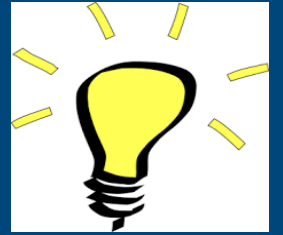
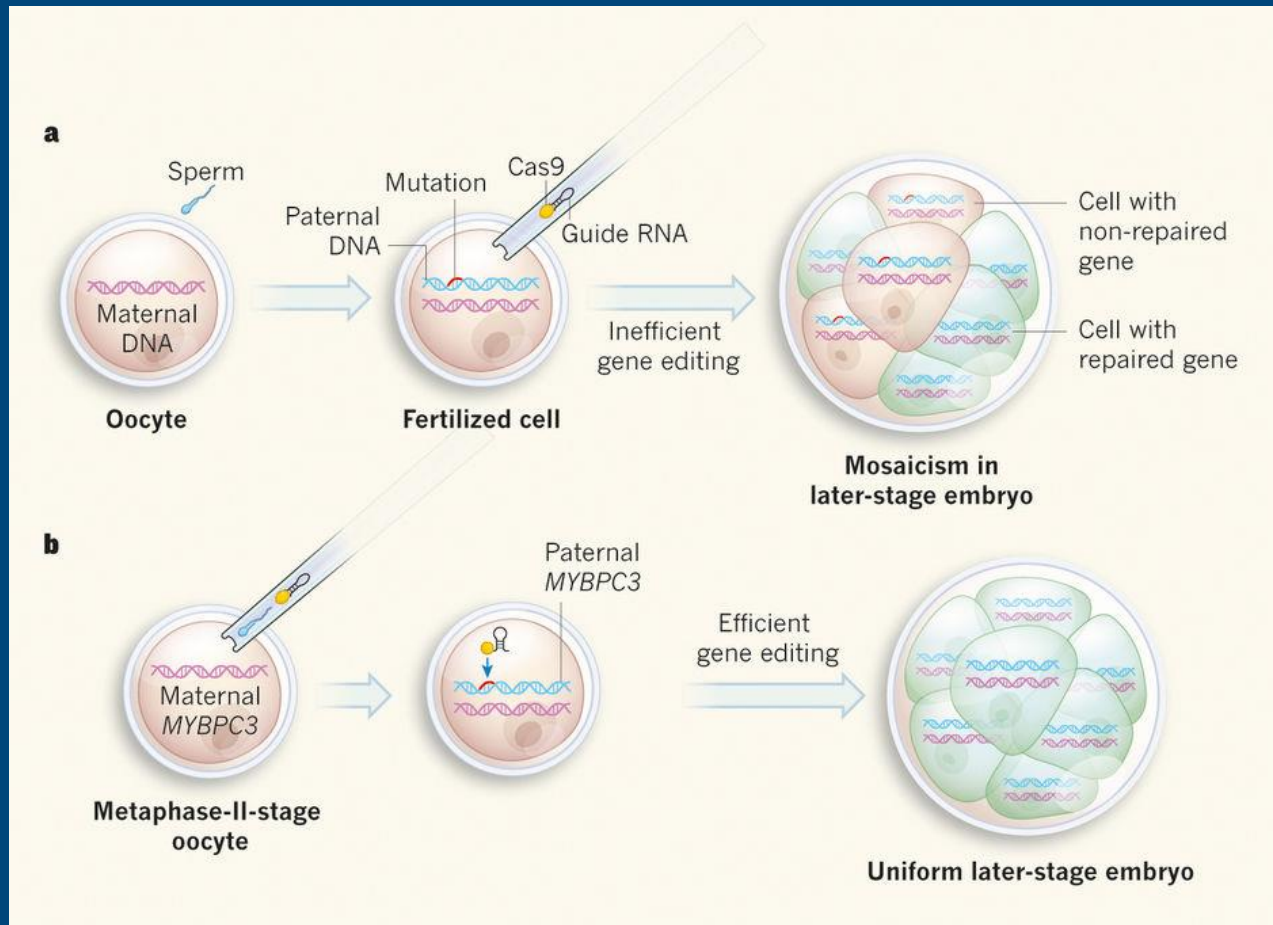
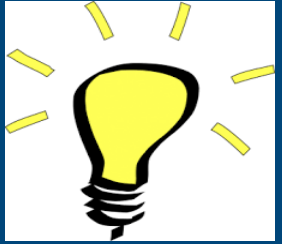


college 3 (28-02)



- Tissue engineering
- Proefdieren

Correction of a pathogenic gene mutation in **human** embryos using CRISPR

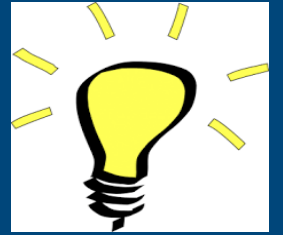


Ipv heel mens behandelen, kun je beter beginnen bij het embryo.

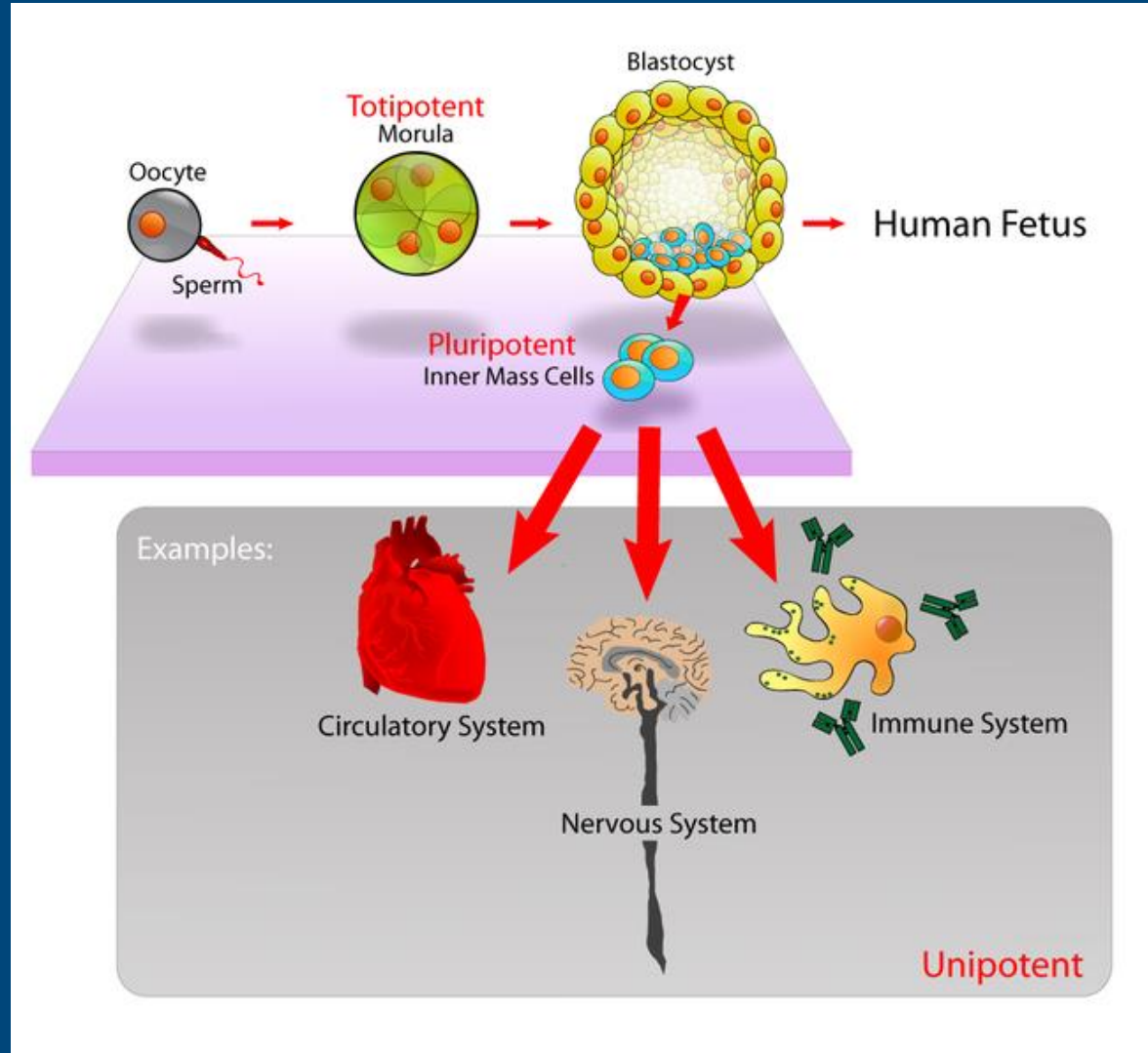
=> truc 5

http://www.nature.com/nature/journal/v548/n7668/fig_tab/nature23533_F1.html

Embryonale stamcel => Volwassen weefsels met “adult stem cells”



