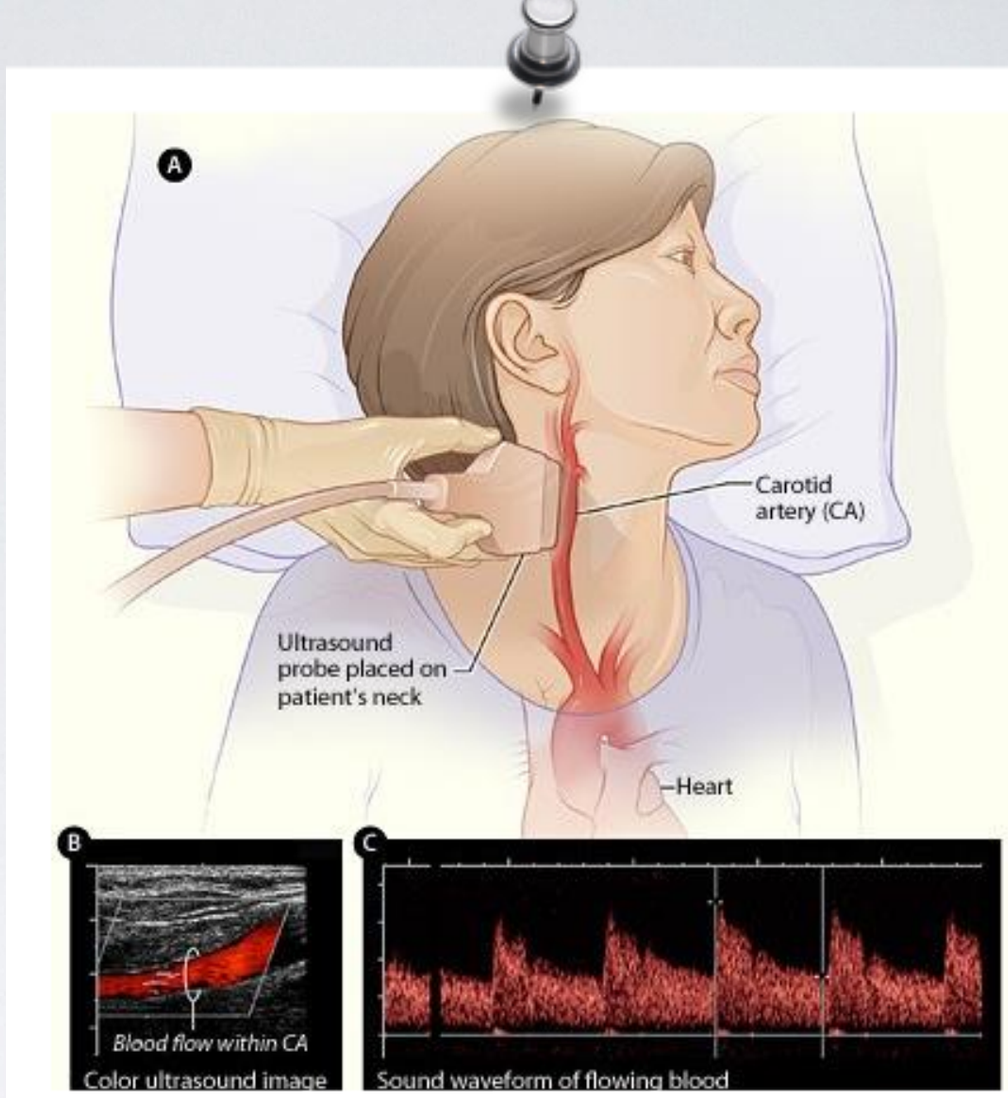
A necklace and cuff that can measure pulse, echocardiogram (ECG), blood oxygenation, temperature and other vital signs

