REGENERATIVE MEDICINE

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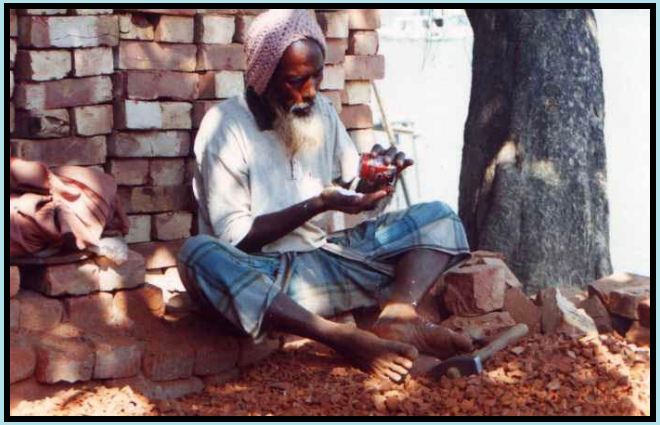
Scien

MANAGEMENT OF PUDs IN THE PAST

MEDICAL TREATMENT

- ANTACIDS
- ANTICHOLINERGIC DRUGS
- SODA (SODIUM BI CARBONATE)

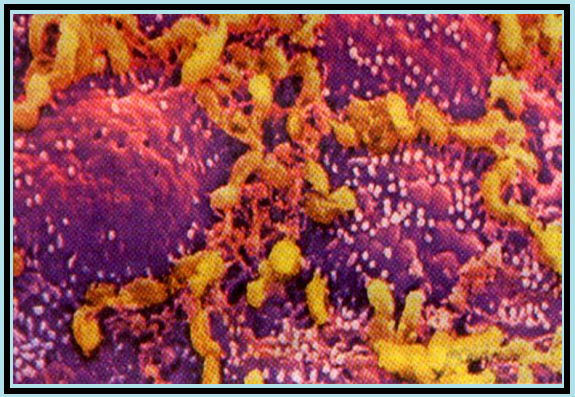


ROLE OF SURGEONS

CURRENT CONCEPT:
CURABLE DISEASE ?

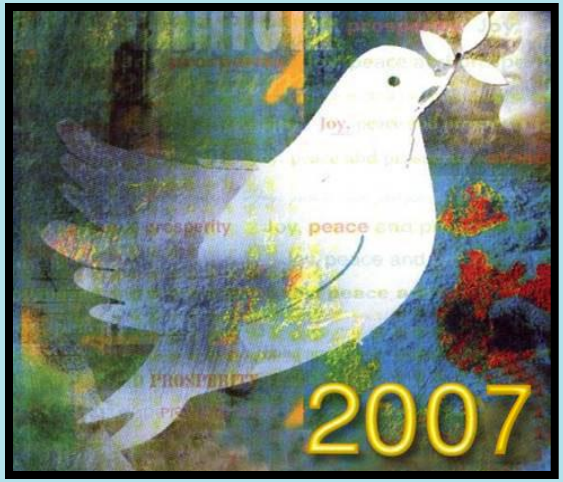
- OBJECTIVES IN THE PAST
- **- RELIEF OF SYMPTOMS**
- **- HEALING OF ULCER**
- **- PREVENTION OF RECURRENCE**

Helicobacter Pylori

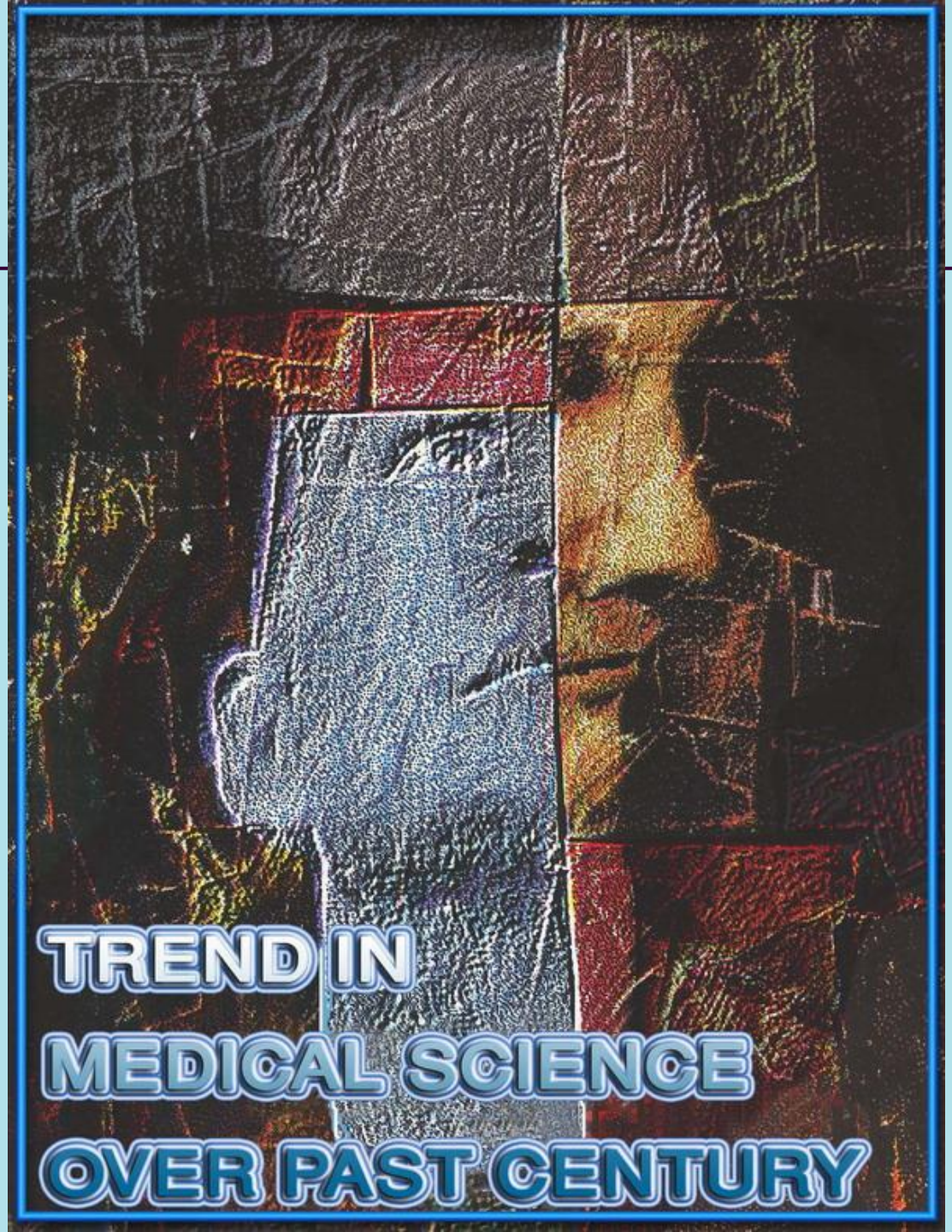


ELECTRON MICROGRAPH OF *Helicobector pylori* SPREAD ACROSS THE GASTRIC MUCOSAL SURFACE

ARE PUDs PREVENTABLE ?