ES

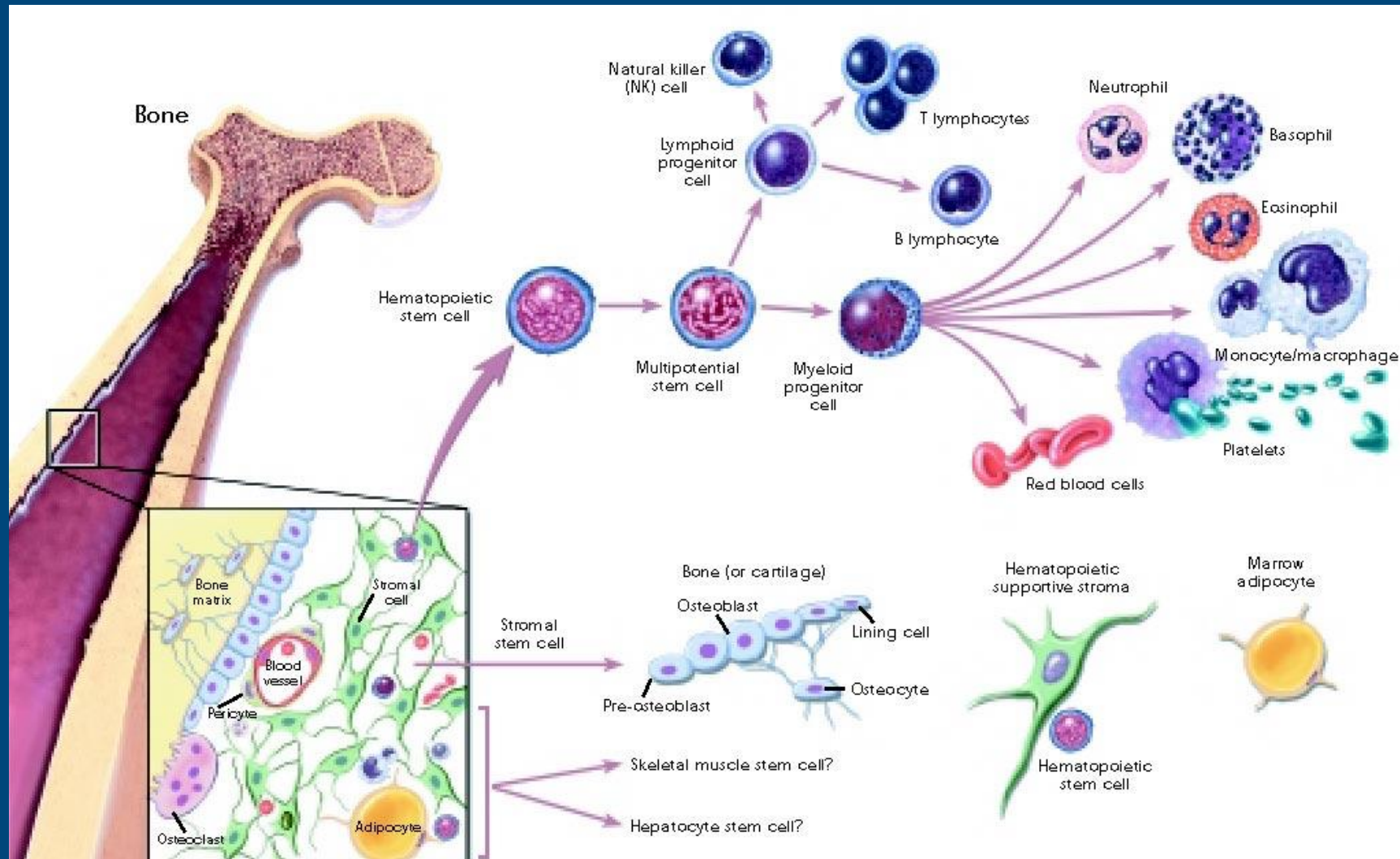
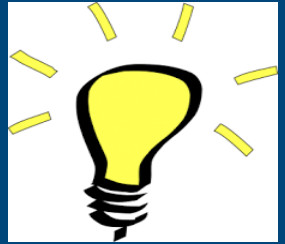


Adult
Stem
cells

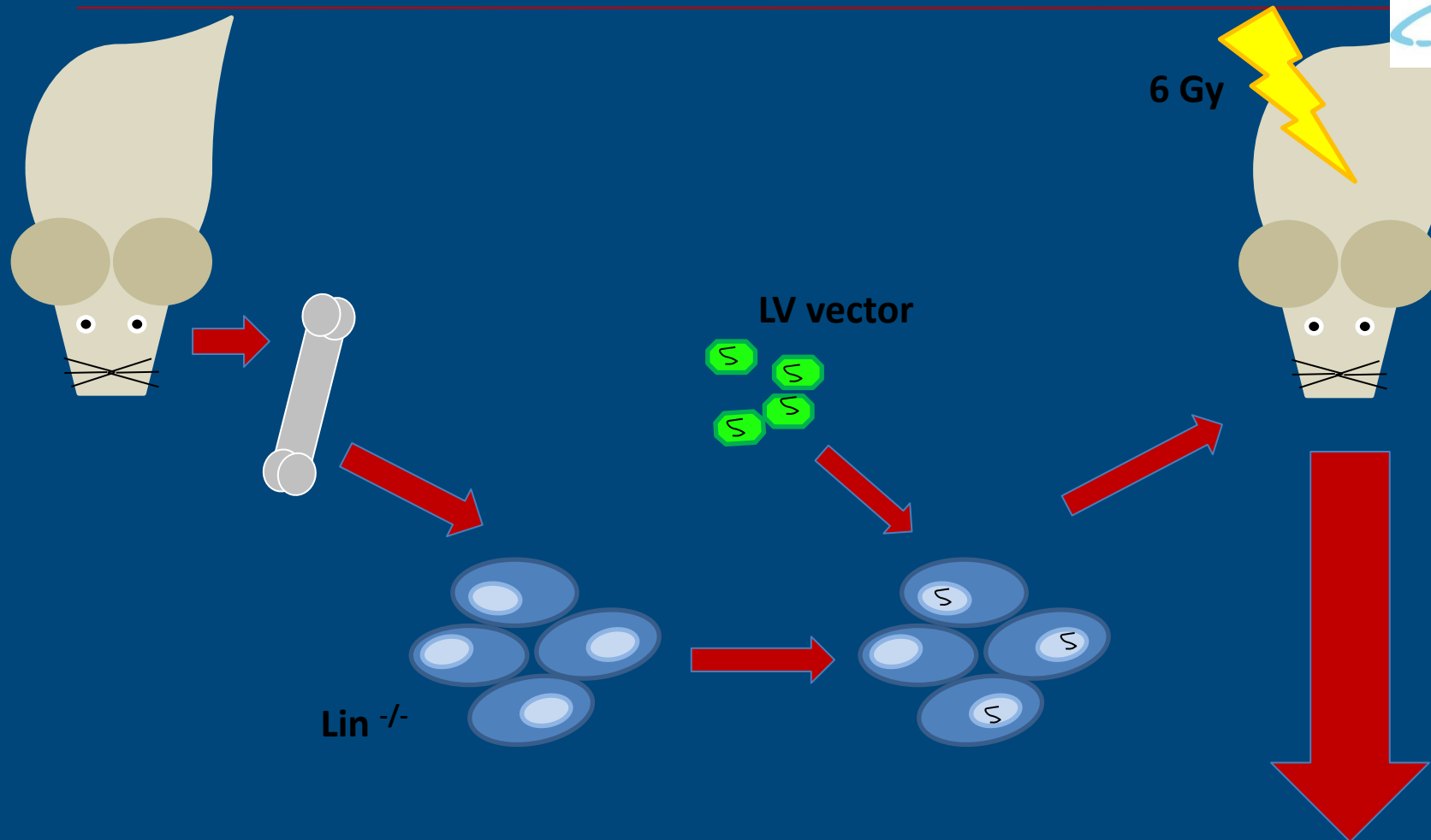
Na de embryonale ontwikkeling blijven stamcellen actief => adult stem cells

Stamcellen in het beenmerg (adult stem cells)

