



**UTM**  
UNIVERSITI TEKNOLOGI MALAYSIA



**TECHNISCHE  
UNIVERSITÄT  
ILMENAU**

# ENGINEERING IN HEALTHCARE

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## OUTLINE

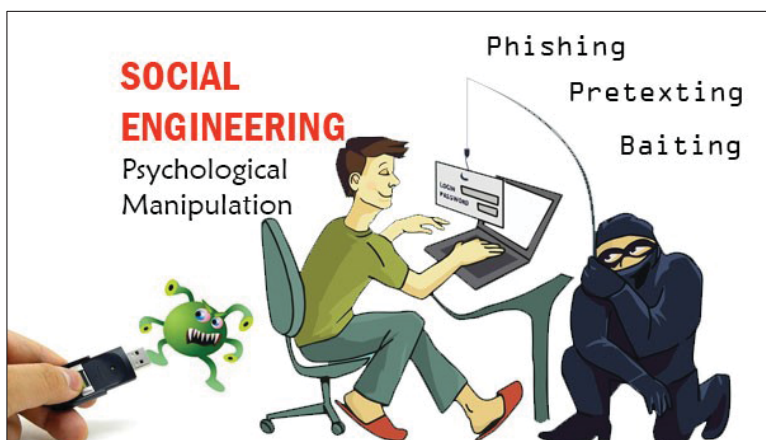
- INTRODUCTION
- HEALTH CARE SYSTEM
- ROLE OF ENGINEER
- BIOMEDICAL ENGINEERING
- FUTURE HEALTHCARE TECHNOLOGY

# INTRODUCTION

- **ENGINEERING DEFINITION [WEBSTER, DICTIONARY]**

- Design and build (a machine or structure).
  - "the men who engineered the tunnel"
- Modify (an organism) by manipulating its genetic material.
  - "genetically engineered plants"
- Skilfully arrange for (something) to occur.
  - "she engineered another meeting with him"
- The application of science and mathematics by which the properties of matter and the sources of energy in nature are made useful to people
- The design and manufacture of complex products : software *engineering*
- Calculated manipulation or direction (as of behavior): social *engineering*
- **Engineering** is the creative application of science, mathematical methods, and empirical evidence to the innovation, design, construction, operation and maintenance of structures, machines, materials, devices, systems, processes, and organizations.

# INTRODUCTION



# INTRODUCTION

- **HEALTHCARE DEFINITION [WEBSTER, OXFORD, DICTIONARY]**

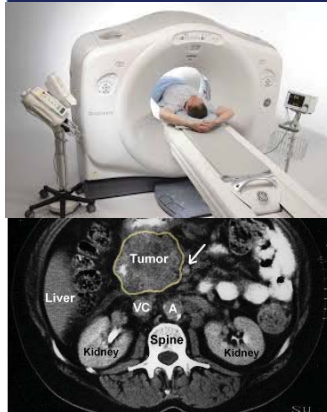
- Health care is efforts made to maintain or restore physical, mental, or emotional well-being especially by trained and licensed professionals.
- Health care is the maintenance or improvement of health via the prevention, diagnosis, and treatment of disease, illness, injury, and other physical and mental impairments in human beings.
- Health care is delivered by health professionals (providers or practitioners) in allied health fields. Physicians and physician associates are a part of these health professionals.
- Dentistry, midwifery, nursing, medicine, optometry, audiology, pharmacy, psychology, occupational therapy, physical therapy and other health professions are all part of healthcare.
- It includes work done in providing primary care, secondary care, and tertiary care, as well as in public health.

# INTRODUCTION

## PREVENTION (DETECTION)



## DIAGNOSIS



## TREATMENT



## REHABILITATION

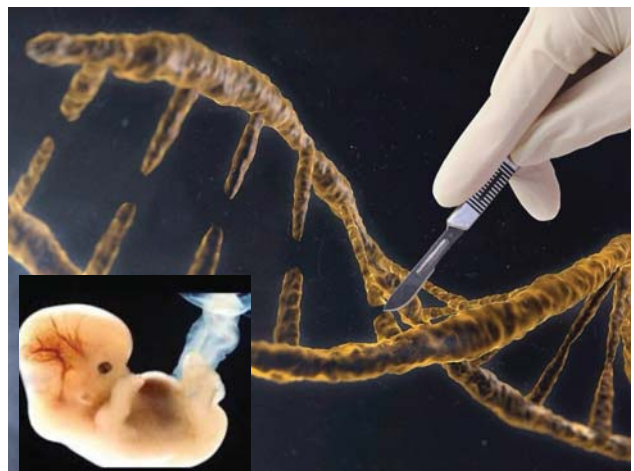


# INTRODUCTION

- **DEFINITION OF ENGINEERING IN HEALTHCARE**

- creative application of science, mathematical methods, and empirical evidence to the innovation, design, construction, operation and maintenance of  
structures, machines, materials, devices, systems, processes, and organizations for  
maintenance or improvement of health via  
the prevention, diagnosis, and treatment of disease, illness, injury, and other physical and mental impairments in human beings.