INVENTION OF VACCINES AGAINST *H. pylori* INFECTION

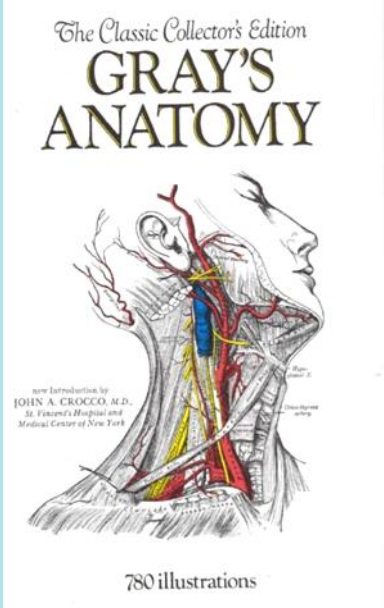

TREND IN
MEDICAL SCIENCE
OVER PAST CENTURY

Medicine and Technology

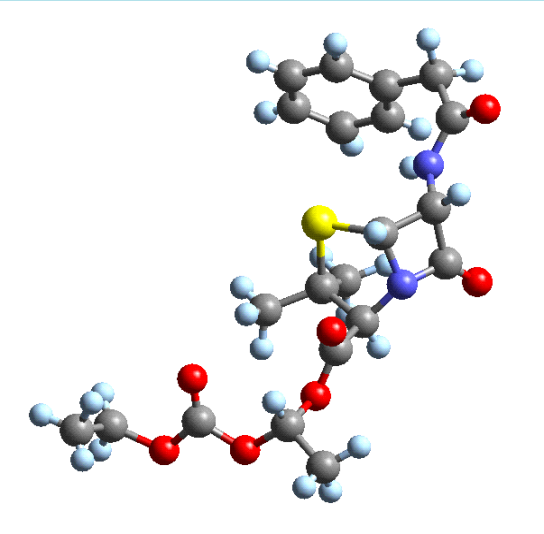
- Medicine increasingly technological
- Medical technology interacts with medical culture and organisation
- Medical eras
  - Overlaid on each other
  - Combination of medical technology and culture

Mechanical Medicine

- “Cut and sew”
- Up to WW II
- Anatomy, surgery, transfusions
- Bacteria and antiseptics
- Nobel prizes for specific diseases: 1901 von Behring (Diphtheria), 1902 Ross (Malaria), 1905 Koch (Tuberculosis).
- The surgery as the key hospital part



Chemical Medicine



- “Take a pill”
- Solve problem chemically
- Antibiotics, psychopharmacology
- Transplants
- Nobel prizes for treatment methods:

  1945 Fleming, Chain & Florey, 1948 Muller (DDT),

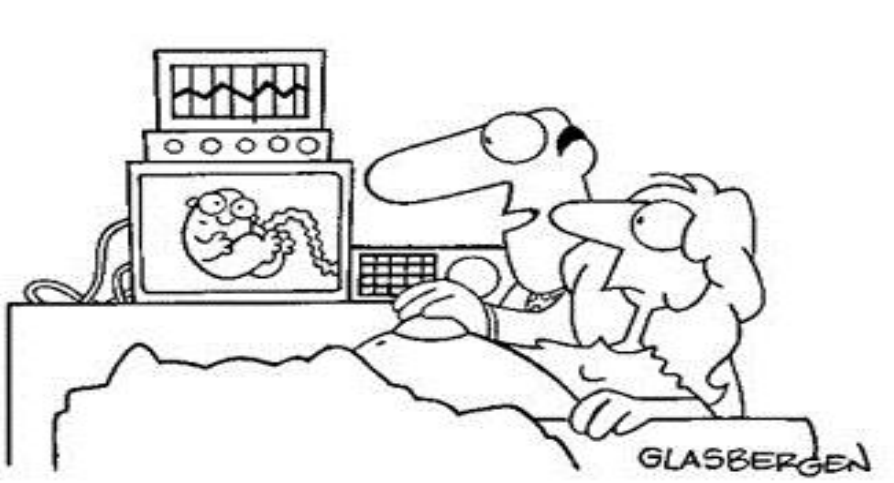
  1956 Cournand et al. heart catheter, 1979 Cormack & Hounsfield CAT scan, 1990 Murray & Thomas transplants
- Policlinical treatments

Electronic Medicine

- “The machine that goes ’bing’”
- Track body signals
- 70’s and forward
- Intensive care
- CAT/PET/MRI/Ultrasound
- Endoscopy, keyhole surgery
- Centralized technical systems at centralized hospitals

Current Known Trends

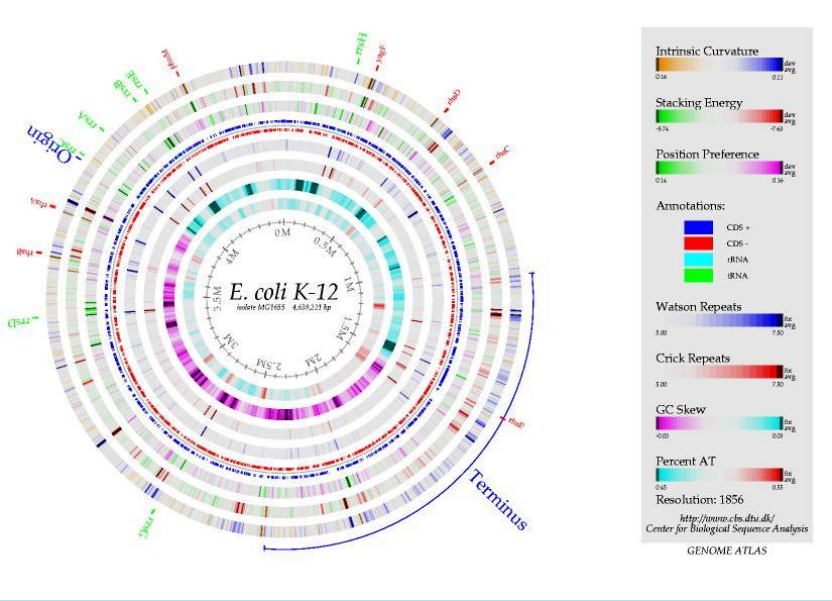
- Increasing globalization of medicine
- Doctor-patient relation changing
- Demographics: older population, more chronic illnesses
- What exists in the lab today



"Your baby is developing very nicely. Would you like to send him an e-mail?"

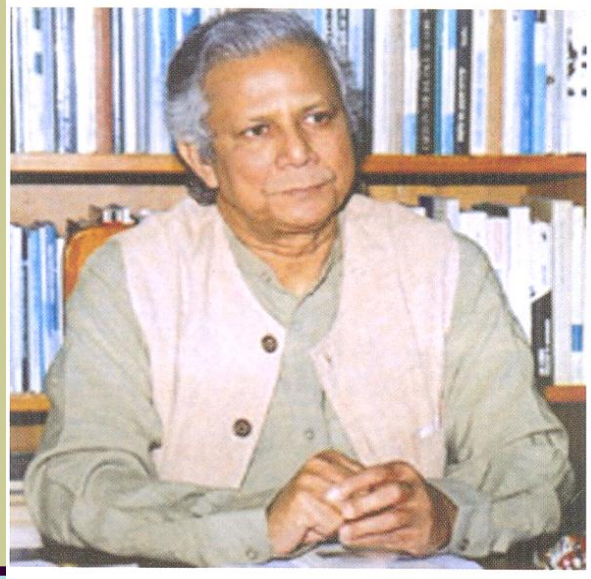
Transformative Technology

- Today nobel prizes on cell- and gene level
- Control at the lowest level
- “Human health is fundamentally biological, and biology is fundamentally molecular”
- Next likely medical eras:
  - InfoTech medicine
  - Biotech medicine
  - Nanotech medicine



Biotech Medicine

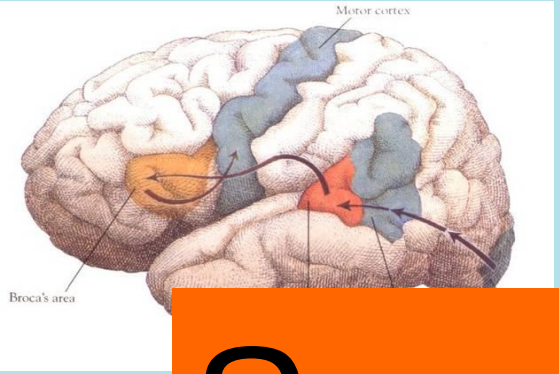
- Regenerative medicine
- Rational drug design
- Bionics
- Genetic testing
- Vaccines
- Enhancing medicine