Team Zensor of Northern Ireland

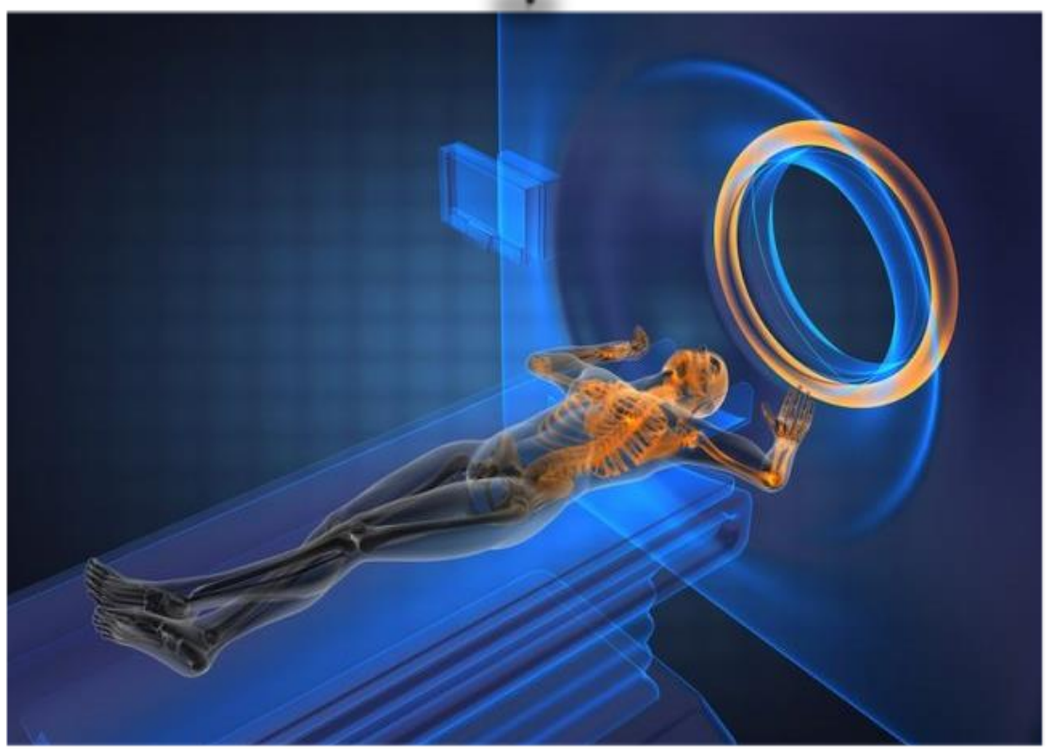
A device that can measure echocardiogram (ECG), respiration rate, temperature, motion, and blood and urine samples

Imaging methods

Ultrasound, X-rays, particle beams, and magnetic resonance



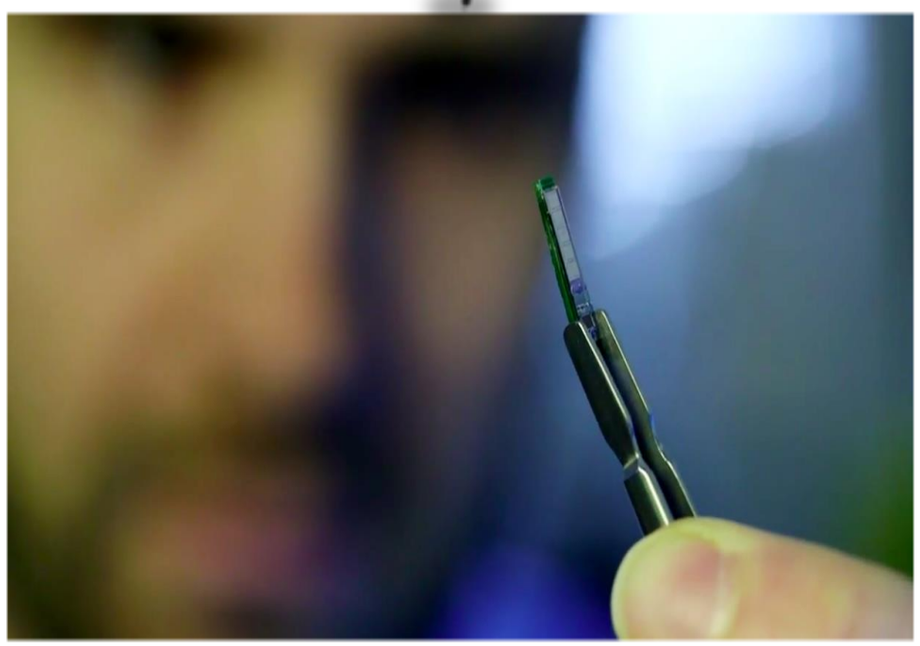
Functional ultrasound, including Doppler and color Doppler ultrasound for measuring and visualizing blood flow in vessels within the body or in the heart