# INTRODUCTION

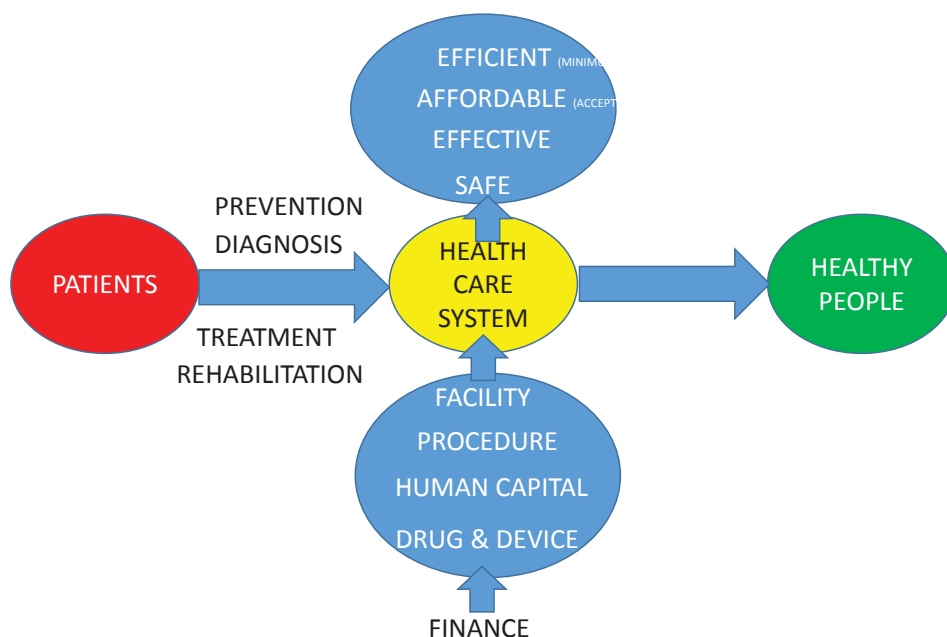


# INTRODUCTION

## • MOTIVATION

- TO SHARE KNOWLEDGE AND EXPERIENCE IN BIOMEDICAL ENGINEERING
- TO EXPLORE POSSIBLE RESEARCH COLLABORATION IN THE AREA OF ENGINEERING APPLICATION IN HEALTH CARE

# HEALTH CARE SYSTEM



# HEALTH CARE SYSTEM

## HEART PATIENT MANAGEMENT

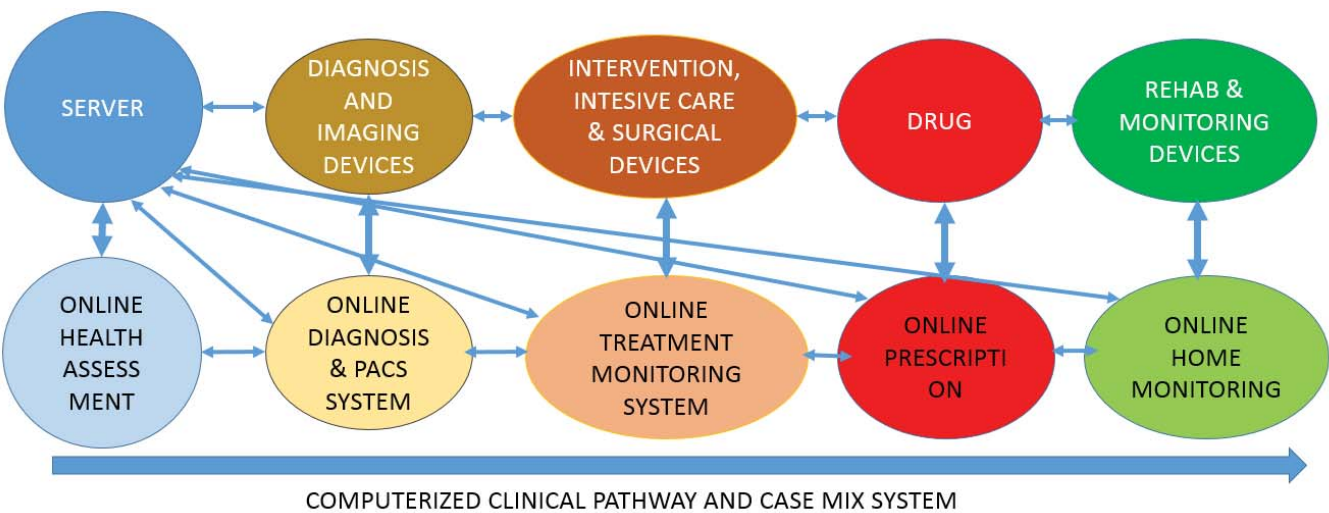
CLINICAL STAGE	PREVENTION	DIAGNOSIS	TREATMENT	REHABILITATION
CLINICAL ACTIVITY	<ul style="list-style-type: none"> <li>HEALTHY LIFE PROMOTION</li> <li>HEALTHY LIFE IMPLEMENTATION</li> <li>HEART RISK ASSESMENT</li> <li>EARLY DETECTION</li> <li>SUPPLEMENTATION</li> </ul>	<ul style="list-style-type: none"> <li>ECG MEASUREMENT</li> <li>ECHO IMAGING</li> <li>STRESS TEST</li> <li>BIOMARKER DETECTION</li> <li>CT IMAGING</li> <li>MRI IMAGING</li> </ul>	<ul style="list-style-type: none"> <li>MEDICATION</li> <li>INTERVENTION</li> <li>SURGERY</li> <li>INTENSICE CARE</li> </ul>	<ul style="list-style-type: none"> <li>PHYSICAL THERAPY</li> <li>MENTAL THERAPY</li> <li>SUPPLEMENTATION</li> <li>MEDICATION</li> <li>HOME MONITORING</li> </ul>
HEALTH PROFESSIONAL	GP / NURSE	SPECIALIST	SPECIALIST	GP / NURSE
IT SUPPORT SYSTEM	ONLINE HEALTH ASSESMENT	ONLINE DIAGNOSIS AND PACS SYSTEM	ONLINE INTENSIVE CARE MONITORING SYSTEM	ONLINE HOME MONITORING