Tributes to Country's first Nobel Laureate Muhammad Yunus

Cardiovascular Accidents

Stroke



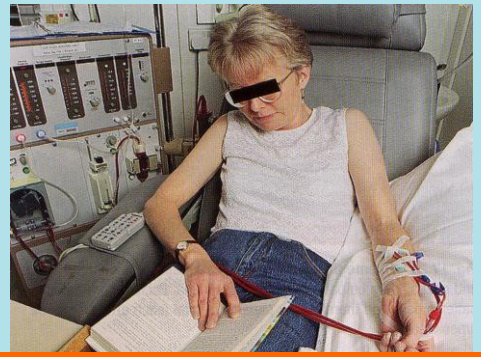
Myocardial Infarction

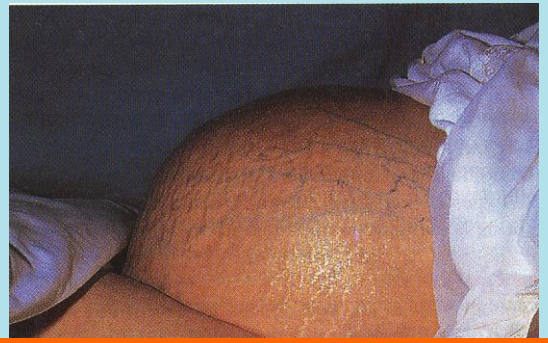
Scope For Organ Transplantation

Diabetes Mellitus

Hypertension

Organ Failure

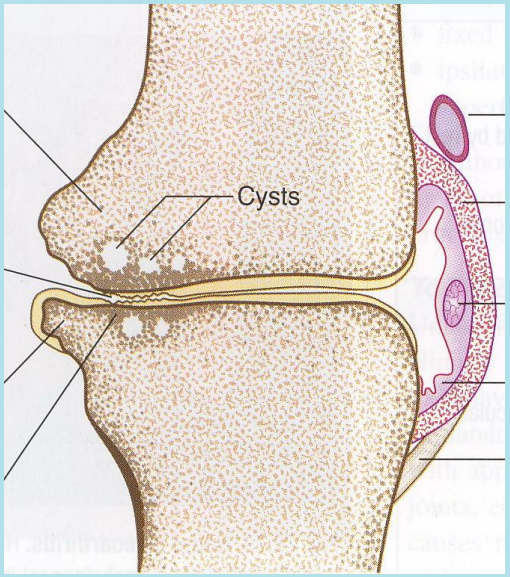




Scope For Organ Transplantation

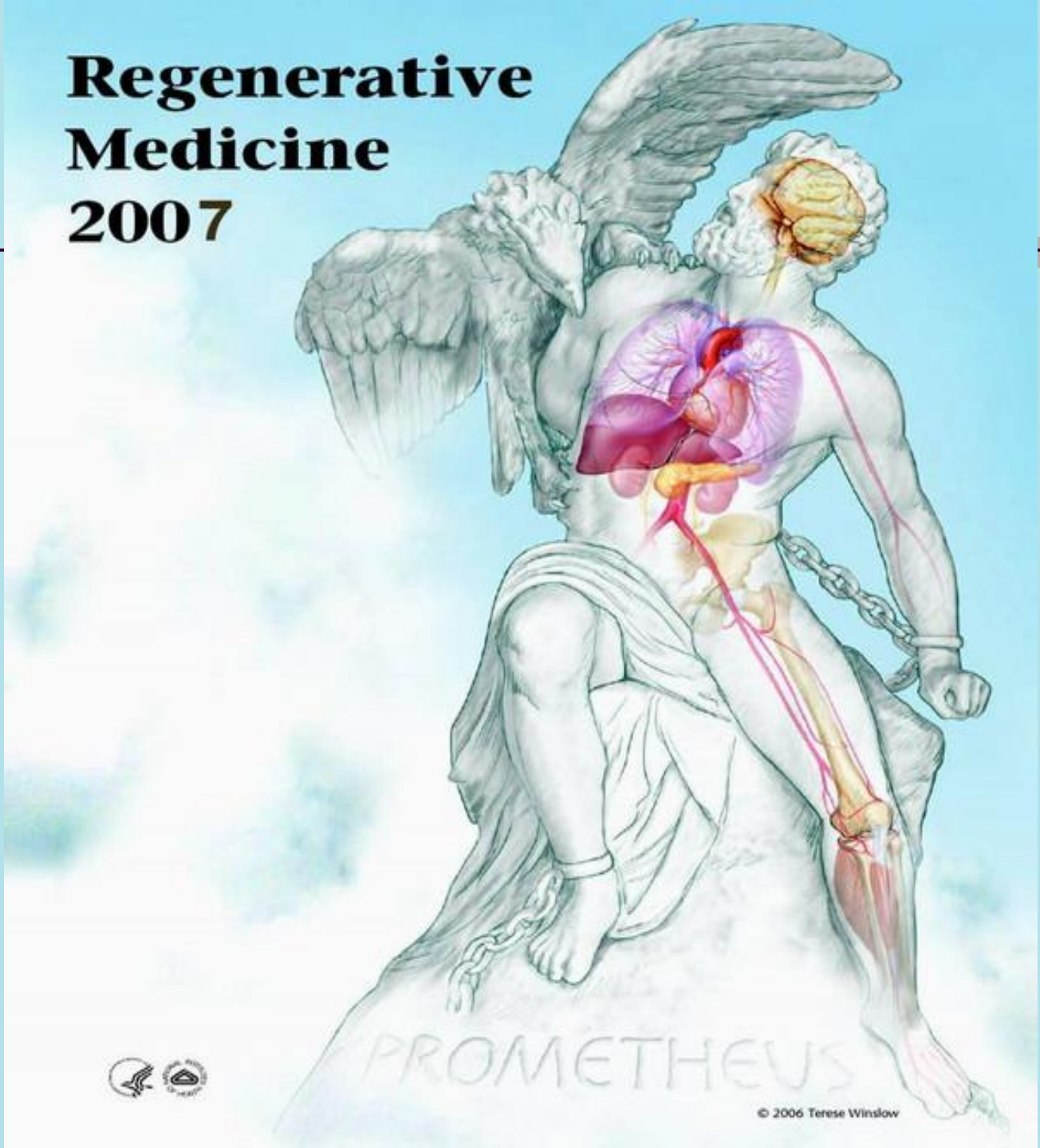
Heart Failure

Degenerative Diseases and others



Osteoarthritis

Parkinson's Disease


Regenerative
Medicine
2007
PROMETHEUS
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Definition of Regenerative Medicine

- Regenerative medicine is an emerging interdisciplinary field of research and clinical applications focused on the repair, replacement, or regeneration of cells, tissues, or organs to restore impaired function resulting from any cause, including congenital defects, disease, and trauma.

- It uses a combination of several technological approaches that moves it beyond traditional transplantation and replacement therapies.

- These approaches may include, but are not limited to, the use of stem cells, soluble molecules, genetic engineering, tissue engineering, and advanced cell therapy.

How regenerative medicine works

- Regenerative medicine is the application of tissue science, tissue engineering, and related biological and engineering principles that restore the structure and function of damaged tissues and organs.
- This new field encompasses many novel approaches to treatment of disease and restoration of biological function through the following methods:

- **Using therapies that prompt the body to autonomously regenerate damaged tissues**
- **Using tissue engineered implants to prompt regeneration**
- **Direct transplantation of healthy tissues into damaged environments**

How regenerative medicine works

- **Collectively, these treatments allow for two substantial advances over current medicine.**
- **The first advance is the potential to *in vivo (in the living body)* regenerate currently irreparably damaged tissues so that they return to full functionality.**
- **The second advance is to be able to produce tissues *in vitro (in the laboratory)* to be used for transplantation purposes when regeneration is not possible.**
- **This technology has the potential to cure diseases ranging from diabetes (through regeneration of islets) to the repair of cancerous tissues (by replacing the removed cancerous tissue with externally grown healthy tissue).**

By creating these "tissues for life," regenerative medicine treatments will undoubtedly lead to a tremendous improvement in quality of life and healthcare.

Why do we need Regenerative Medicine?