=> Truc 5b



Experimental Approach (ex vivo)



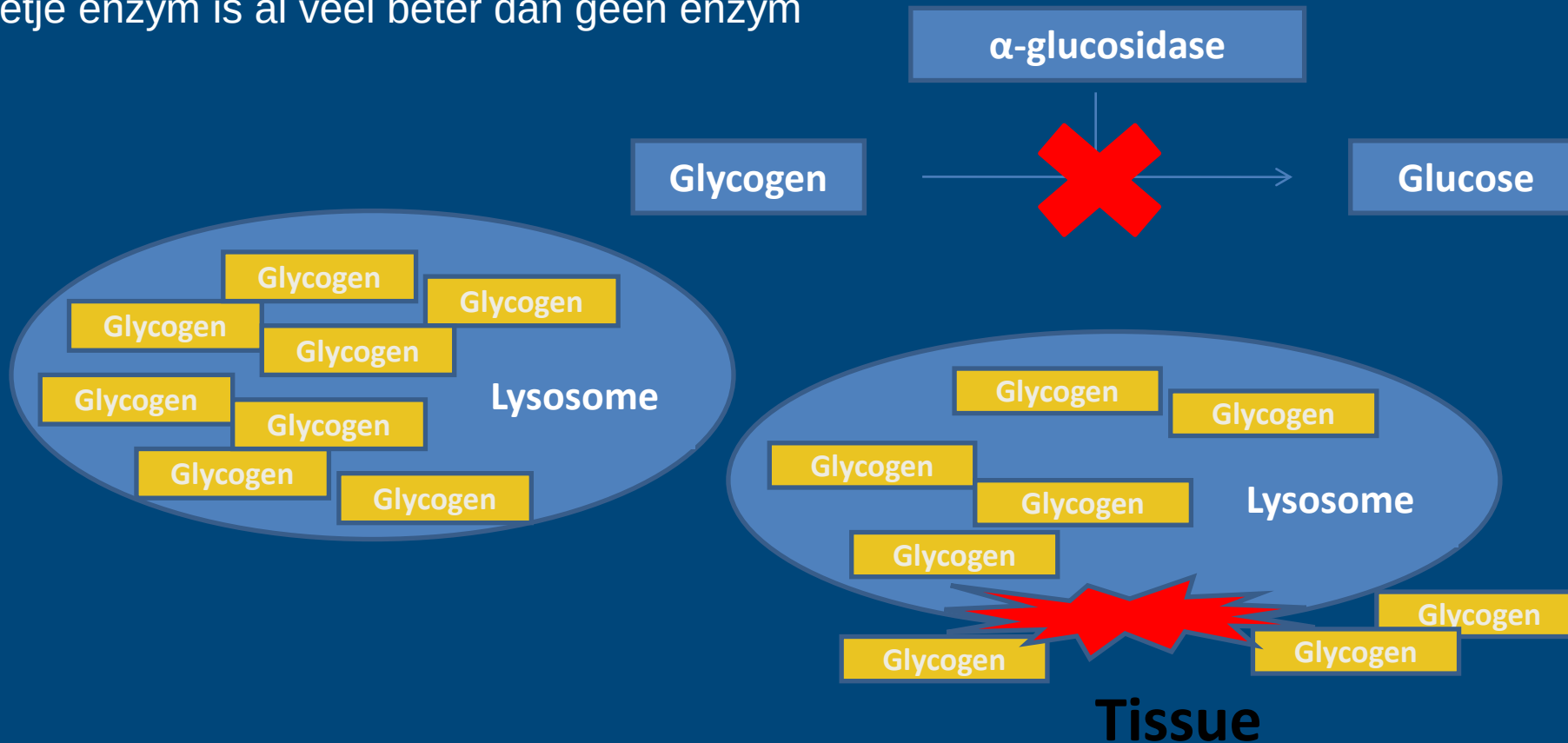
Expression of the transgene in all hematopoietic cells
Ex vivo possible through use of stem cells (quality control)

stamcel => college 2

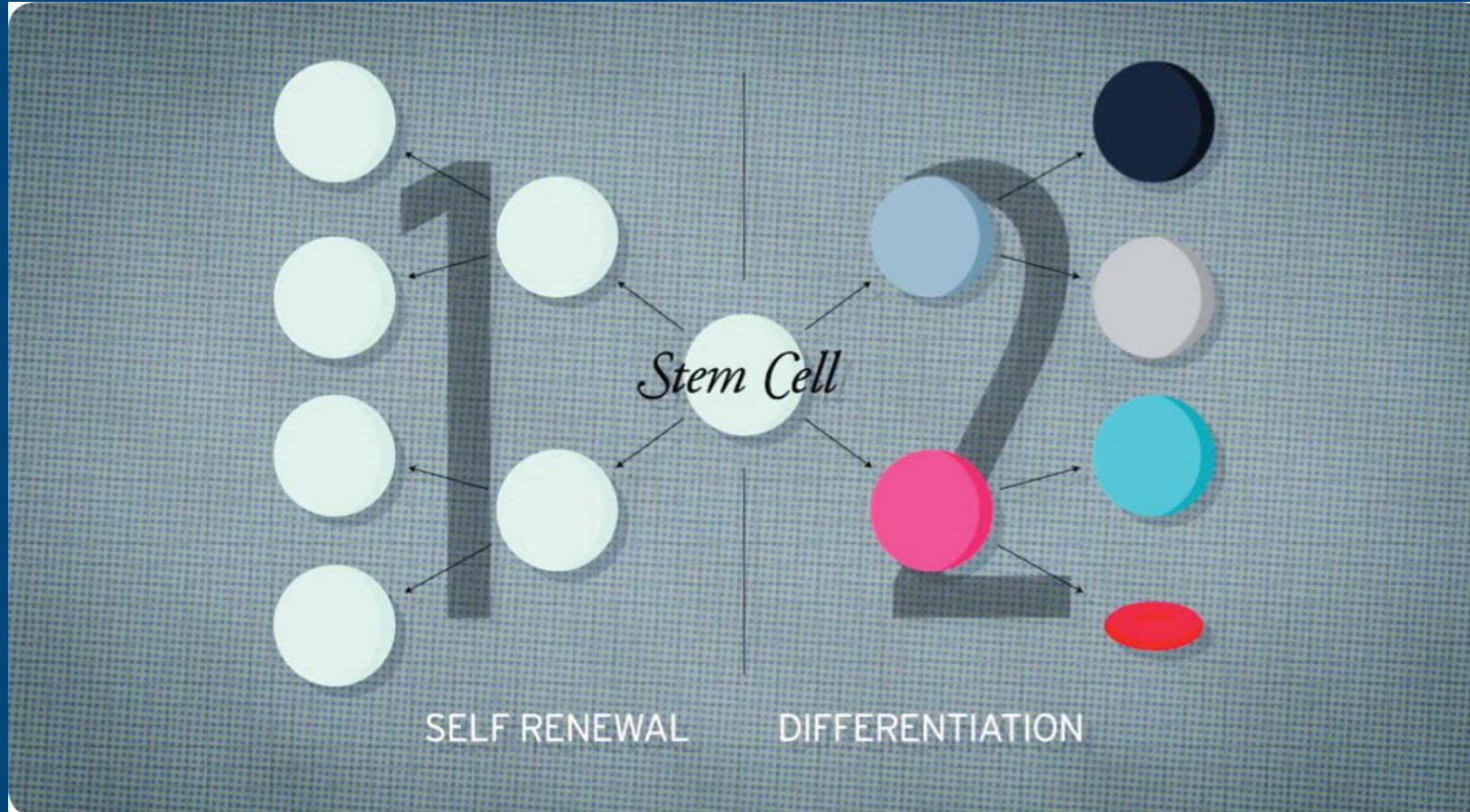
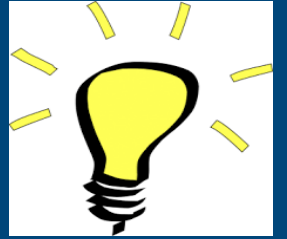
Gen/stamceltherapie: Pompe Disease

Autosomal recessive lysosomal storage disorder
Deficiency in α -glucosidase (GAA)