## INCREASING ROLE OF MEDICAL INFORMATICS

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# HEALTH CARE SYSTEM

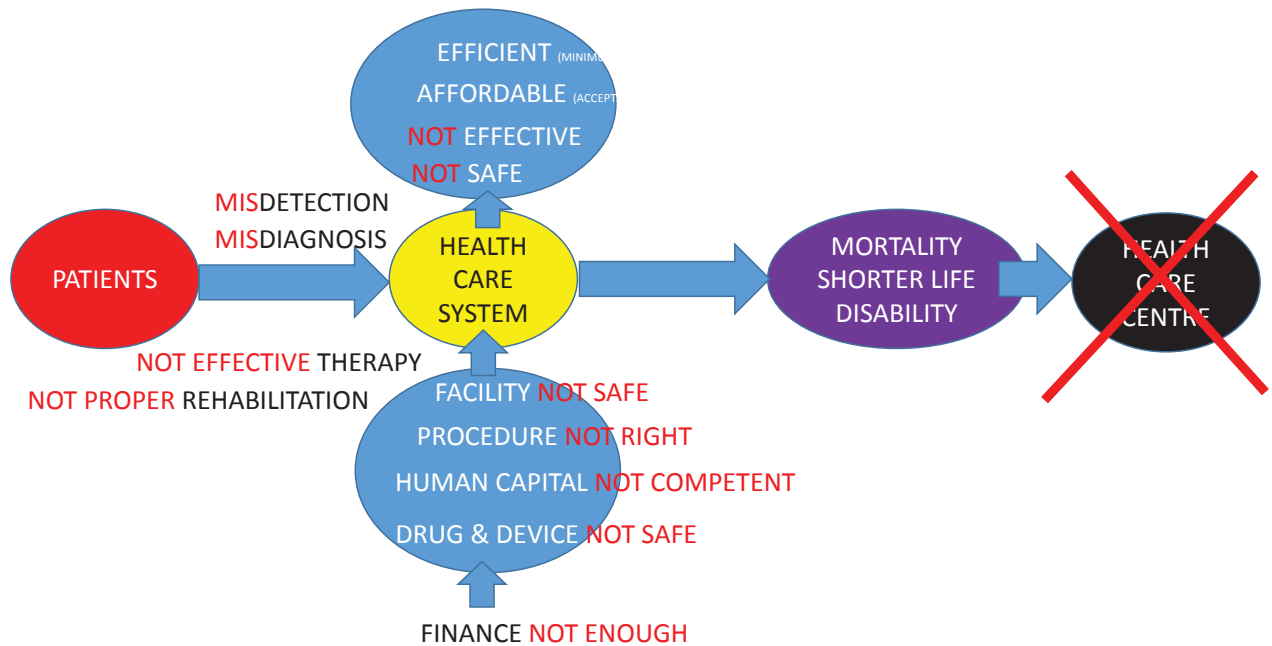
## • CURRENT PATIENT MANAGEMENT



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# HEALTH CARE RISK



# HEALTH CARE RISK

- INCUBATOR KILLS BABY

## Perawat Asyik Main Smartphone, Bayi Mungil Terpanggang Di Inkubator

Thursday, October 30, 2014 Berita Indonesia



## HEALTH CARE RISK

- VENTILATOR  
KILLS  
PATIENT



Youth Dies Alleged Ventilator Malfunction at MIMS, Angry Relatives Attack Hospital Staff