- Regenerative medicine is a revolutionary approach that focuses on curing conditions as opposed to treating them.
- Regenerative medicine empowers doctors with the ability to replace damaged tissue in patients with healthy organic tissue that is accepted and functions like the body's own.
- These therapies will cure a variety of diseases ranging from diabetes to cancer.
- Regenerative medicine will lead to improved patient care while eliminating the cost of treatments such as insulin injections or dialysis.

Regenerative Medicine is a cure, not a treatment

- What truly differentiates regenerative medicine from many current therapies is that regenerative medicine has the potential to provide a cure to failing or impaired tissues.
- One such example is insulin therapy for type 1 diabetes.
- While insulin can help patients manage diabetes, these therapies do not cure diabetes, nor do they prevent long-term complications, such as kidney failure.
- Through regenerative medicine, insulin-producing pancreatic islets could be regenerated *in vivo* or grown *in vitro* and implanted, creating the potential for curing the patient and completely eliminating the need for future treatments.

Regenerative Medicine is a cure, not a treatment

- **Other potential regenerative medical advances include the ability to improve myocardial (heart) functions, which would help combat heart failure.**
- **Regenerative medicine will enable doctors to grow new blood vessels through vascular endothelial growth factor (VEGF) techniques, and by improving myocyte growth.**
- **With these techniques, heart damage could be repaired, saving countless lives.**
- **Another benefit of regenerative medicine will be the advancement of our knowledge of the immune system as scientists**

Regenerative medicine can combat end-organ failure

- One of the greatest needs for regenerative therapy is in the field of whole organ replacement.

- Despite broad public education about organ donation, there remains a large and growing gap in the number of organ donors *versus* the demand for organs.

- In 2002 alone, there were:

  - **12,800 organ donors (deceased and living)**
  - **24,900 life saving transplants**
  - **88,242 patients still on the waiting list at the end of the year**
  - **6,439 people who died while waiting for a transplant.**

REGENERATIVE MEDICINE &

STEM CELLS

What are “stem cells”?

- Stem cells are cells that display the abilities

  (1) to self-renew (i.e., to divide and give rise to other stem cells) and

  (2) to produce offspring that develop each of the specialized functions of the body (e.g., blood cells, brain cells, heart cells, kidney cells, etc.)

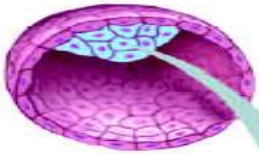
- In vertebrates, stem cells have classically been divided into two groups: embryonic stem cells and somatic or adult stem cells.

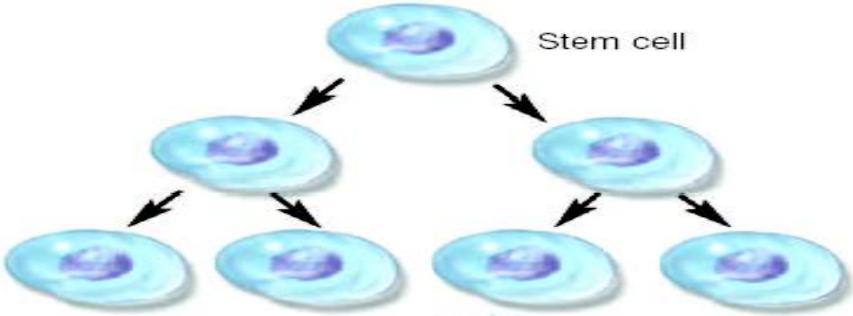
What are “stem cells”?

- The fertilized oocyte (egg) is the “mother” of all stem cells.
- This single cell (the zygote) has the potential to form all the cells and tissues of both the embryo and the placenta, and it is therefore described as totipotent. After several rounds of cell division, at approximately the 64-cell stage, the cells form a structure called the blastocyst.
- One pole of the blastocyst consists of cells that will ultimately differentiate to form the placenta. The opposite portion contains the inner cell mass, which will go on to form the embryo itself.
- Cells within the inner cell mass of the blastocyst are pluripotent. That is, each cell possesses the potential to give rise to all of the different kinds of cells in the human body.
- These pluripotent cells are referred to as embryonic stem (ES) cells upon growth in tissue culture conditions.

Characteristics of Embryonic Stem Cells

1. **Origin:**
   Derived from pre-implantation or peri-implantation embryo

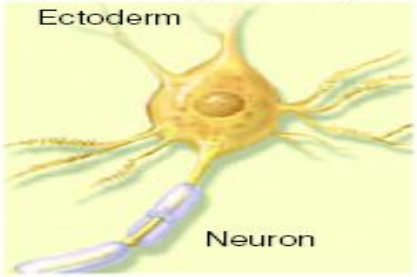




2. **Self-Renewal:**
   The cells can divide to make copies of themselves for a prolonged period of time without differentiating.

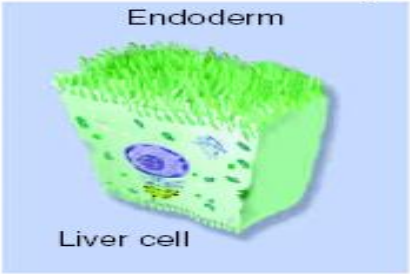
3. **Pluripotency:**
   Embryonic stem cells can give rise to cells from all three embryonic germ layers even after being grown in culture for a long time.

The three germ layers and one example of a cell type derived from each layer:



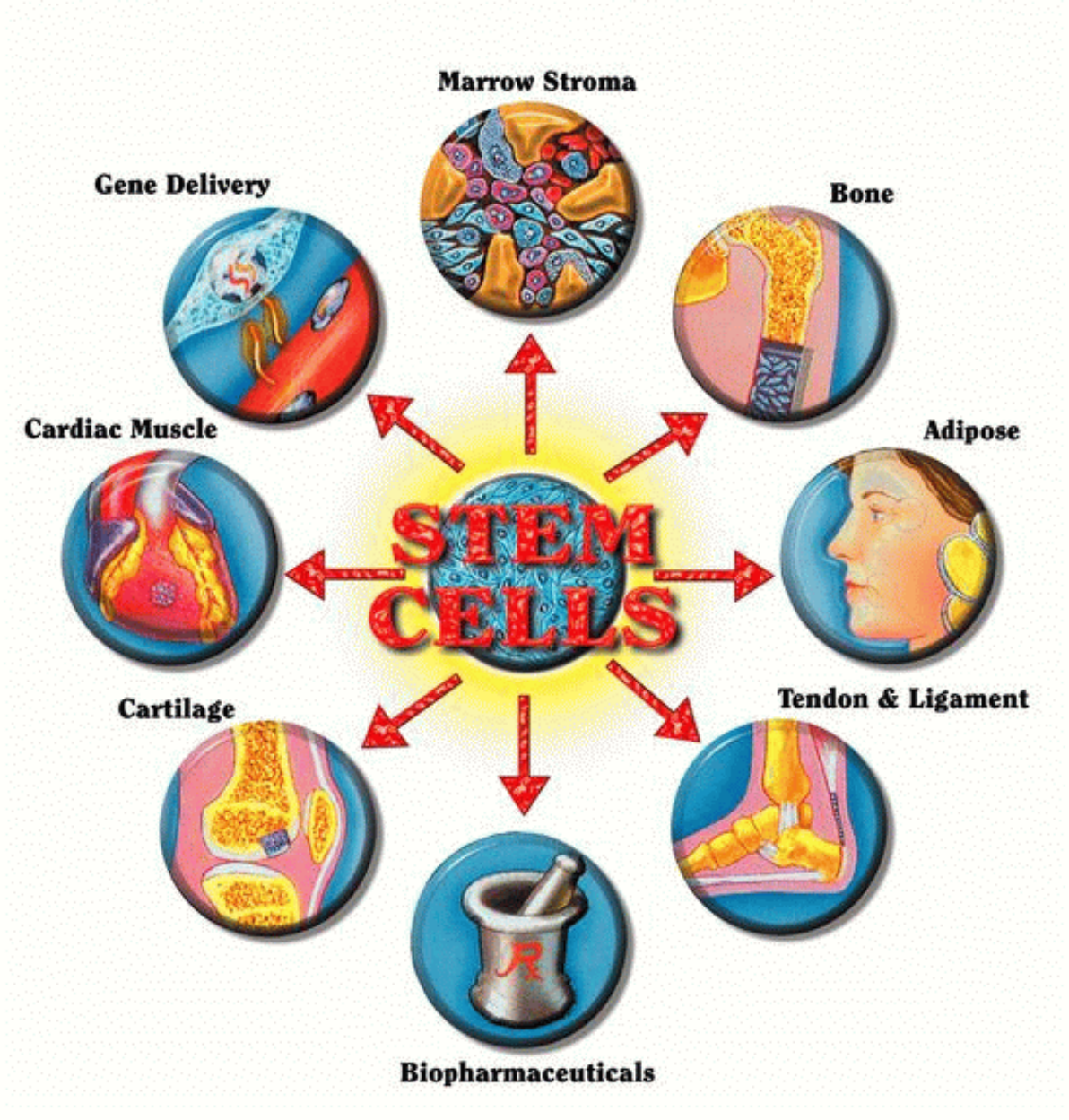
Ectoderm gives rise to: brain, spinal cord, nerve cells, hair, skin, teeth, sensory cells of eyes, ears nose, and mouth, and pigment cells.