=> Klein beetje enzym is al veel beter dan geen enzym



Stamcellen delen en dochtercellen vormen functioneel weefsel

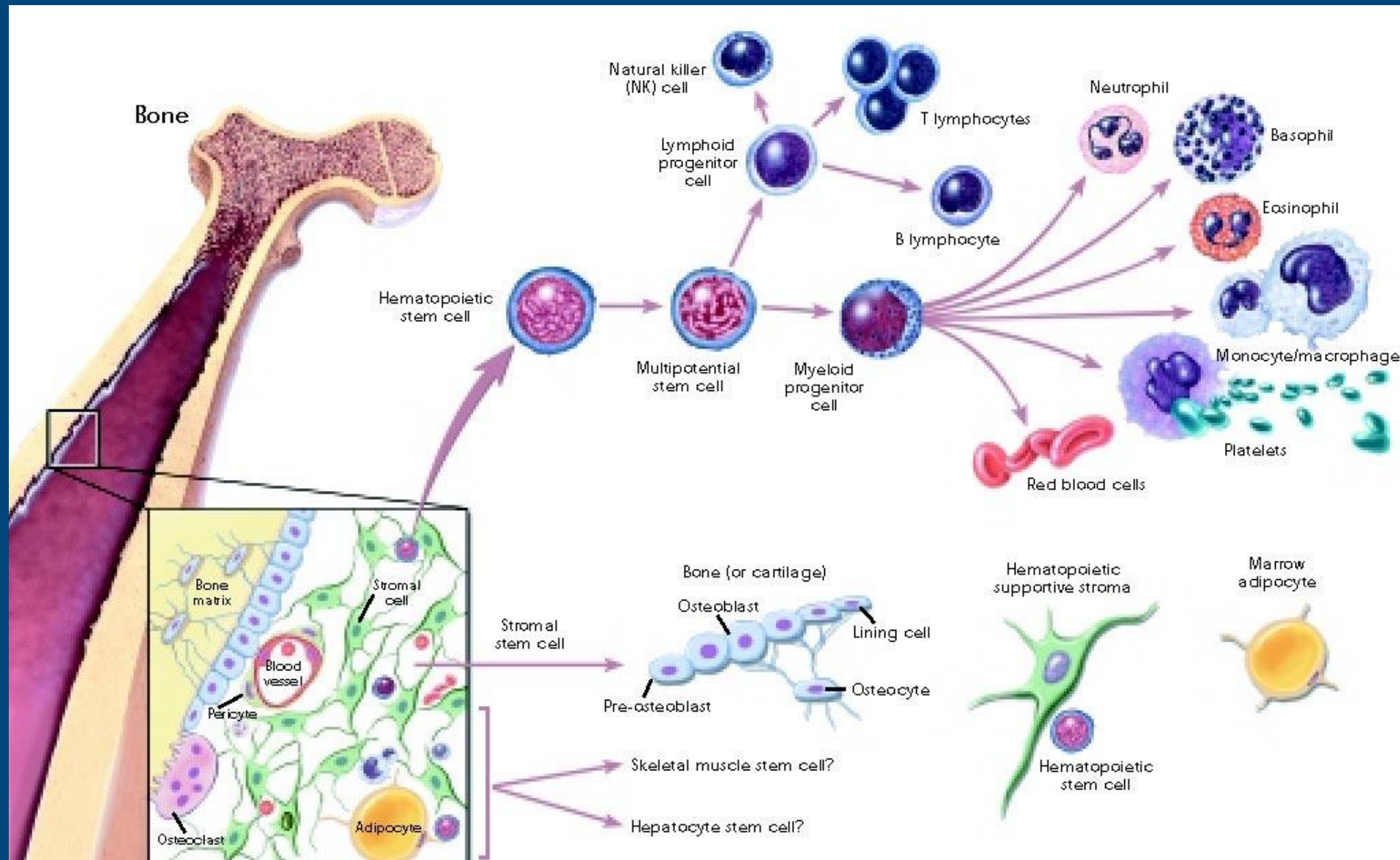
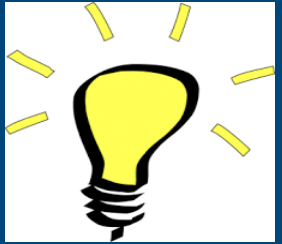


https://www.youtube.com/watch?v=_hbgeQzmU9U

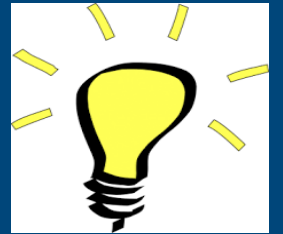
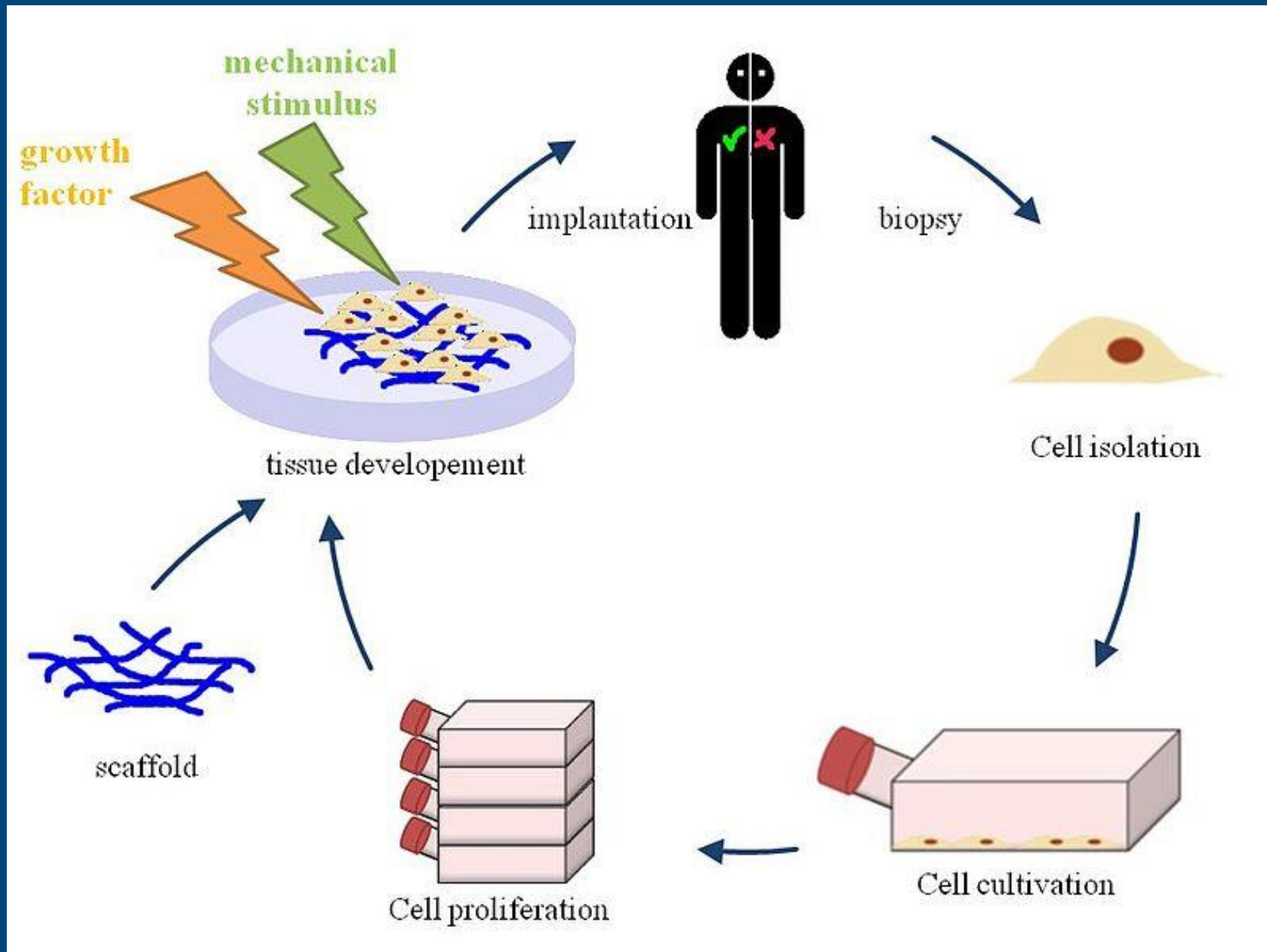
American Association for the Advancement of Science
Science 2014;343:600-610