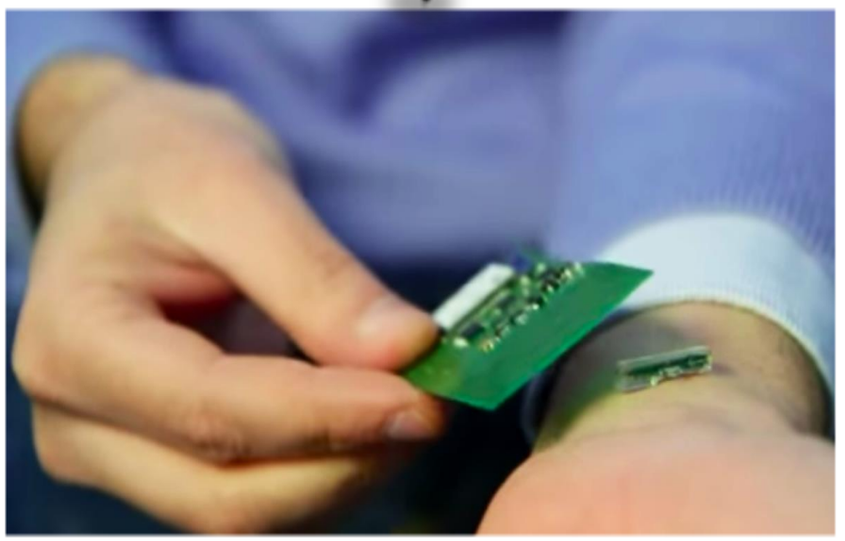


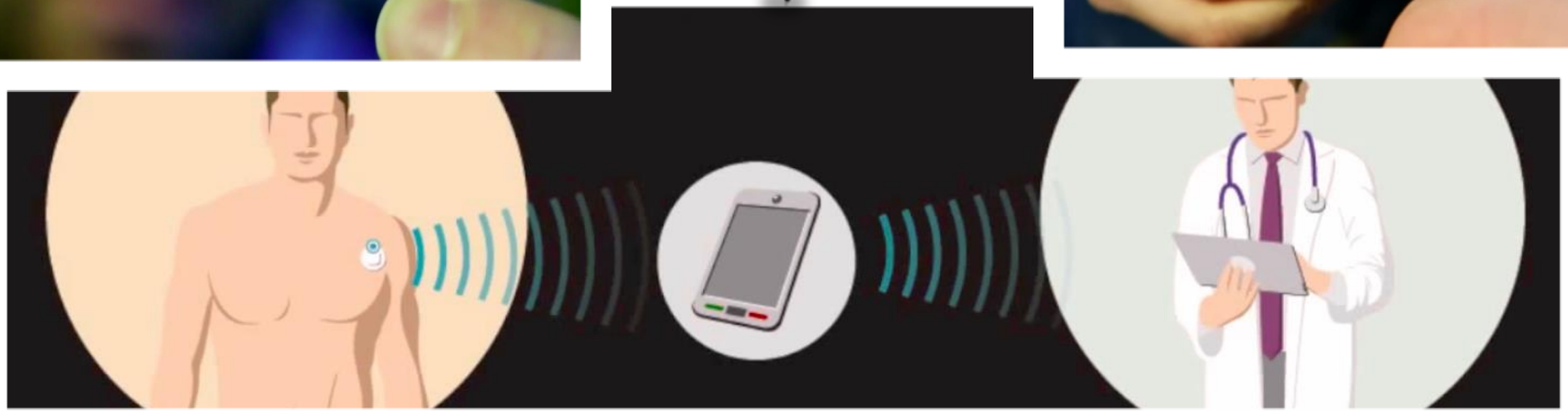
Magnetic resonance imaging (MRI) a scanning technique for creating detailed images of the human body

Diagnostics

Lab-on-a-chip and expert systems





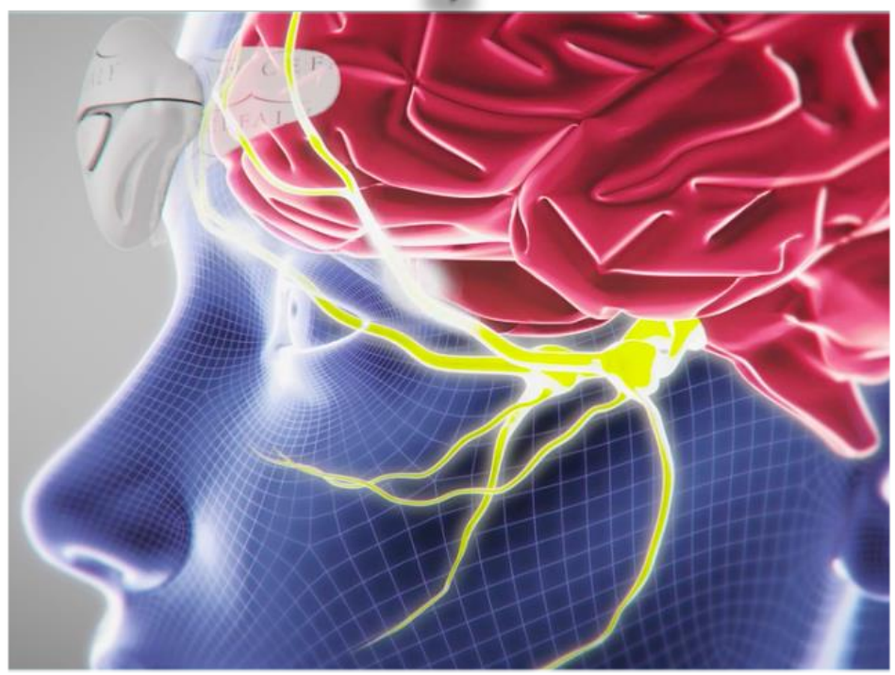


Therapeutic equipment and devices

Kidney dialysis

Transcutaneous electrical nerve stimulation (TENS)

Cefaly is an FDA approved device worn across the forehead as an alternative to pain medication for the prevention of migraines.