Mesoderm gives rise to: muscles, blood, blood vessels, connective tissues, and the heart.



Endoderm gives rise to: the gut (pancreas, stomach, liver, etc.), lungs, bladder, and germ cells (eggs or sperm)

Figure 1.2.Characteristics of Embryonic Stem Cells.


Marrow Stroma
Gene Delivery
Bone
Cardiac Muscle
Adipose
STEM CELLS
Cartilage
Tendon & Ligament
Biopharmaceuticals

Why are “stem cells” important?

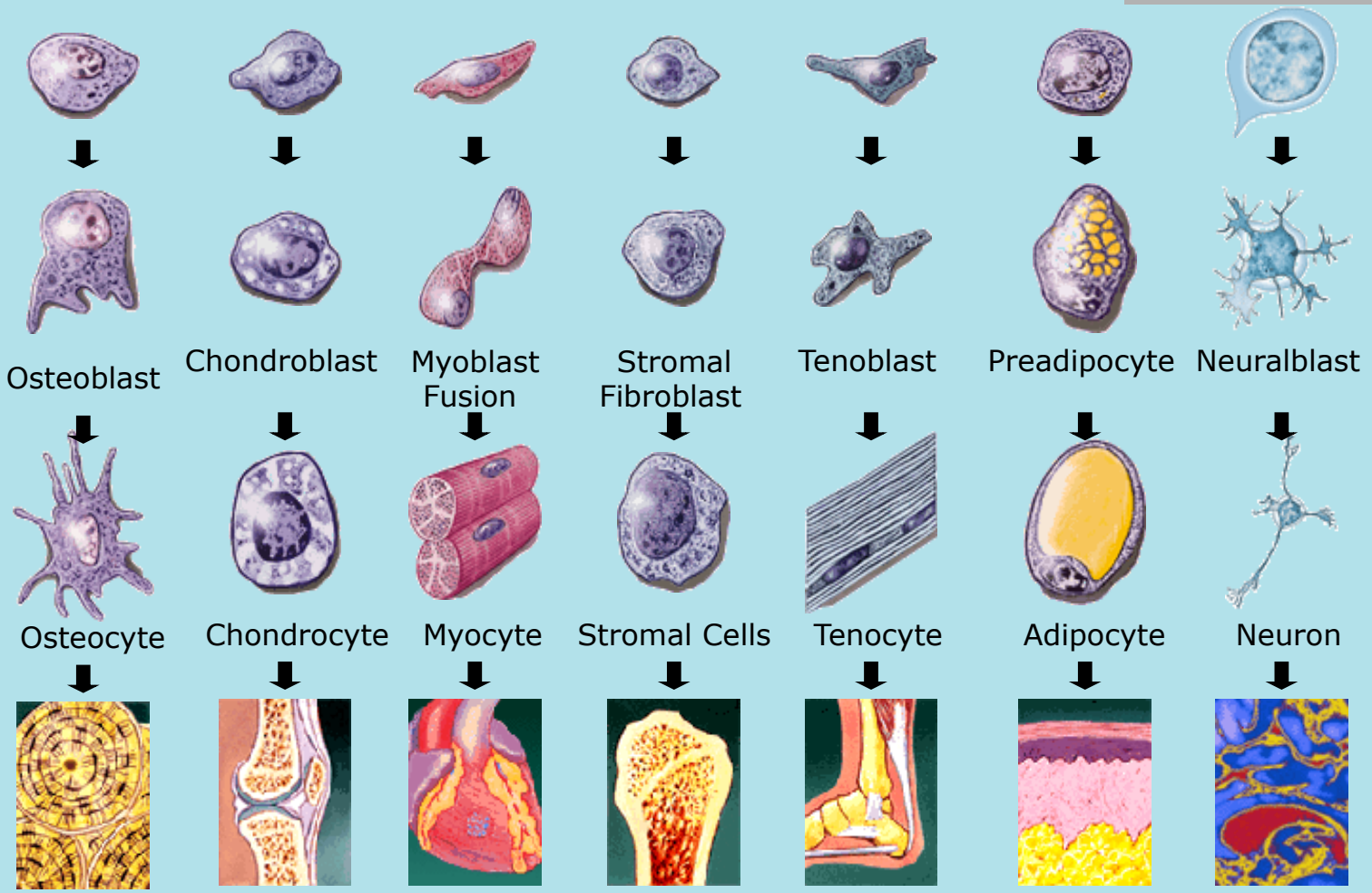
- Because of their pluripotency and renewability, ES cells are believed to hold considerable promise for medical therapy particularly in the field of regenerative medicine.
- Since the first successful isolation of human ES cells in 1998, ES cells have proven to retain their self-renewal capacities in vitro.
- A single line of ES cells can be propagated for years, through several hundred cycles of replication, without compromising its genetic composition.
- Because of this remarkable proliferative capacity, a single healthy “line” of stem cells can provide a wealth of cells for use in research and/or transplantation.
- These properties also make the study of ES cells important for understanding early human development, especially the effects of cell mutations or chromosomal abnormalities on early embryonic development.

Why are “stem cells” important?

- Since cultured ES cells are as yet undifferentiated, they retain the potential to develop into any kind of cell in the human body.

- Moreover, if researchers can learn how to similarly “direct” human ES cells to differentiate into specific tissues, healthy cells from a single ES cell line may someday be used to repair damaged or defective tissue in patients with Parkinson’s disease, Alzheimer’s disease, cardiovascular disease, diabetes and spinal cord injuries, among many other debilitating conditions.

Stem Cell


Osteoblast
Chondroblast
Myoblast Fusion
Stromal Fibroblast
Tenoblast
Preadipocyte
Neuralblast
Osteocyte
Chondrocyte
Myocyte
Stromal Cells
Tenocyte
Adipocyte
Neuron

How can “stem cells” be obtained?

- There are a number of sources for obtaining and isolating stem cells, each of which raises important ethical and policy concerns.

- The four most common sources include: aborted fetal tissue; embryos that remain after in vitro fertilization treatments; specially created “research-purpose” embryos; and mature (or “adult”) somatic cells.

Embryonic germ (EG) cells from aborted fetal tissue

Of the two landmark scientific announcements related to stem cell research in 1998, one involved the extraction of embryonic germ (EG) cells from the gonadal ridge (the portion of a fetus that would develop into testes or ovaries) of a fetus following an elective abortion.

Embryonic germ (EG) cells from aborted fetal tissue

EG cells share many of the distinctive properties of ES cells, including the capacity for long-term self-renewal in vitro and the ability to give rise to multiple cell types of the human body.