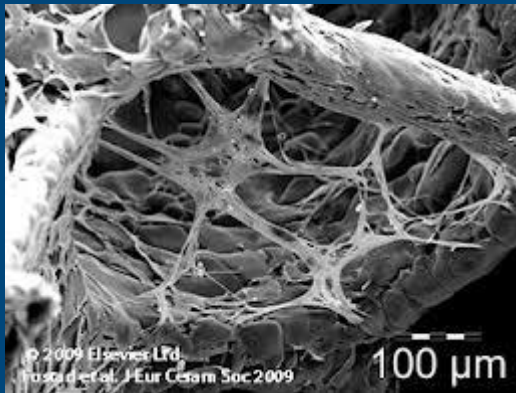
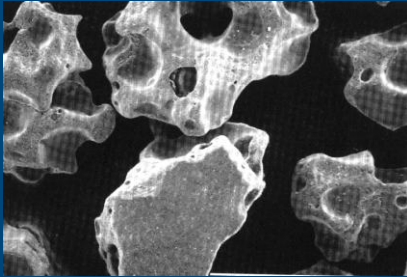
Stamcellen in het beenmerg: Hematopoetische stamcel en de mesenchymale stamcel (MSC)



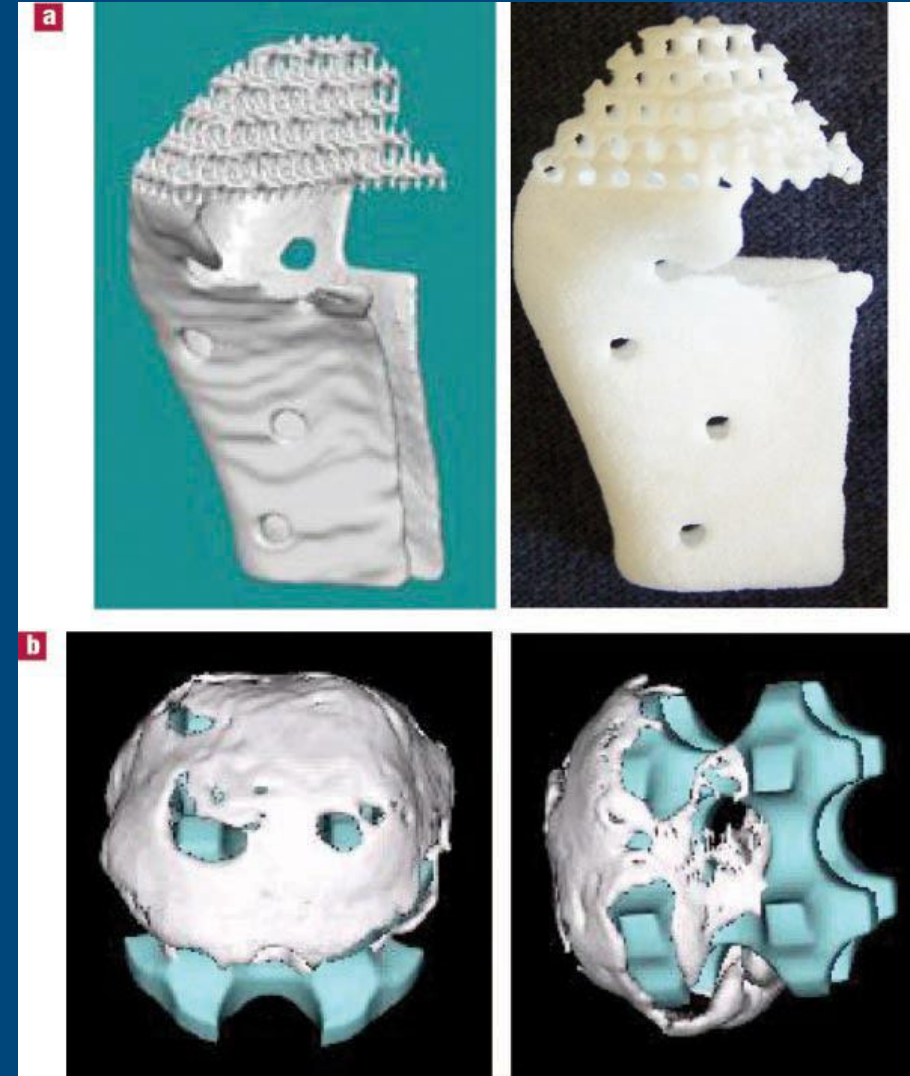
Tissue- engineering



Scaffolds (steigers), geven tijdelijke steun en sturen ontwikkeling

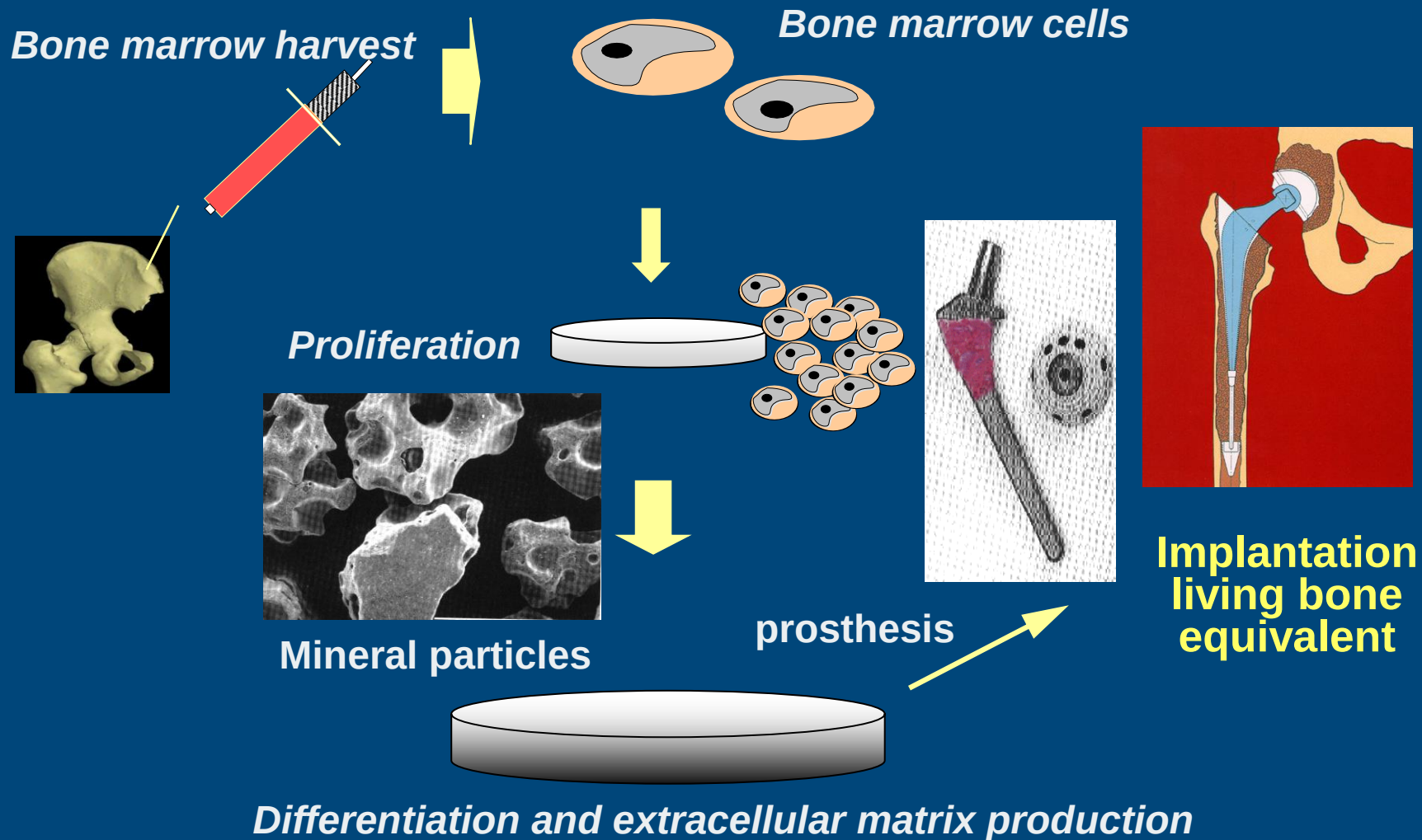
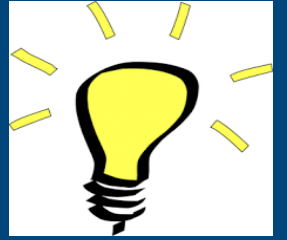


<http://www.citagenix.com/pdf/MBCPvsBovine.pdf>
http://www.integralife.com/products%2Fpdfs%2Fossatura%20brochure_457.pdf