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## HEALTH CARE RISK

- X-RAY MACHINE  
KILLS PATIENT



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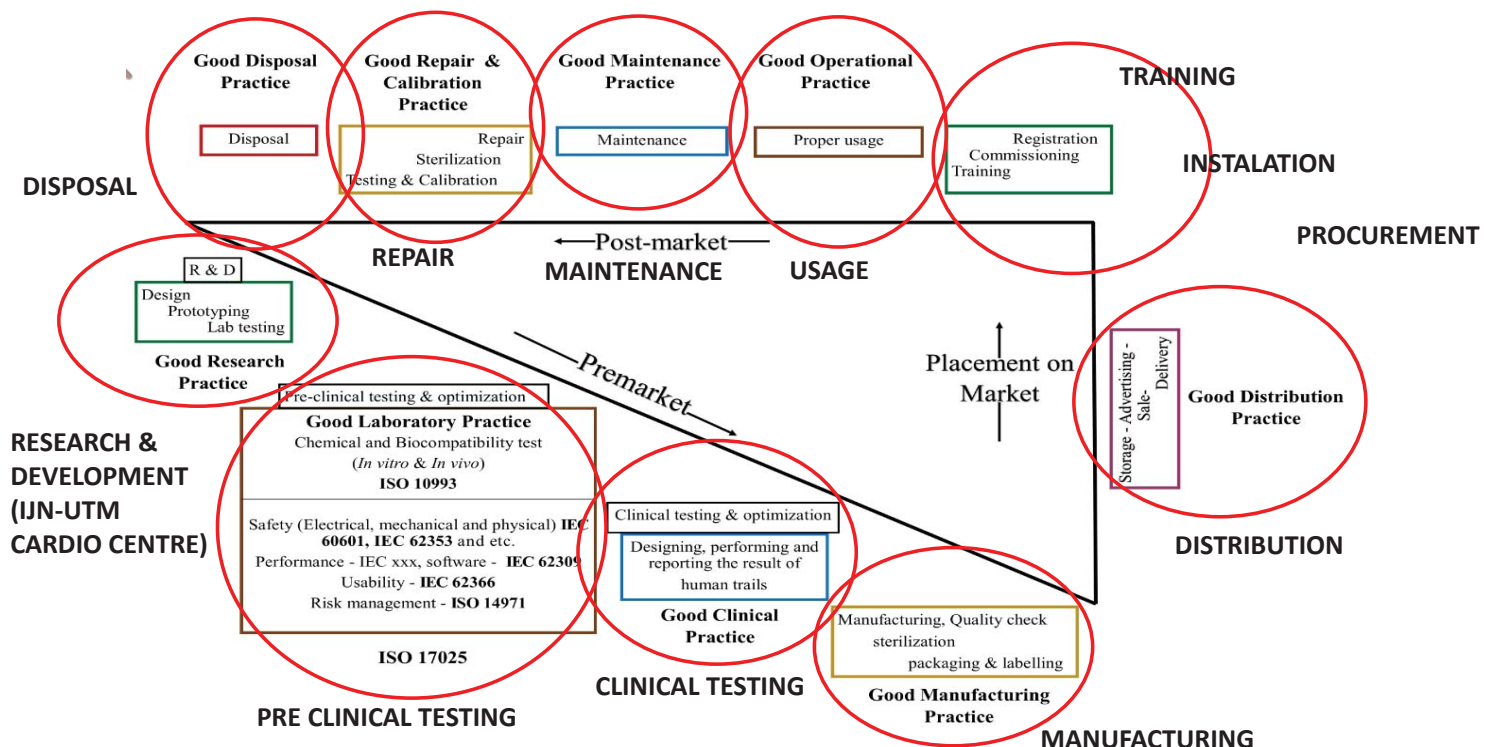


# HEALTH CARE RISK

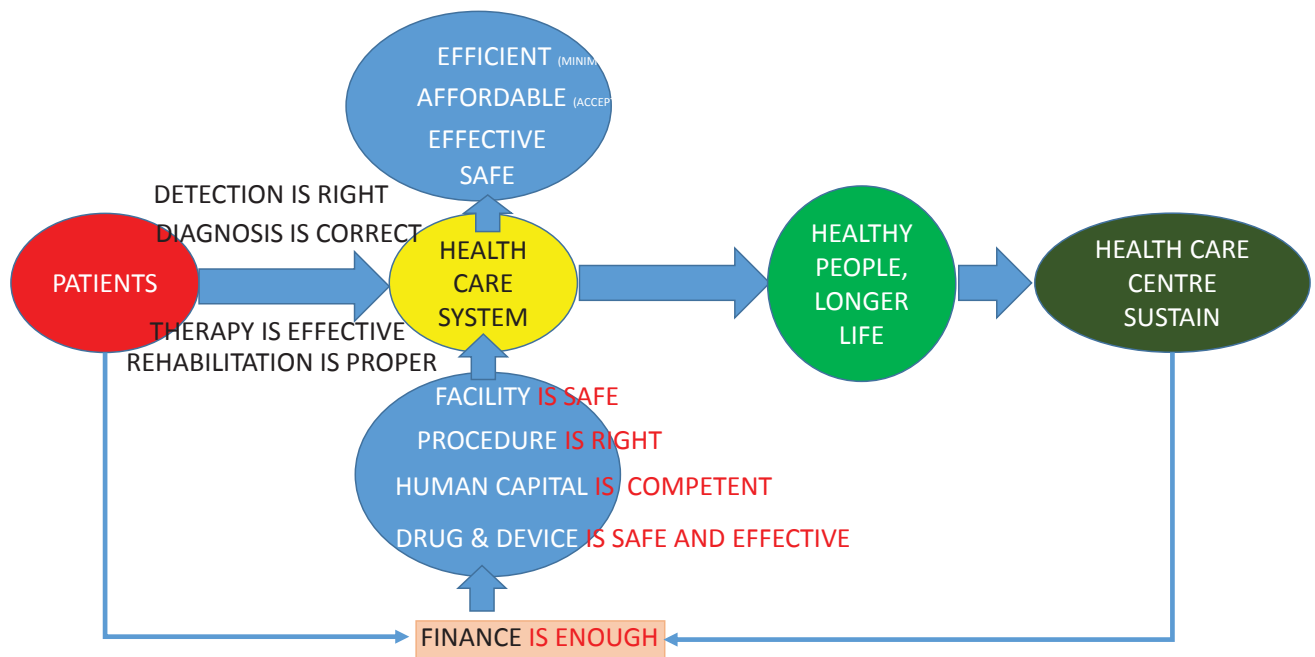
- REASON : MISTAKE IN THE ONE OR MORE MEDICAL DEVICE LIFE CYCLE STAGE
  - MISTAKE IN THE DESIGN
  - MISTAKE IN THE FABRICATION
  - MISTAKE IN THE TESTING
  - MISTAKE IN THE DISTRIBUTION
  - MISTAKE IN THE INSTALATION
  - LACK OF TRAINING
  - MISTAKE IN THE USAGE
  - LACK OF PREVENTIVE MAINTENANCE
  - REPAIR WITHOUT SAFETY TESTING
  - MISTAKE IN THE DISPOSAL (REUSE / REFURBISH)