A modern radiotherapy treatment machine for cancer treatment.
The radiation beam can be pointed at the tumor along almost any direction

Radiation therapy

X-rays and particle beams

Physical therapy devices

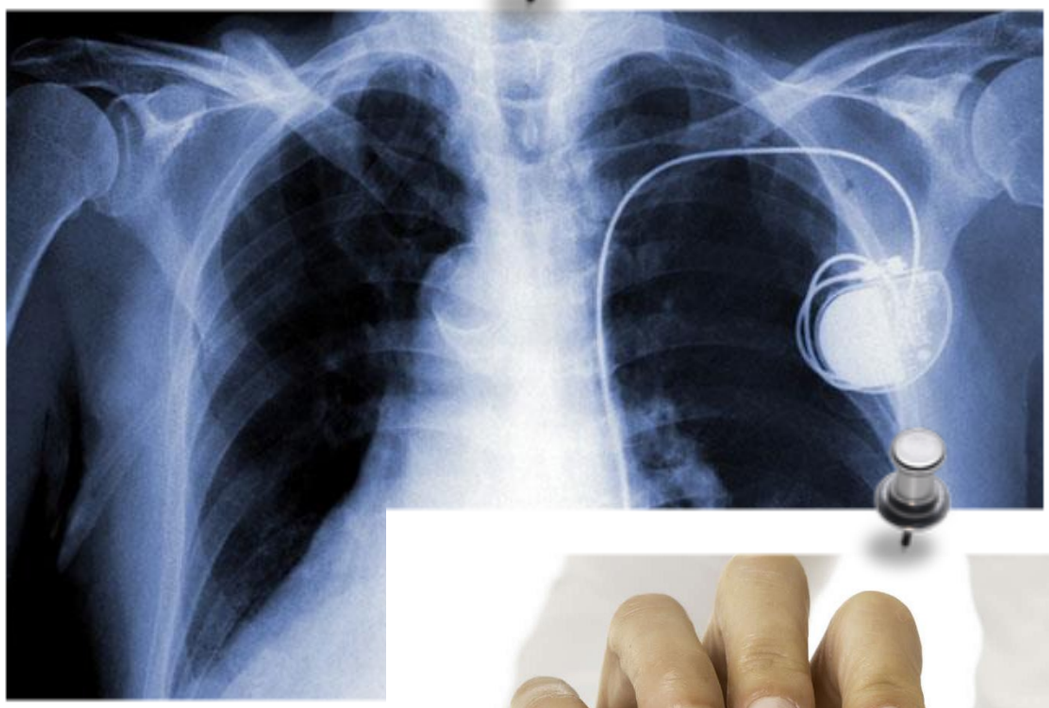
Exercise equipment and wearable tech

Wireless Upper Arm Blood Pressure Monitor

Fitbit Charge 3 shows information like the time, step count, or resting heart rate, health stats including: calories burned, female health tracking, active minutes, etc.

Implanted devices

Insulin pumps,
Pacemakers,
Artificial organs through 3D printing



Professor Alex Seifalian of the Royal Free Hospital in England with a synthetic trachea

INTEGRATIVE LABORATORY ANIMAL TESTING OF MEDICAL DEVICES FOR ABDOMINAL AND MUSCULO-SKELETAL DISORDERS

One Health Project funded by PCARI-CHED & PCHRD-DOST

ANIMAL SURGICAL LABORATORY
FOR HEALTH RESEARCH

ONE HEALTH APPLIED

PH-UC Collaboratory for Device Innovation

PH Biomedical Device Innovation Consortium

Training of Filipino medical surgeons at UCSF

Innovating biomedical devices

ONE HEALTH Facility:

Animal Surgical Laboratory

Testing the safety & efficacy of medical devices

RATIONALE

- Innovation

Medical device

Laboratory animals

- Safety & efficacy

- Final application

Humans

For testing of biomedical devices in medium-sized laboratory animals, (dogs, sheep, pigs and others)

ONE U.P.

Collaborative work among three campuses of the University of the Philippines System

UPLB	UPM	UPD
Veterinary doctors; Animal scientists	Medical doctors	Location

+ Engineers?