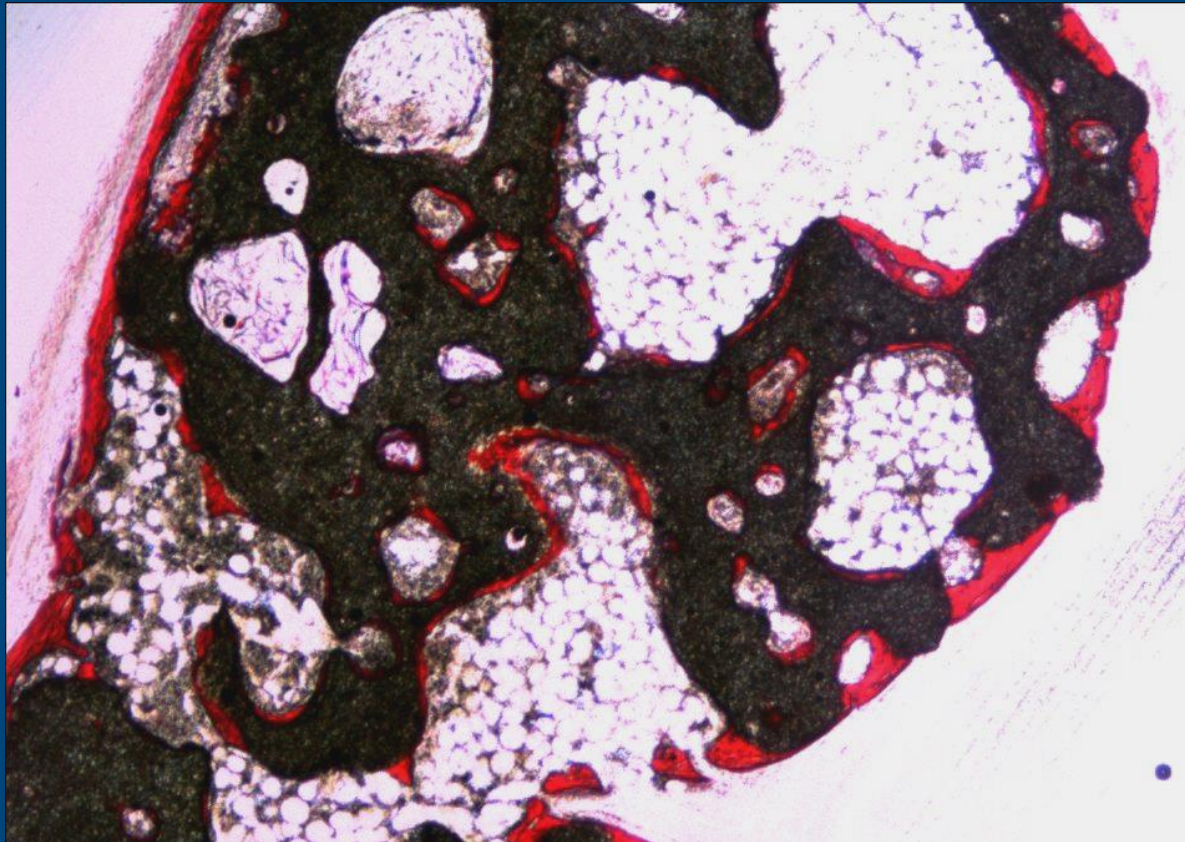
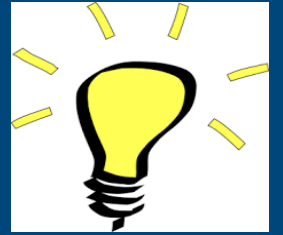


Sintering, electrospinning, 3D-printing, (release of growth factors)

Tissue-engineered bone coated on titanium.



In vivo bone adult stem cells from bone-marrow (MSC)



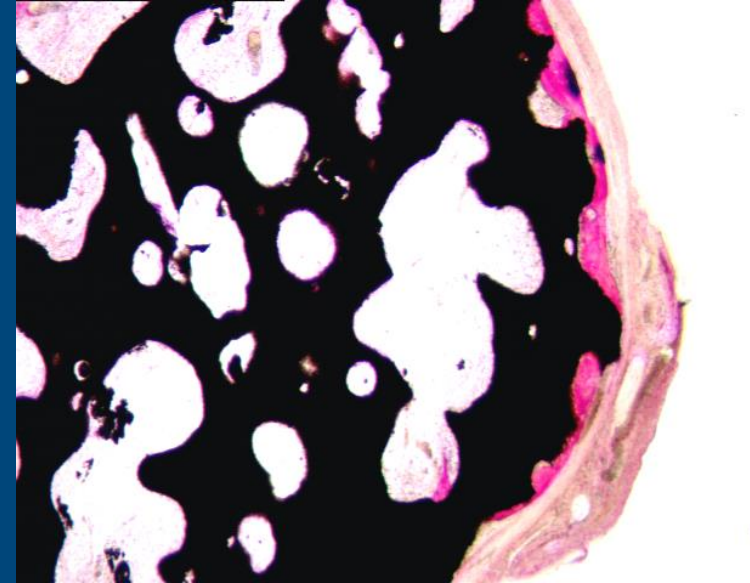
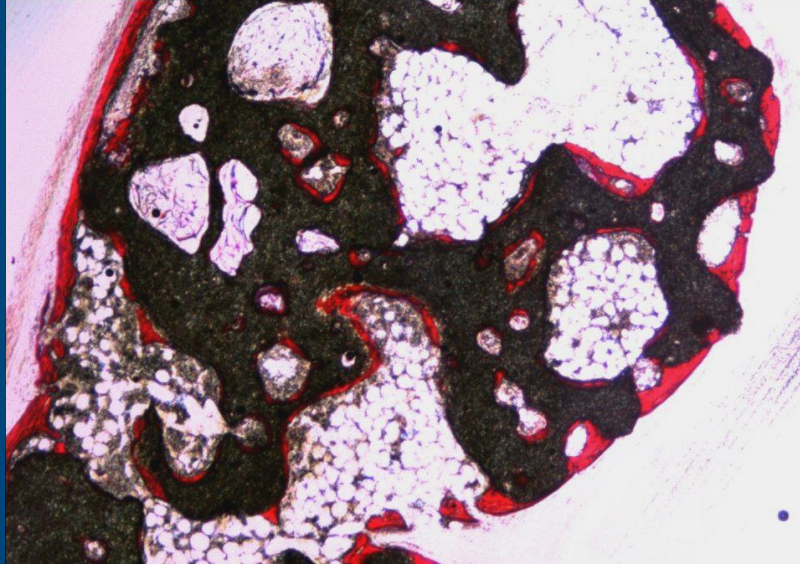
Red = bone