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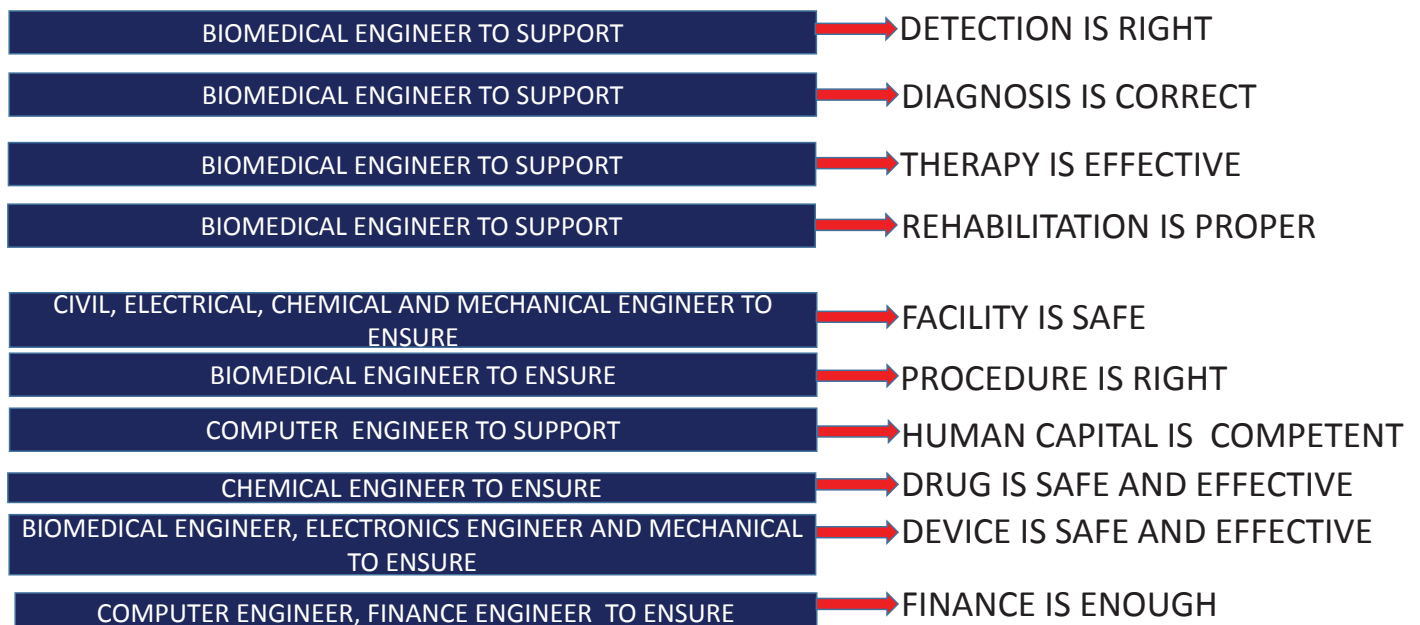
## MEDICAL DEVICE LIFE CYCLE MANAGEMENT



# HEALTH CARE RISK MANAGEMENT



## ROLE OF ENGINEER



# ROLE OF ENGINEER

- **ROLE OF ENGINEER IN DISEASES MANAGEMENT**

- STUDY OF DISEASES EPIDEMIOLOGY (STATISTICS) AND MECHANISM (MODELING) (**RESEARCH CENTRE**)
- DEVELOP INSTRUMENT, SOFTWARE, METHOD OR DEVICE TO MANAGE DISEASES INCLUDING PREVENTION, DIAGNOSIS, TREATMENT AND REHABILITATION (**MEDICAL DEVICE INDUSTRY**)
- SUPPLY, INSTALL, OPERATE, MAINTAIN, REPAIR AND CALIBRATE DEVICE FOR DISEASES MANAGEMENT (**HOSPITAL**)
- CONDUCT TRAINING TO SOLVE PROBLEM IN DISEASES MANAGEMENT (**HEALTH CENTRE, MINISTRY, UNIVERSITY**)