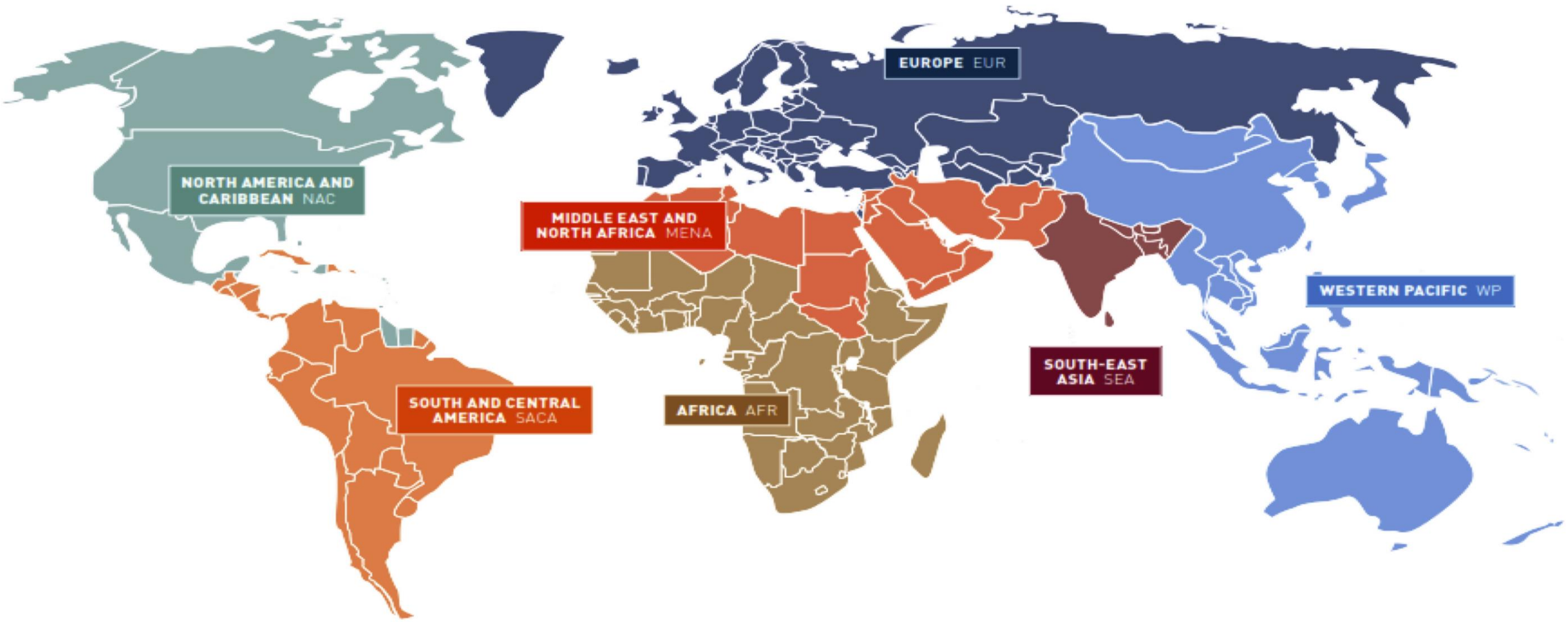
ONE HEALTH PROJECT

- Surgical & laparoscopic approaches for application of medical devices & perisurgical imaging
  - Project Leader: Dr. Loinda R. Baldrias
  - Consultant: Dr. Alfredo Acosta (Balik Scientist)