Embryonic stem (ES) cells from embryos that are in excess of clinical need for infertility treatments

- Couples who utilize in vitro fertilization typically produce many embryos for possible repeat attempts is common for embryos to remain in excess of clinical need.
- In the majority of centers, couples are given several options for the disposition of embryos that may remain after they discontinue their efforts to get pregnant: they may donate the embryos to another couple for their own reproductive efforts, they may direct that the embryos be discarded, or they may donate the embryos for use in scientific research.
- In most cases, couples choose one of the latter options.
- In theory, then, no embryo may be used in research without express informed consent for this use (usually of the donor couple).
- Frozen embryos that are donated for use in research can be thawed and allowed to continue developing to the blastocyst stage, at which point the stem cells can be removed from the inner cell mass.
- This procedure results in the destruction of the embryo.

ES cells from embryos created for research purposes

- While stem cells from existing embryos and aborted fetal tissue are useful, some scientists have argued that it would be of even greater value for researchers to create embryos specifically for research purposes.

- The creation of research-purpose embryos would ensure an adequate supply of embryos for research and treatment purposes, and it would also allow for maximum control over the genetic properties of the resulting stem cells, which is particularly important for transplantation and regenerative medicine.

ES cells from embryos created for research purposes

- In the past, embryos have been created for research by in vitro fertilization techniques, but recent discussion has been dominated by the prospect of using “somatic cell nuclear transfer” (SCNT or “cloning”) as a means of creating embryos for stem cell research.
- In nuclear transfer, an oocyte’s nucleus is removed, and a nucleus from a somatic cell is inserted into the enucleated oocyte.
- With the new nucleus, the egg has the full complement of chromosomes of a cell instead of the half complement that an oocyte usually contains.
- Thus, a sperm is not needed to contribute a second half complement of chromosomes, and the oocyte can be stimulated to become an embryo.

ES cells from embryos created for research purposes

- The created embryo is then grown to the blastocyst stage, at which point the pluripotent cells can be extracted from the inner cell mass.
- The resulting stem cells are genetic clones of the cell from which the nucleus was obtained.

ES cells from embryos created for research purposes

- Some scientists have postulated that application of this technique could be revolutionary to human therapeutic organ repair, since it could provide a perfectly matched donor for every patient.

- If a patient needs a kidney, for example, scientists may someday be able to direct ES cells cloned from that patient's own somatic cells to differentiate into kidney cells, creating a new organ that is an exact genetic match to the patient and therefore poses no risk of immunologic rejection.

ES cells from embryos created for research purposes

- More imminent than the creation of whole organs is the possibility of using stem cells with the patient's own genetic code to regenerate damaged tissues (such as nerve tissue damaged by Parkinson's disease) or to match tissue for autologous cell replacement therapies.

- These applications fall into the category of treatments that have lately been labeled "therapeutic cloning."

- While promising, there are still many scientific issues to be addressed before the use of therapeutic cloning for the treatment of disease can be considered a realistic possibility.

Adult stem cells

- In adult human beings cell division is constantly underway, providing the body with renewable sources of cells that naturally die.
- The replacements for the body's cells come from relatively undifferentiated cells that are programmed to generate specific types of cells.
- These adult or somatic stem cells (AS cells) are multipotent cells—like embryonic stem cells, they have the ability to self-renew, but their progeny can give rise not to all the different types of cells that comprise the human body, but to all the different types of cells that comprise a particular tissue or organ (e.g., all of the cells of the blood, heart, liver or brain).

Adult stem cells

- The principal sources of somatic stem cells include bone marrow, cornea, retina, brain, skeletal muscle, dental pulp, skin, pancreas, liver, and the lining of the intestine.
- The hematopoietic stem cell is probably the best-characterized stem cell in the human body.
- These cells divide slowly in the bone marrow and replenish themselves throughout life.
- Every hour, 10 billion red blood cells and 100 million white blood cells are produced in the marrow from hematopoietic stem cells and are released into our circulating blood.
- Sources of hematopoietic stem cells already in use for transplantation to treat a number of malignant and non-malignant diseases are: bone marrow, growth factor mobilized-peripheral blood, and umbilical cord blood.

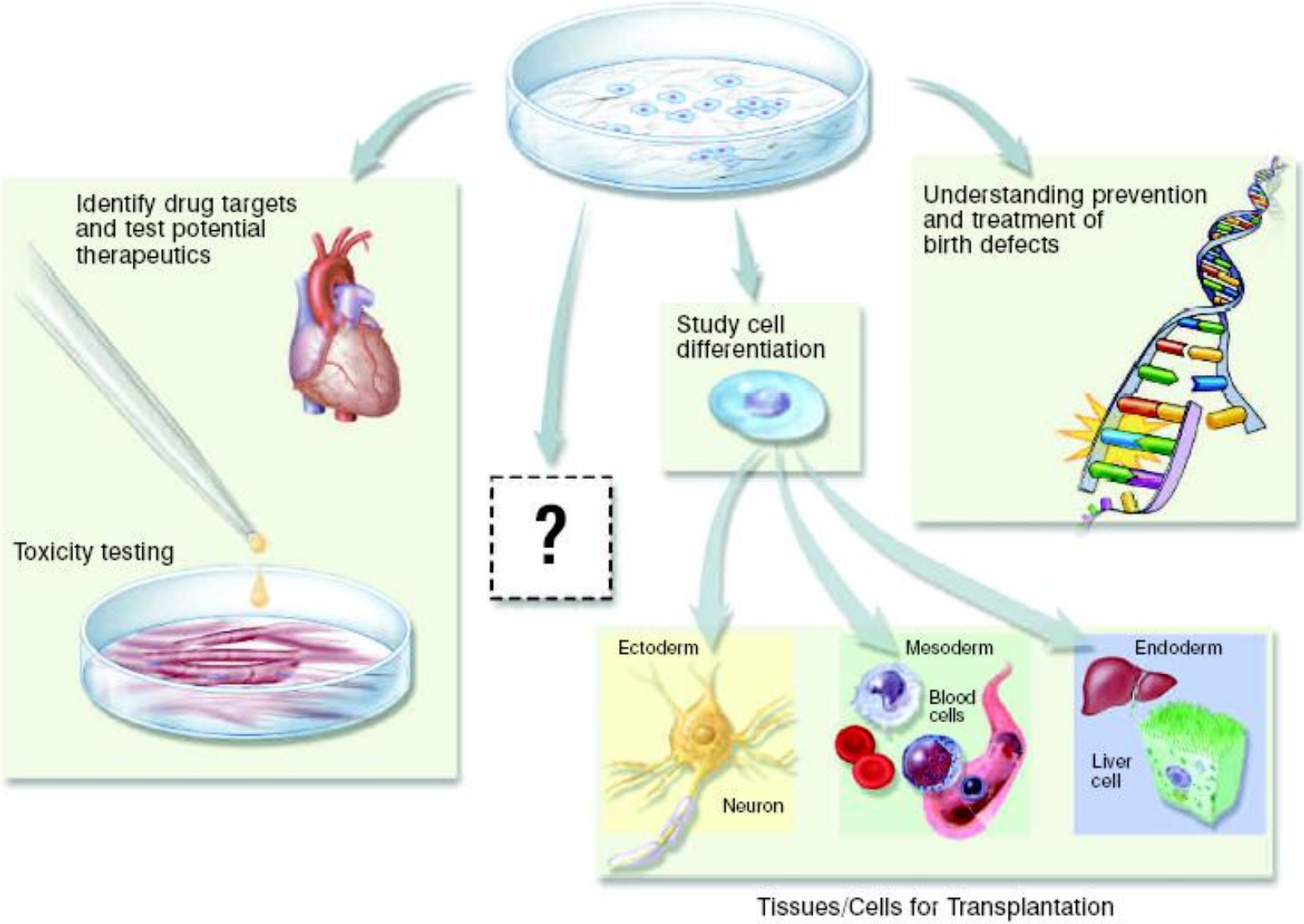
Adult stem cells

- There has long been considerable interest in the concept of adult stem cell plasticity—the capacity of a cell to generate cells of a completely different organ upon transplantation.
- However, it may be that adult stem cells of one organ type have the ability to give rise to cells of another organ.
- A number of studies have reported that adult stem cells possess such plasticity.
- Bone marrow cells have been demonstrated to give rise to muscle cells, brain stem cells have contributed to blood and muscle, and so on