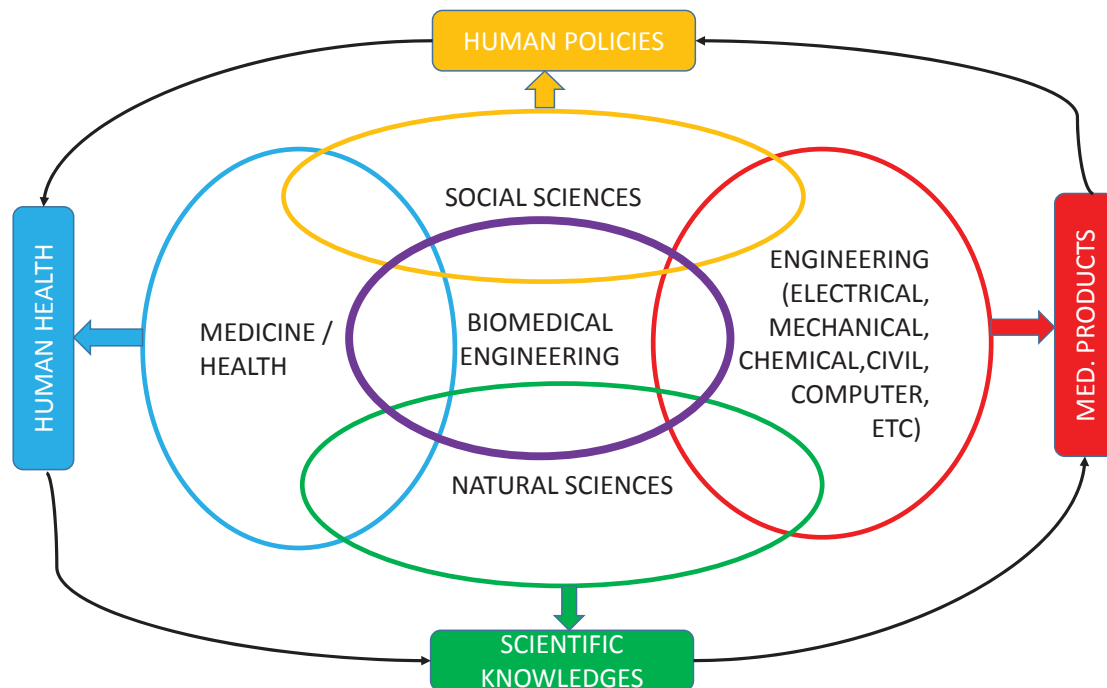
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# ROLE OF ENGINEER

- **MINISTRY OF HEALTH:**
  - REGULATOR, INSPECTOR, AUDITOR
- **INSURANCE COMPANIES**
  - ANALYST, AUDITOR
- **HEALTHCARE CENTRES**
  - HOSPITAL PLANNER
  - TRAINER
  - MAINTENANCE ENGINEER
  - TESTING ENGINEER
  - DEVICE MANAGER

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# BIOMEDICAL ENGINEERING



# BIOMEDICAL ENGINEERING

## Biomedical engineers typically do the following:

- Design equipment and devices, such as artificial internal organs, replacements for body parts, and machines for diagnosing medical problems (DEVELOPER)
- Install, adjust, maintain, repair, or provide technical support for biomedical equipment (OPERATION ENGINEER)
- Evaluate the safety, efficiency, and effectiveness of biomedical equipment (EVALUATOR)
- Train clinicians and other personnel on the proper use of equipment (TRAINER)
- Work with life scientists, chemists, and medical scientists to research the engineering aspects of the biological systems of humans and animals (RESEARCHER)
- Prepare procedures, write technical reports, publish research papers, and make recommendations based on their research findings (AUTHOR)
- Present research findings to scientists, nonscientist executives, clinicians, hospital management, engineers, other colleagues, and the public (PRESENTER)

# BIOMEDICAL ENGINEERING

The following are examples of specialty areas within the field of biomedical engineering:

- **Bioinstrumentation** uses electronics, computer science, and measurement principles to develop devices used in the diagnosis and treatment of disease. (Medical Electronics)
- **Biomaterials** is the study of naturally occurring or laboratory-designed materials that are used in medical devices or as implantation materials.
- **Biomechanics** involves the study of mechanics, such as thermodynamics, to solve biological or medical problems.
- **Clinical engineering** applies medical technology to optimize healthcare delivery. (Hospital Engineering)
- **Rehabilitation engineering** is the study of engineering and computer science to develop devices that assist individuals with physical and cognitive impairments. (Medical Electronics, Medical Informatics and Biomechanics)
- **Systems physiology** uses engineering tools to understand how systems within living organisms, from bacteria to humans, function and respond to changes in their environment. (Medical Informatics and Medical Physics)
- **Medical Informatics** apply ICT in the healthcare and diseases management.
- **Medical Physics** uses physics / radiation for diagnosis and treatment of diseases.