Black = scaffold

White = bone-marrow

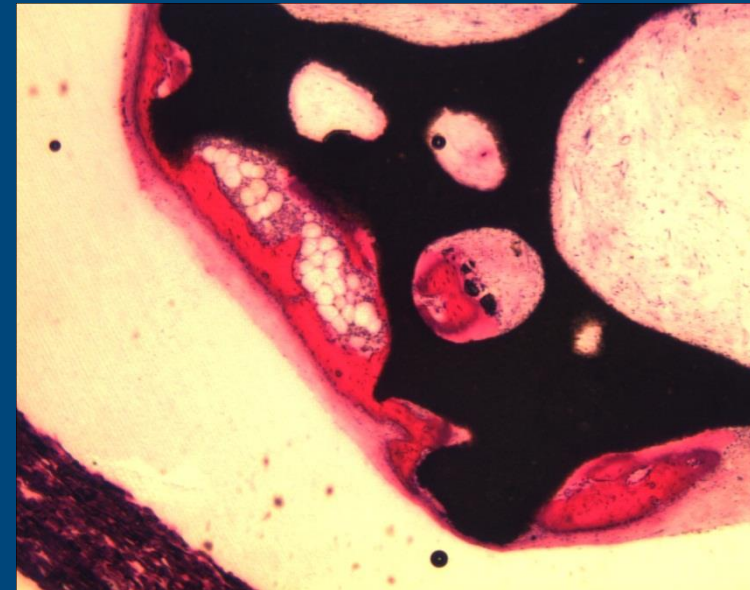
First trials with rat MSC

In vivo bone adult stem cells from bone-marrow (MSC) rat v. human

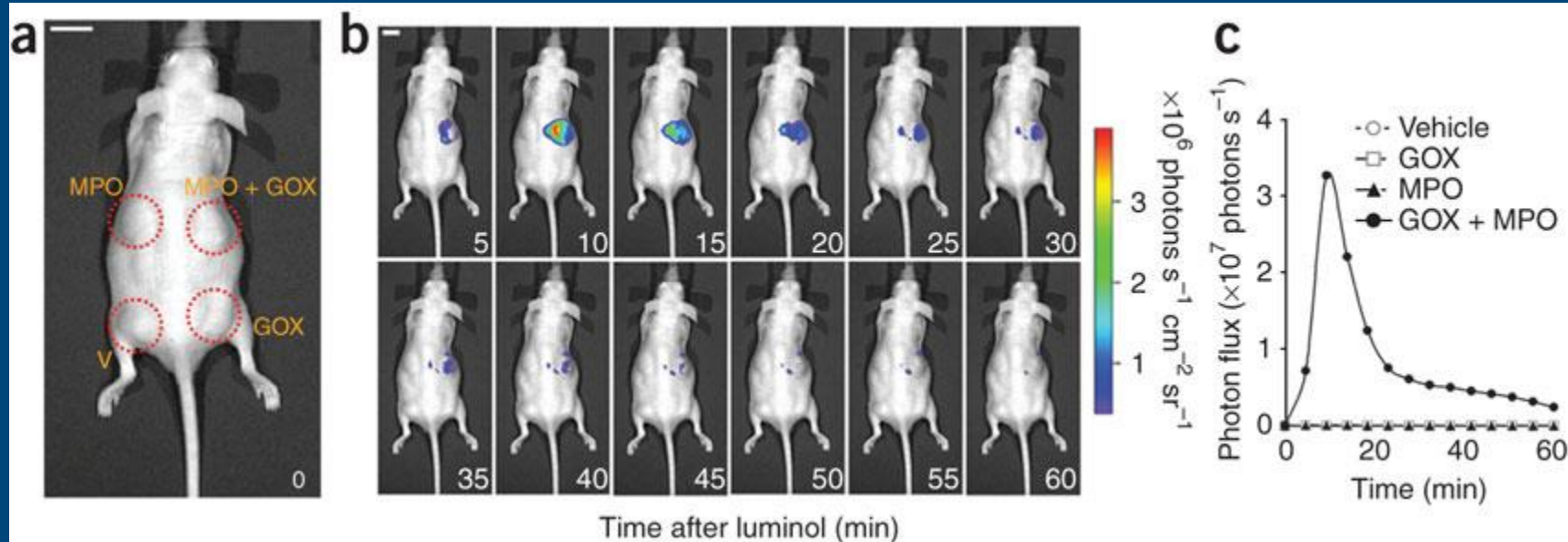
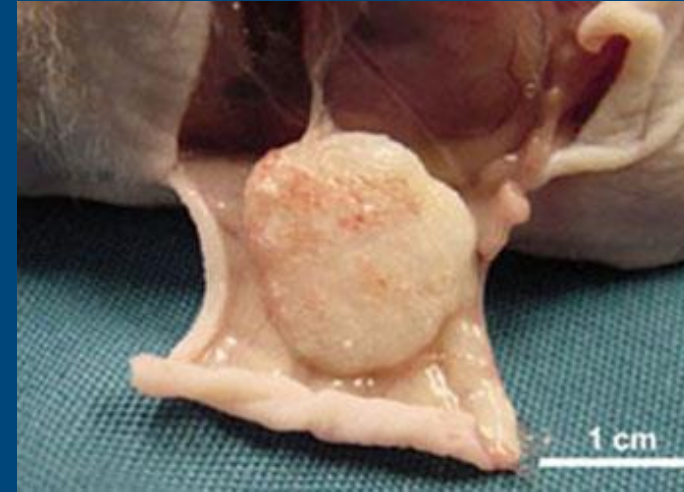
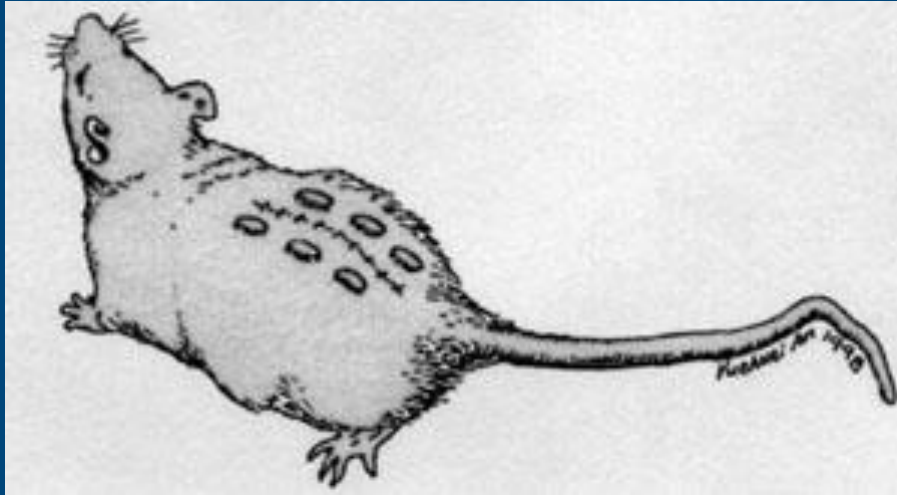
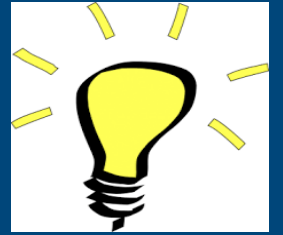


Large differences between donors!
Unexpected => interesting !