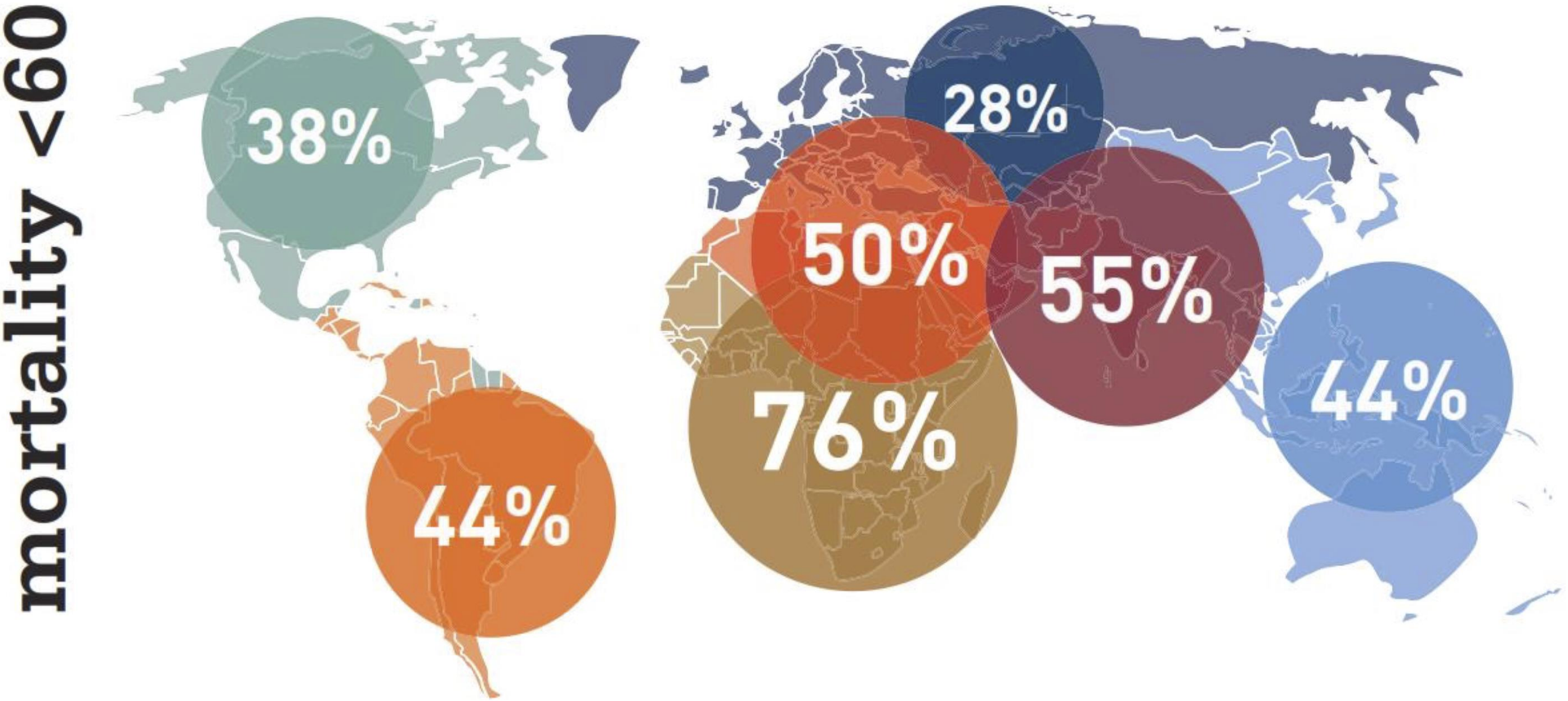
OH PROJECT TO ADDRESS DIABETES

- Diabetes: the silent killer
  - A condition in which a person has a high blood sugar (glucose) level as a result of the body either not producing enough insulin or because body cells do not properly respond to the insulin that is produced

IDF Regions and global projections of the number of people with diabetes (20-79 years), 2013 and 2035



IDF REGION	2013 MILLIONS	2035 MILLIONS	INCREASE %
Africa	19.8	41.4	**109%**
Middle East and North Africa	34.6	67.9	**96%**
South-East Asia	72.1	123	**71%**
South and Central America	24.1	38.5	**60%**
Western Pacific	138.2	201.8	**46%**
North America and Caribbean	36.7	50.4	**37%**
Europe	56.3	68.9	**22%**
World	**381.8**	**591.9**	**55%**



Proportion of deaths due to diabetes in people under 60 years of age, 2013

Diabetes poses a worldwide **epidemic threat** among developed and developing nations

INSULIN INJECTION

- Widely-used diabetes treatment but may:
  - Cause hypoglycemia
  - Cause autonomic failure
  - high risk of morbidity and mortality due to insulin resistance