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# BIOMEDICAL ENGINEERING

MEDICAL DOCTOR	ENGINEER
Doctors, or physicians, examine patients to diagnose their conditions.	Engineers evaluate problems, processes or products to determine logical solutions.
Physicians ask patients about their prior medical histories, and they may inquire about illnesses or conditions that patients' family members might have had.	The task may require the development of an entirely new method or product, or the modification of existing processes and materials.
They ask patients to describe symptoms, including the duration and intensity. If necessary, physicians write orders for the patient to have lab tests conducted.	Engineers conduct research and tests, such as determining how well a new type of concrete can withstand earthquakes.
They may write prescriptions or recommend changes in lifestyle.	They may build prototypes or conduct all modelling in a computer.
Although physicians who are in private practice may primarily work normal business hours, they may also be on call for emergencies on holidays, at night or on weekends. Doctors who work at hospitals may have to work schedules outside of traditional hours.	Most engineers work traditional business hours and days, but overtime is sometimes required to meet deadlines.
Most physicians' offices employ a staff of nurses, medical assistants, billing specialists or receptionists.	Engineers might work alone, or they might supervise engineering techs, lab assistants, clerical personnel or even other engineers.


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# BIOMEDICAL ENGINEERING

PARAMATER	MEDICAL DOCTOR	ENGINEER
EDUCATION BACKGROUND	APPLIED BIOLOGY	APPLIED PHYSICS
THINKING METHOD	MEMORY BASED THINKING EVIDENCE BASED	CREATIVE THINKING PREDICTION BASED
CUSTOMER/HUMAN INTERACTION	PATIENT AS CUSTOMER	INDUSTRY AS CUSTOMER
RISK	PATIENT LIFE	PEOPLE LIFE & ENVIROMENT SAFETY
TESTING METHOD	ZERO FAILURE	FAILURE ANALYSIS (MANY FAILURE)
ETHICS	PATIENT SAFETY AND COMFORT	ORGANIZATION, ENVIROMENT
PROFESSIONAL ASSOCIATION	STRONG CONTROL	WEAK CONTROL
OBJECT	MOSTLY HUMAN	MOSTLY NON HUMAN

# BIOMEDICAL ENGINEERING

### Quick Stats

 **\$86,950**  
MEDIAN SALARY




 **2.6%**  
UNEMPLOYMENT RATE

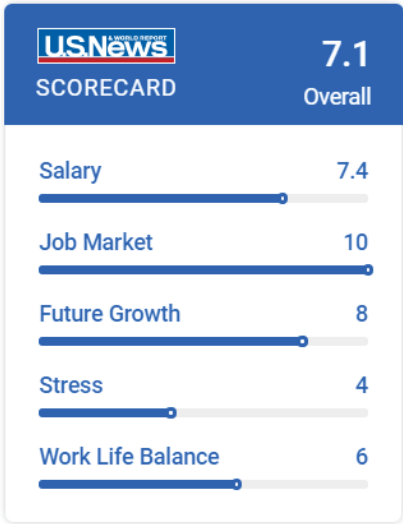
 **5,100**  
NUMBER OF JOBS

## Rankings

Biomedical Engineers rank #2 in [Best Engineering Jobs](#). Jobs are ranked according to their ability to offer an elusive mix of factors. Read more about [how we rank the best jobs](#).

### Biomedical Engineers are ranked:

-  #2 in [Best Engineering Jobs](#)
-  #6 in [Best STEM Jobs](#)
-  #27 in [The 100 Best Jobs](#)





# FUTURE HEALTHCARE TECHNOLOGY

- CONNECTED CARDIOVASCULAR DIAGNOSIS DEVICES



WIRELESS LONG TIME ECG MEASUREMENT DEVICE



WIRELESS CONNECTED SLEEP APNEA MEASUREMENT DEVICE

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# FUTURE HEALTH CARE TECHNOLOGY

- CONNECTED CARDIOVASCULAR TREATMENT DEVICES



ONLINE DEFIBRILLATOR

ONLINE INSULIN DELIVERY DEVICE

ONLINE PAIN MANAGER

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# FUTURE HEALTHCARE TECHNOLOGY