Adult stem cells

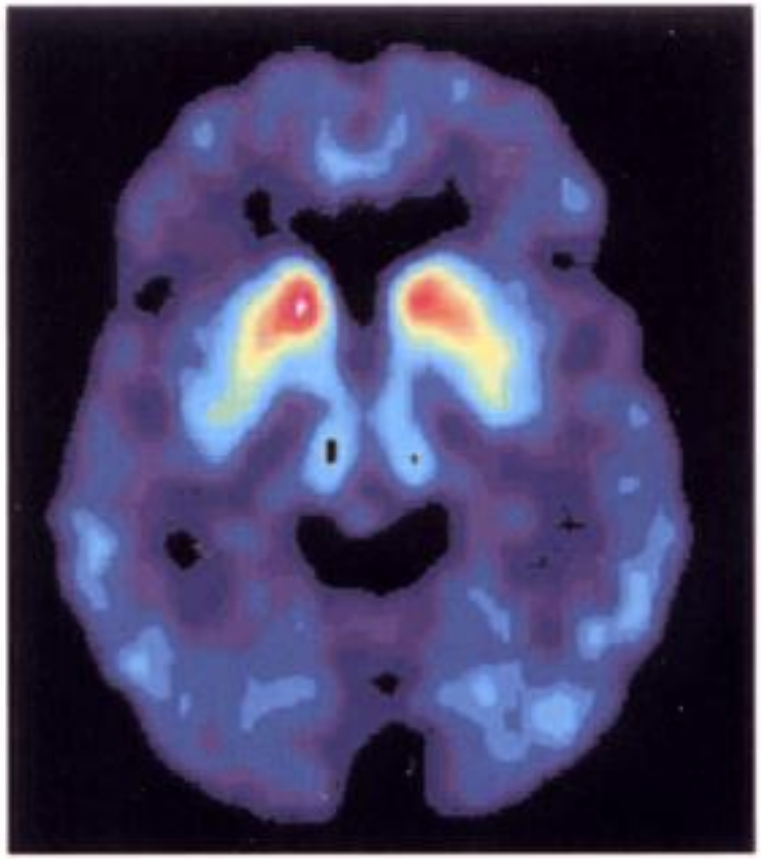
- However, whether or not adult stem cells truly possess plasticity is still far from certain.
- Scientists have shown that adult stem cells from one organ can take on the appearance of cells from another organ, but they have yet to definitively prove that the transformed cells have also assumed the function of the new organ.
- Much research remains to be done to prove that adult stem cells have the type and extent of plasticity found in ES cells.

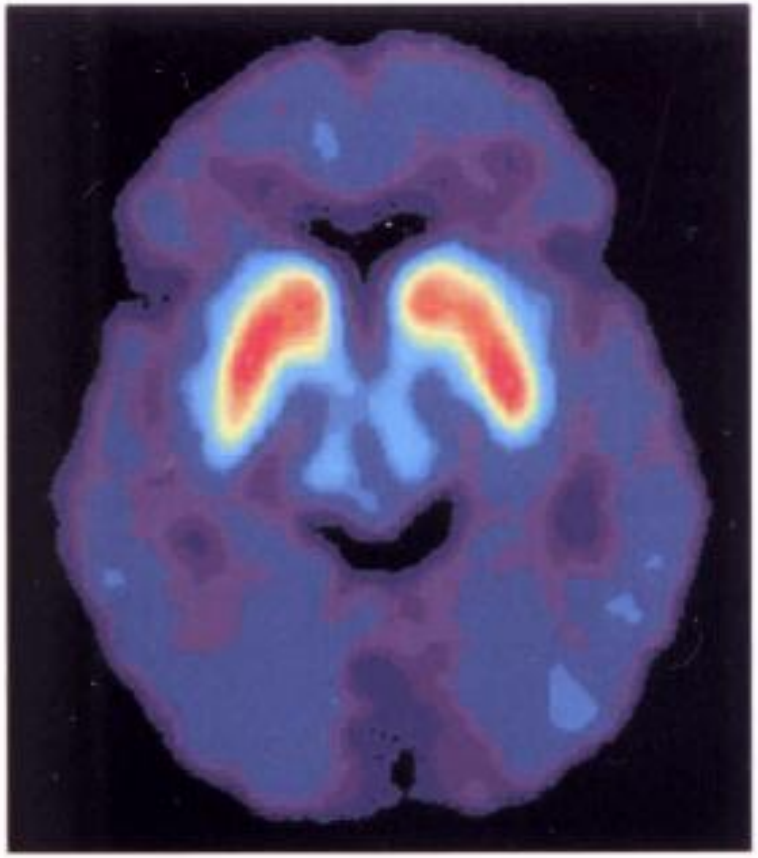
The Promise of Stem Cell Research



F The Promise of Stem Cell Research

Dopamine-Neuron Transplantation





Positron Emission Tomography (PET) images from a Parkinson's patient before and after fetal tissue transplantation. The image taken before surgery (left) shows uptake of a radioactive form of dopamine (red) only in the caudate nucleus, indicating that dopamine neurons have degenerated. Twelve months after surgery, an image from the same patient (right) reveals increased dopamine function, especially in the putamen.

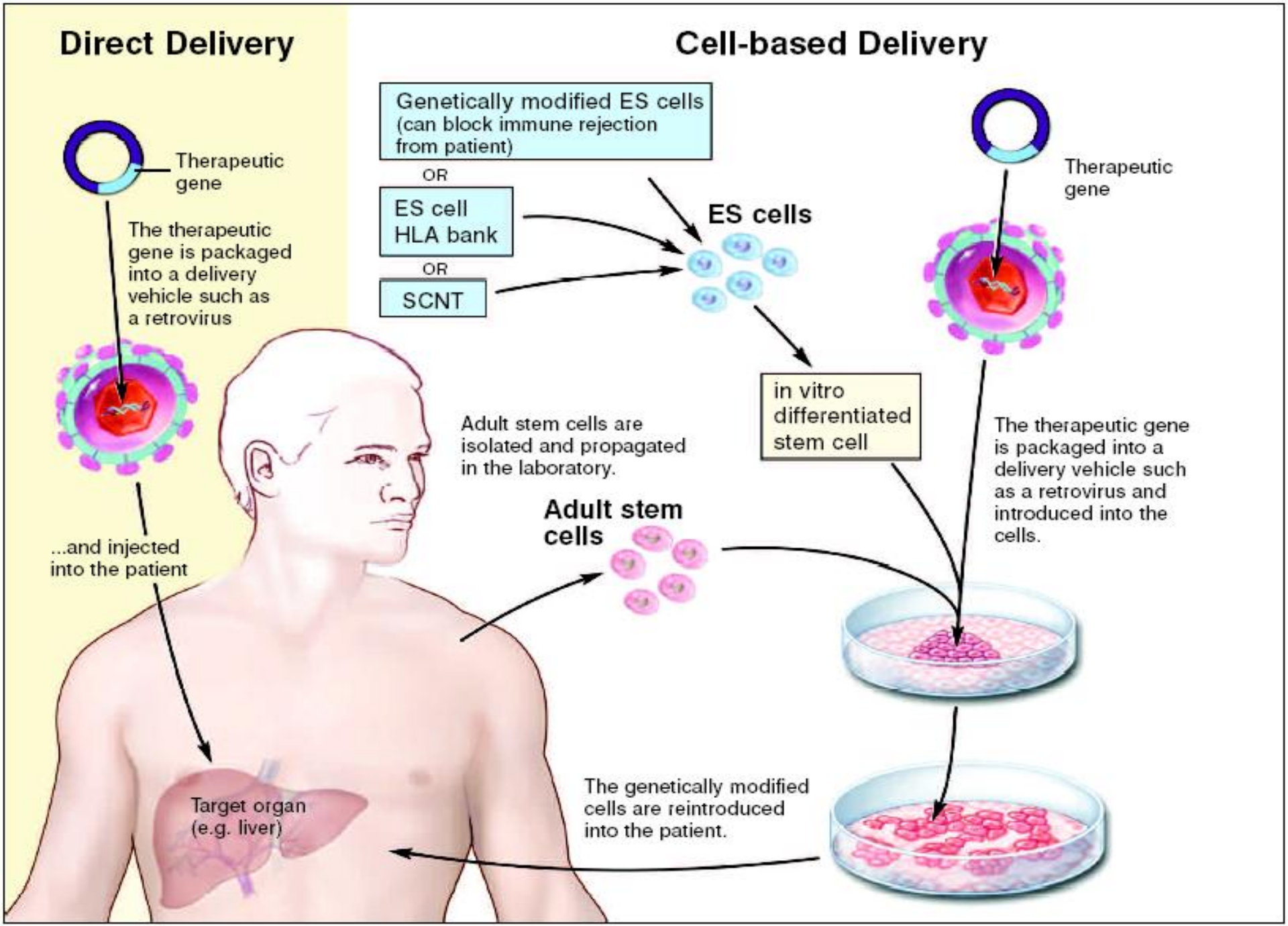


Figure 4.3. Strategies for Delivering Therapeutic Transgenes into Patients.