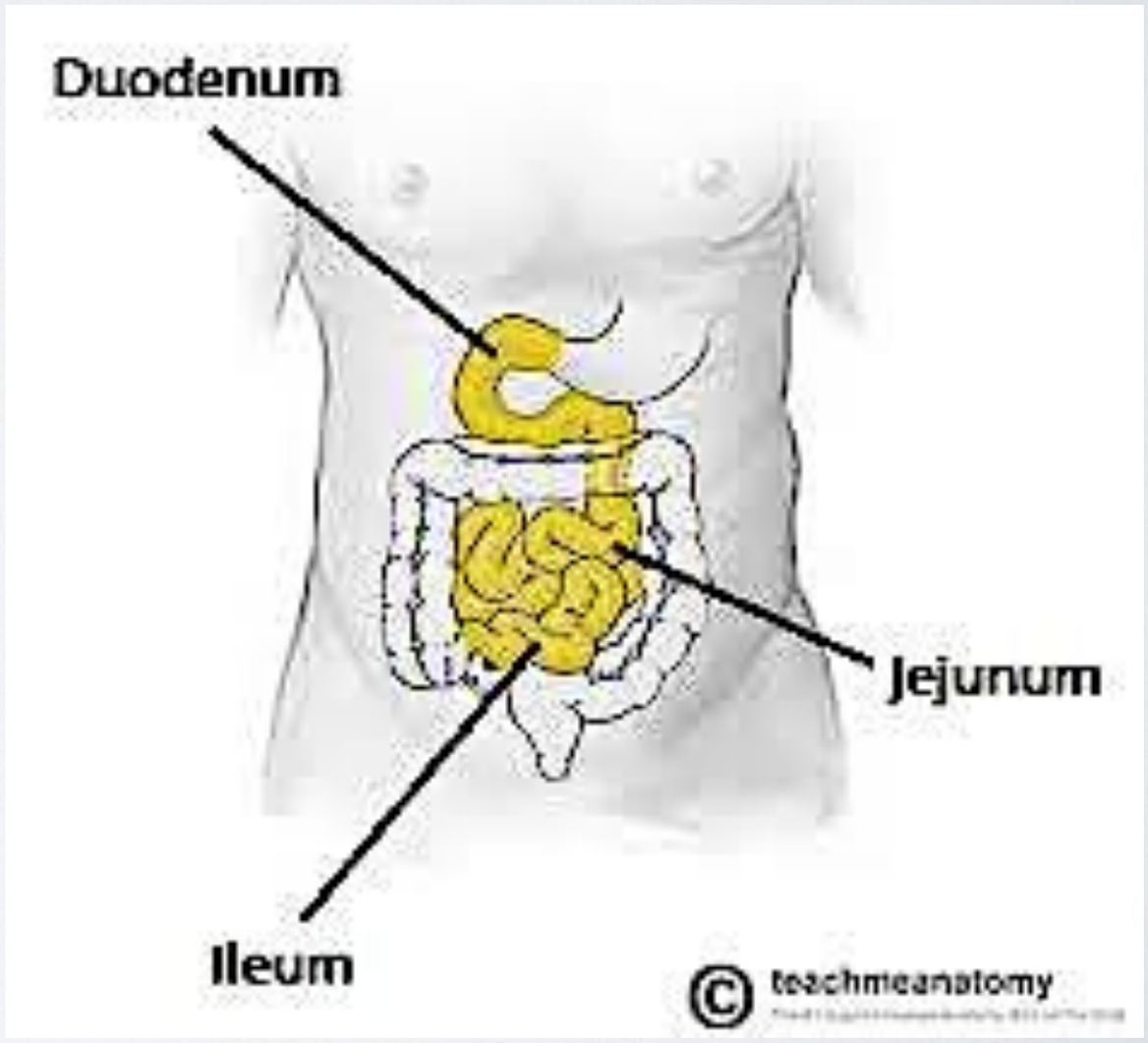
GLUCAGON-LIKE PEPTIDES (GLP) 1

- **GLP-1 – peptide** hormone produced by intestinal enteroendocrine L-cells;
  - augments beta cell regeneration;
  - produces endogenous insulin

- Significance: adjunct therapy for diabetes; may be used as an anti-diabetic treatment if it can be preserved from enzymatic degradation

OH PROJECT

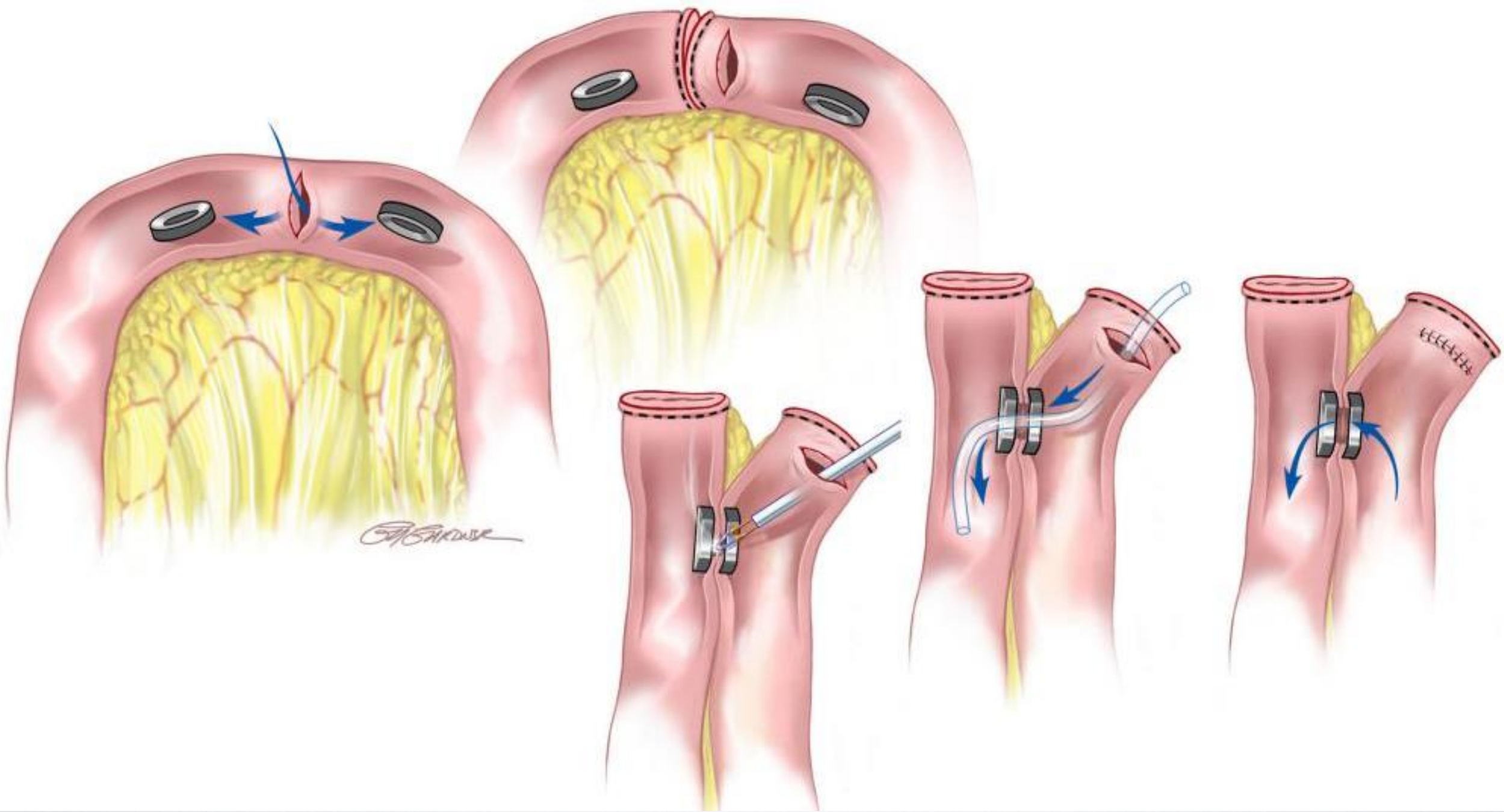
- Use of biomedical device to prevent enzymatic degradation of GLP-1