- CONNECTED CARDIOVASCULAR REHABILITATION / HOME MONITORING DEVICES



ONLINE POST SURGERY HEALTH MONITOR



ONLINE ELDERLY HEALTH MONITOR

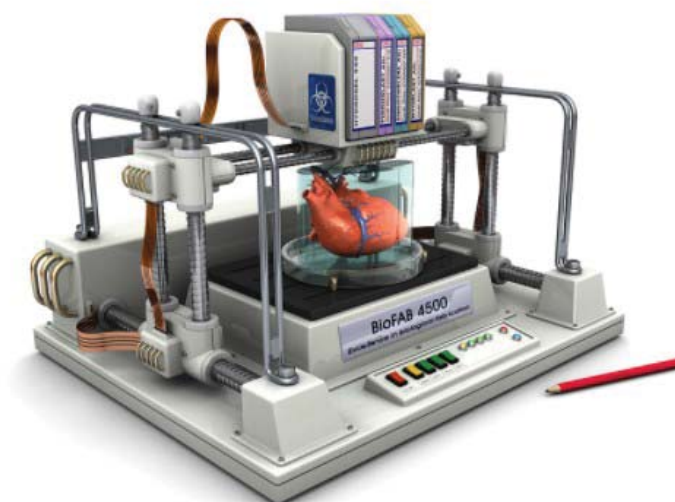


ONLINE VITAL SIGN MONITOR

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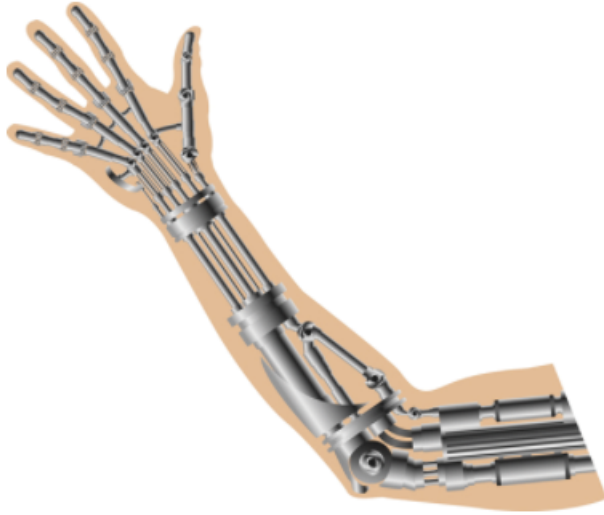
# FUTURE HEALTHCARE TECHNOLOGY

- 2025     **3D-printed human organs**



# FUTURE HEALTHCARE TECHNOLOGY

- 2026 **Robotic hands matching human capabilities**



# FUTURE HEALTHCARE TECHNOLOGY

- 2029 **Human-like AI is becoming a reality**



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# FUTURE HEALTHCARE TECHNOLOGY

- 2034 **Ectogenesis is transforming reproductive rights**



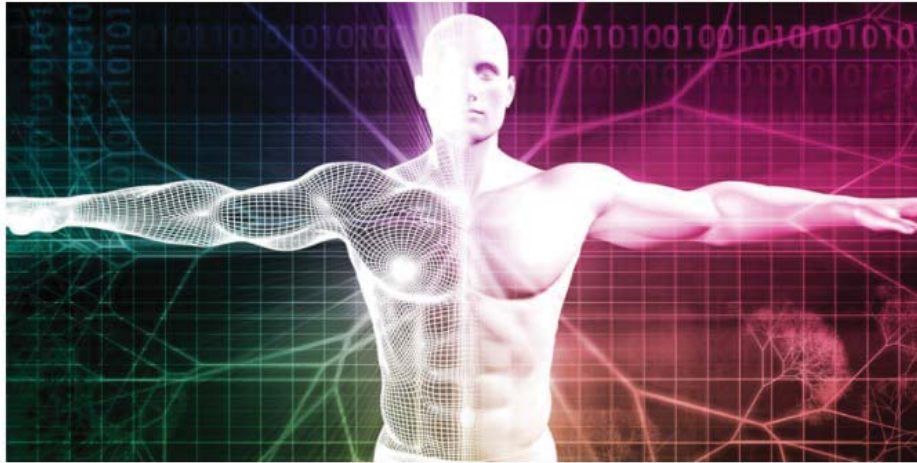
# FUTURE HEALTHCARE TECHNOLOGY

- 2035 **Swarm robotics are reaching the nanometre scale**



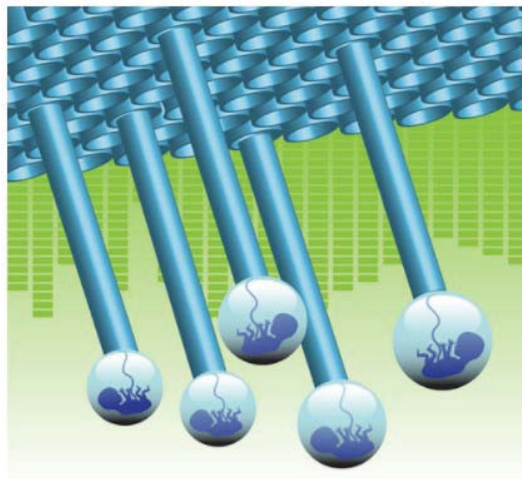
# FUTURE HEALTHCARE TECHNOLOGY

- 2036 **Transhuman sports competitors**



# FUTURE HEALTHCARE TECHNOLOGY

- 2053 **Genetically engineered "designer babies" for the rich**





# FUTURE HEALTHCARE TECHNOLOGY

- 2080 **Some humans are becoming more non-biological than biological**



# FUTURE HEALTHCARE TECHNOLOGY

- 2110 **AUTONOMOUS CANCER DIAGNOSIS AND THERAPY MACHINE**