Ranking (Score)[a]	Applications of Regenerative Medicine
1 (415)	Novel methods of insulin replacement and pancreatic islet regeneration for diabetes
2 (358)	Autologous cells for the regeneration of heart muscle
3 (339)	Immune system enhancement by engineered immune cells and novel vaccination strategies for infectious disease
4 (272)	Tissue-engineered skin substitutes, autologous stem or progenitor cells, intelligent dressings, and other technologies for skin loss due to burns, wounds, and diabetic ulcers
5 (238)	Biocompatible blood substitutes for transfusion requirements
6 (200)	Umbilical cord blood banking for future cell replacement therapies and other applications
7 (157.5)	Tissue-engineered cartilage, modified chondrocytes, and other tissue engineering technologies for traumatic and degenerative joint disease
8 (121.5)	Gene therapy and stem cell transplants for inherited blood disorders
9 (105.5)	Nerve regeneration technologies using growth factors, stem cells, and synthetic nerve guides for spinal cord and peripheral nerve injuries
10 (80)	Hepatocyte transplants for chronic liver diseases or liver failure

What is the current state of regenerative medicine?

- **Regenerative medicine to date has made a number of advances in the field of simple tissues such as skin, bone, and cartilage.**

- **Progress towards obtaining more complex tissues is ongoing.**

Commercial Opportunities in Stem Cell Biology: Stem Cells, Regenerative Medicine and the Endless Pipeline

- Heart Failure (affects 5 million Americans)
- Kidney Failure (affects 0.5 million Americans)
- Stroke (affects 4 million Americans)
- Diabetes (affects 16 million Americans)
- Arthritis (affects 25 million Americans)
- Macular Degeneration (affects 2 million Americans)
- Spinal Cord Injury (affects 0.5 million Americans)
- Peripheral Vascular Disease (affects 3 million Americans)

Current barriers to progress in regenerative medicine

- There are two major barriers facing regenerative medicine.
- The first barrier is a lack of research related to the fundamental “building block” areas of the science.
- The second barrier is the lack of interdisciplinary study, which can be attributed to the focus of private funding in the field.

What is the future of regenerative medicine technology?

- Despite the availability of some first generation products, researchers know very little about the underlying science of regenerative medicine.
- In order to build complex tissues and organs, scientists first must understand how tissues interact with each other.

What is the future of regenerative medicine technology?

- If a directed and well-funded research effort were to begin, regenerative medicine could begin producing results within 5 years. At the 5-year mark, complex skin, cartilage, bone, and blood vessel products would begin to reach markets.
- Within 10 years, organ patches that repair damaged tissues would potentially be available.
- Within 20 years, full organ regeneration is a strong possibility.

CHALLANGE

RATIONAL USE OF KNOWLEDGE FOR BENEFITS OF MANKIND

হযরত আবু হুরায়রা (রাঃ) হইতে বর্ণিত, তিনি বলেন, রাসূলুল্লাহ্ ছাল্লাল্লাহু আলাইহি ওয়াসাল্লাম বলিয়াছেন ঃ আল্লাহ্ তা'আলা এমন কোন রোগ নাযিল করেন নাই, যাহার ঔষধ পয়দা করেন নাই।------ বুখারী

FROM HOLY QURAN

১। "হে মানব আমি তোমাদেরকে এক পুরুষ ও এক নারী থেকে সৃষ্টি করেছি এবং তোমাদেরকে বিভিন্ন জাতি ও গোত্রে বিভক্ত করেছি, যাতে তোমরা পরস্পর পরিচিত হও।"

- সূরা হুজরাত (আয়াত-১৩)

২। "আমি মানুষকে সৃষ্টি করেছি মিশ্র শুক্রবিন্দু থেকে এভাবে যে, তাকে পরীক্ষা করব। অতঃপর তাকে করে দিয়েছি শ্রবন ও দৃষ্টি শক্তি সম্পন্ন।"

- সূরা আল-ইনসান (আয়াত-২)

৩। "আমি সৃষ্টি করেছি তোমাদেরকে। অতঃপর কেন তোমরা তা সত্য বলে বিশ্বাস কর না।"

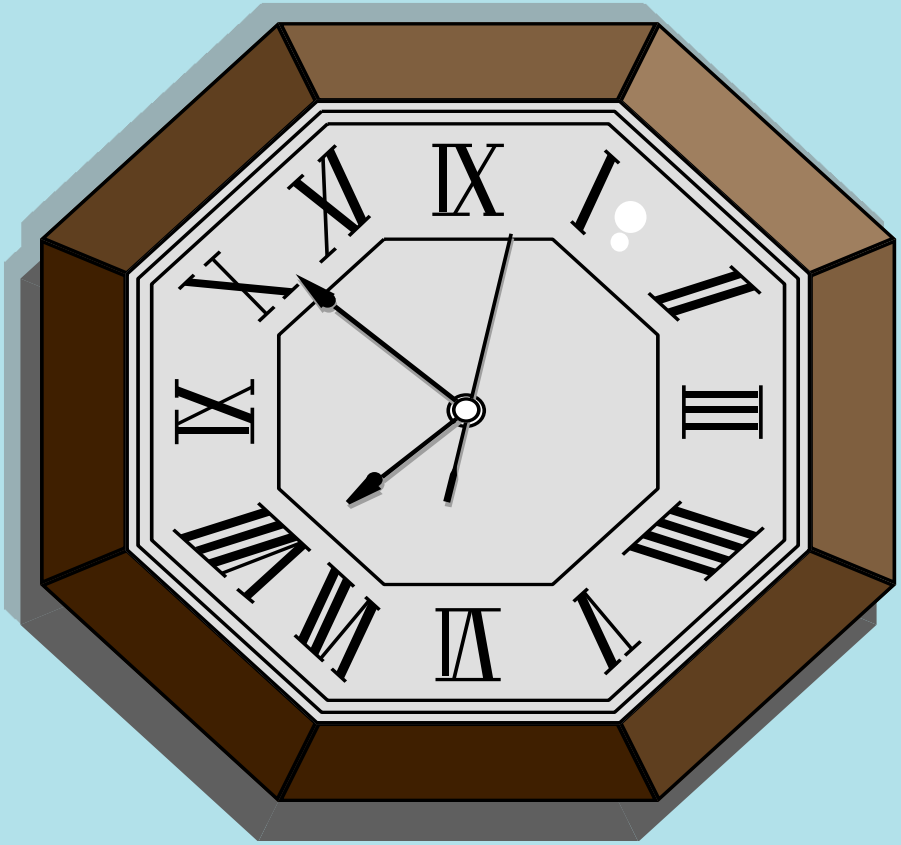
- সূরা ওয়াকিয়া (আয়াত - ৫৭)

CONCLUSION

- **Regenerative medicine offers the potential to cure countless fatal and debilitating conditions through therapies that spur *in vivo* regeneration and *in vitro* creation of healthy tissue for implantation.**

- **The next evolution of medical technology is now insight, and has the potential to become reality in the next 20 years.**

LET US LOOK FORWARD....



Good luck!

THANK YOU