BIOMEDICAL DEVICE TO BE TESTED

- **Anastomotic Magnets**
  - Using it between the duodenum and the distal small intestine segments to prevent degradation o

ANASTOMOTIC MAGNETS



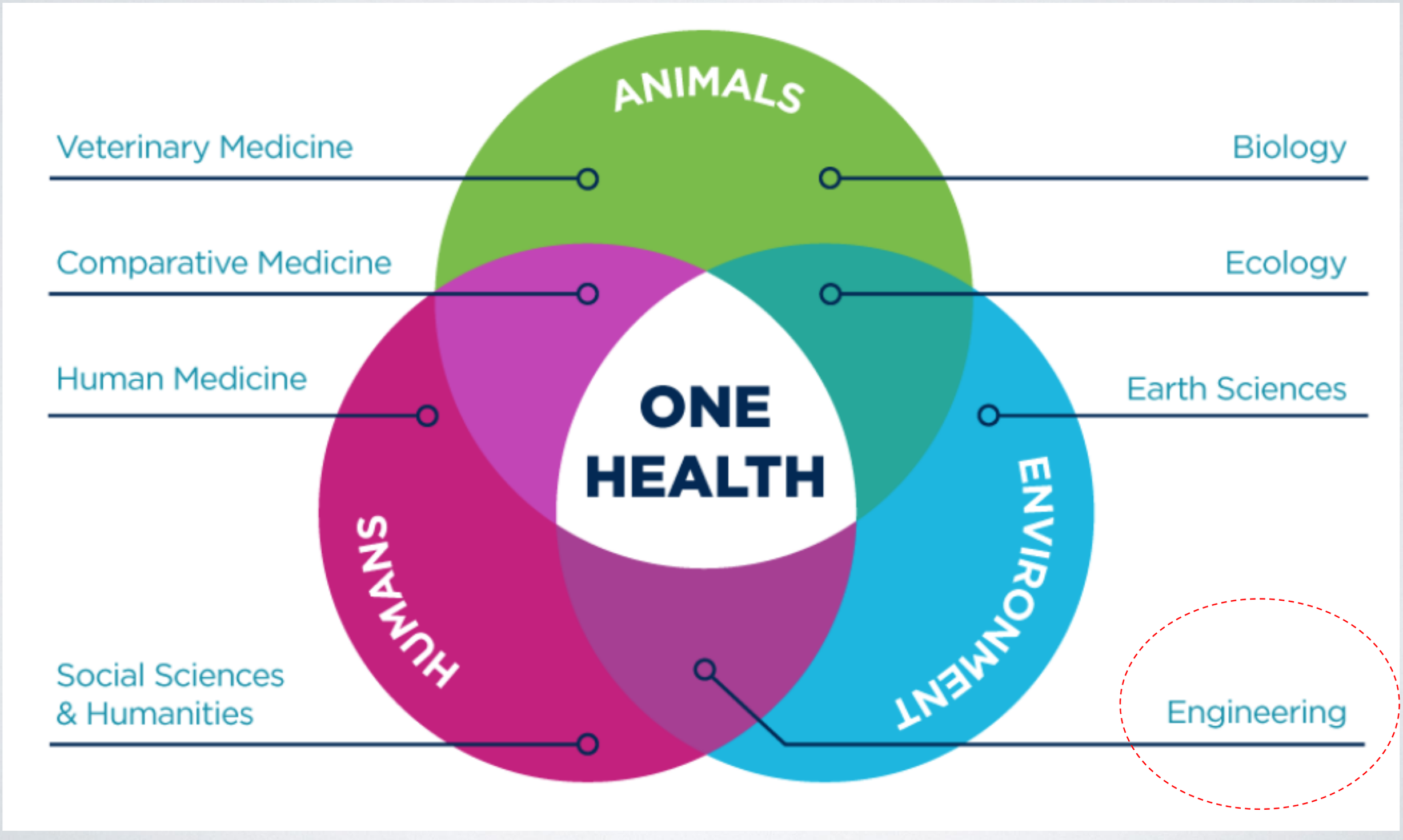
ONE HEALTH FACILITY:

ANIMAL SURGICAL LABORATORY

VETERINARY MEDICAL RESEARCH INSTITUTE (VMRI)

Funding agencies:

BIOENGINEERING TO DEVELOP BIOMEDICAL DEVICES



CONCLUSION

- Challenges we face demand that different professions need to work together
- Integrated surveillance: improve early recognition and control of zoonoses with syndrome reporting surveillance system
- Integrated BIOMEDICAL RESEARCH: improved development of diagnostics, therapeutics, medical devices

CONCLUSION

- Enhanced scientific knowledge and technology if we work together to better solve health problems.
- One Health implementation will benefit - protect & save lives during our generation & in future generations
- **COLLABORATION**: multi-disciplinary strategy to best promote health of man, animals and plants interacting in a complex, ever-changing natural environment

Thank you for listening!

Loinda Rugay Baldrias, DVM, MVS, PhD
lrbaldrias@up.edu.ph
College of Veterinary Medicine
University of the Philippines Los Baños

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