Red = bone
Black = scaffold

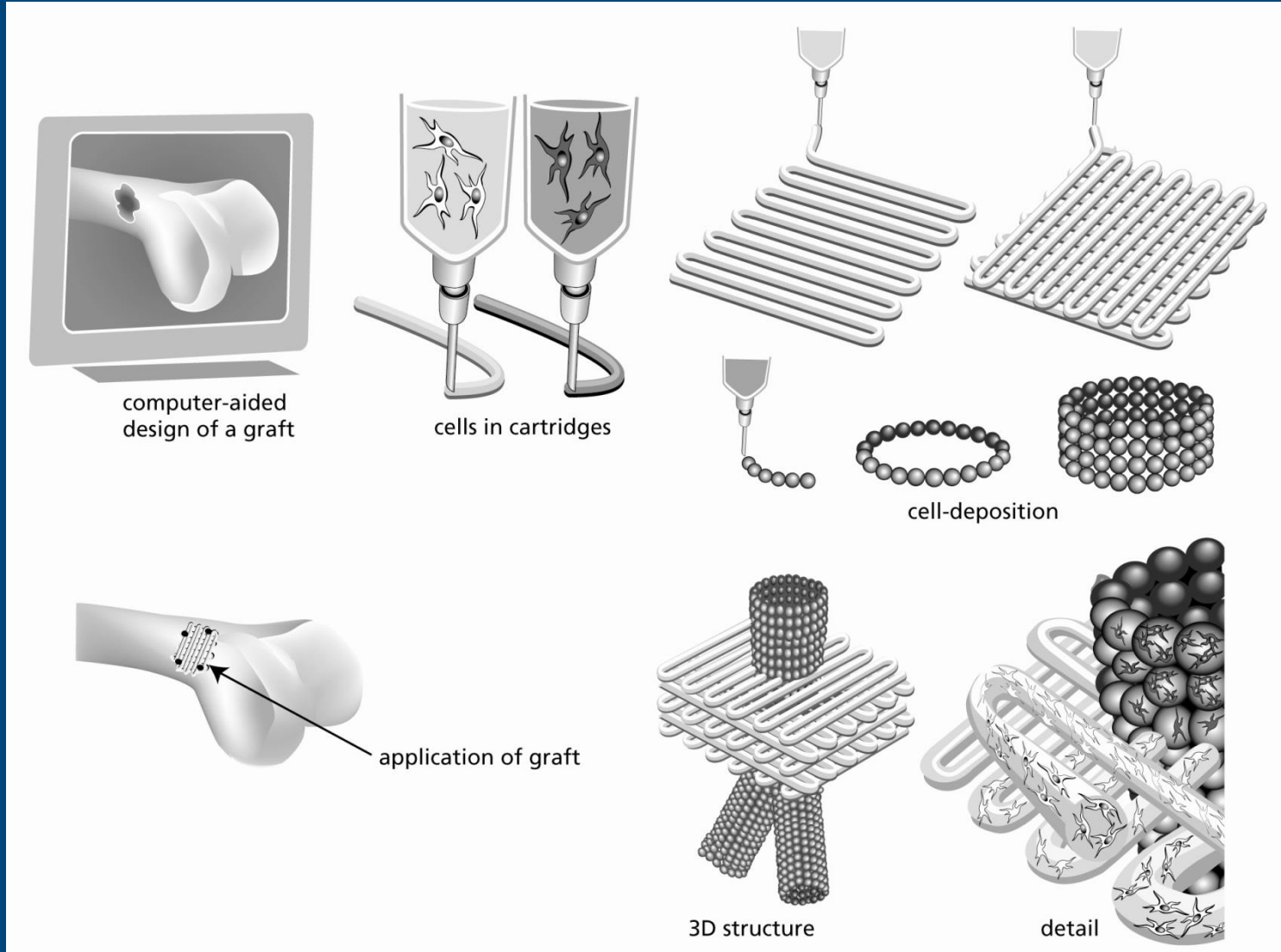


Proefdiergebruik bij Tissue-engineering



Tissue printing

<http://www.youtube.com/watch?v=zuB3LWwXdWM>



<http://www.youtube.com/watch?v=9VHFlwJQIkE>

<http://www.youtube.com/watch?v=9RMx31GnNXY>

MSC therapie, met vet stamcellen



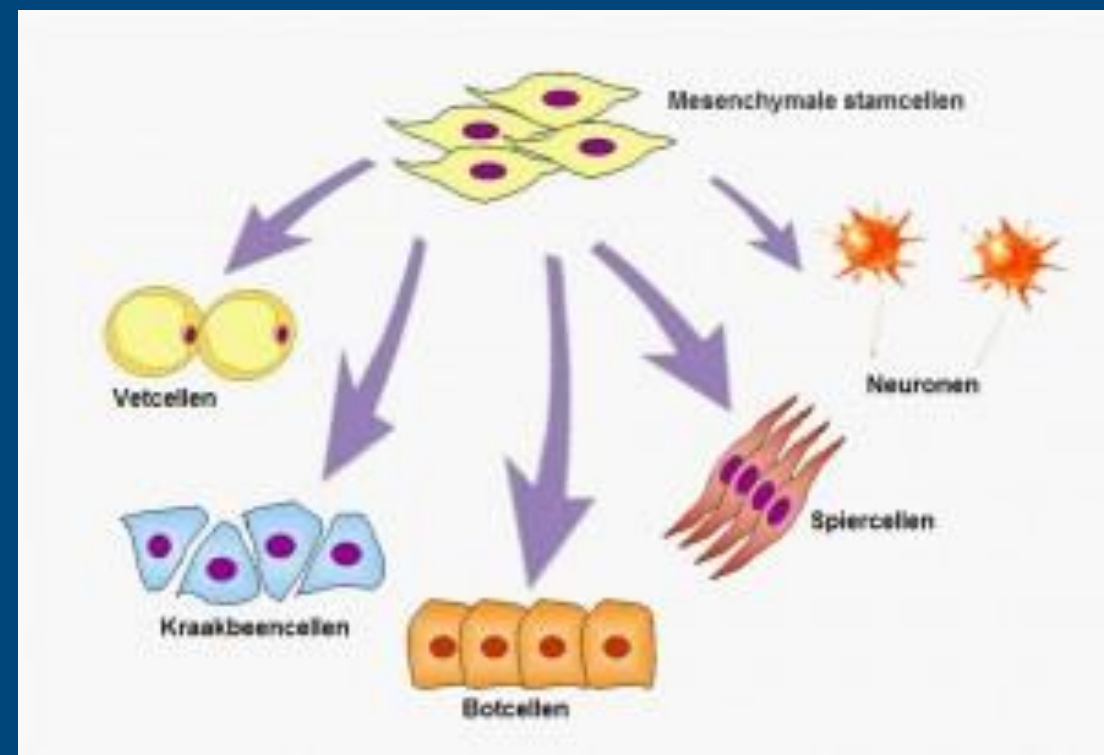
- **SCIENCE ADVANCES 4 JANUARY 2023**
- An injectable nanofiber-hydrogel composite with **adipose-derived stem cells** promotes regenerative healing of perianal fistula.

Navelstreng stamcel (MSC-achtig) Halverwege Embryonaal en Adult



Mesenchymale stamcellen (MSC's) zijn multipotente stamcellen die voor het eerst zijn ontdekt in het beenmerg. Jaren later bleken er ook Mesenchymale stamcellen in het navelstreng voor te komen die **nog flexibeler, jonger en krachtiger waren dan in het beenmerg.**

Hoewel hun fysiologische rol onduidelijk blijft. Kunnen wetenschappers de MSC's in vitro laten delen en onder de juiste omstandigheden, tot verschillende soorten cellen/weefsels laten specialiseren. Denk hierbij aan botweefsel, vetcellen, spierweefsel, kraakbeenweefsel etc.. De in vitro gekweekte cellen hebben ook immuun regulerende eigenschappen en beschikken over eigenschappen om beschadigd weefsel te herstellen. Wetenschappers ontdekken steeds meer toepassingen in stamceltherapie en geloven dat deze stamcellen in de nabij toekomst gebruikt kunnen worden tegen verschillende ziektes en bij weefselherstel.

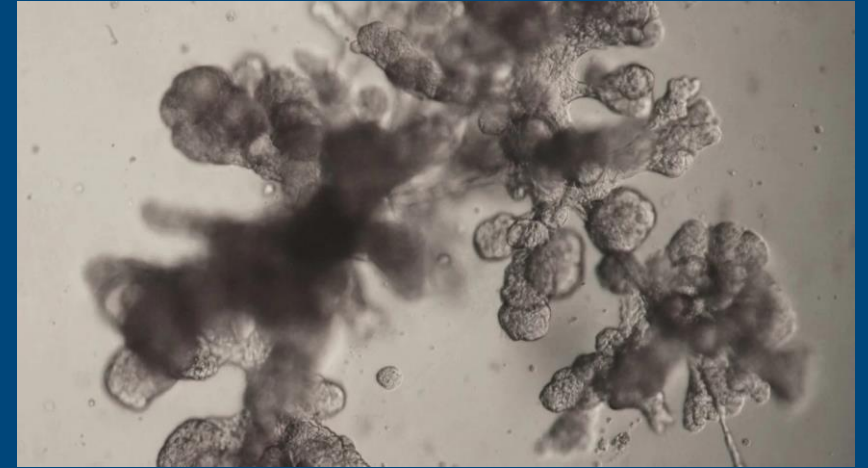


Ook voor kweekvlees!

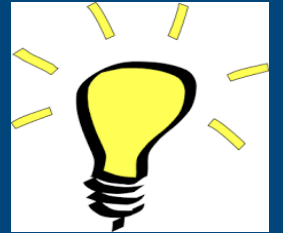
Speekselklier stamceltransplantatie. => organoids (en werk van Dr.Licht!)



- **Verminderde kwaliteit van leven**
- Jaarlijks zijn er in Nederland zo'n 2.500 nieuwe patiënten met een tumor in het hoofdhalsg gebied. Een groot deel van deze patiënten heeft met bestraling een goede kans op genezing. Een vervelende complicatie hierbij is dat bij 40% van de patiënten na de behandeling de speekselklieren niet goed meer werken. Hierdoor hebben ze continu last van een droge mond. Kauwen en slikken is lastig, hun smaakvermogen vermindert, praten is erg moeilijk en het gebit wordt beschadigd. Hierdoor hebben deze patiënten vaak een sterk verminderde kwaliteit van leven.
- Om dit probleem te verhelpen doet de onderzoeksgroep van UMCG-hoogleraar Radiotherapie **Rob Coppes** al jaren onderzoek naar
- Begin deze eeuw kwam Coppes op het idee om patiënten met een droge mond te behandelen met stamceltransplantatie. Hij identificeerde stamcellen van de speekselklier bij de muis en vervolgens bij de mens. Hierna werden de stamcellen opgekweekt in het laboratorium, waar ze **minispeekselkliertjes (organoïden)** vormden en vermenigvuldigd kunnen worden. Vervolgens toonden experimenten met muizen aan dat de behandeling aanslaat en dat bij muizen de speekselklieren weer aangroeiden.
- Hierna werden van mensen afkomstige speekselklierstamcellen in het laboratorium opgekweekt en bij muizen ingebracht. Wederom sloeg de behandeling aan. Vervolgens vertaalden de onderzoekers de resultaten naar de mens en werd de methode veilig en geschikt gemaakt voor klinisch gebruik.
- 1 vandaag (171222)



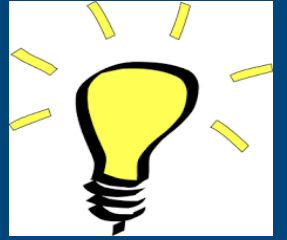
Large-scale smart bioreactor with fully integrated wireless multivariate sensors and electronics for long-term in situ monitoring of stem cell culture



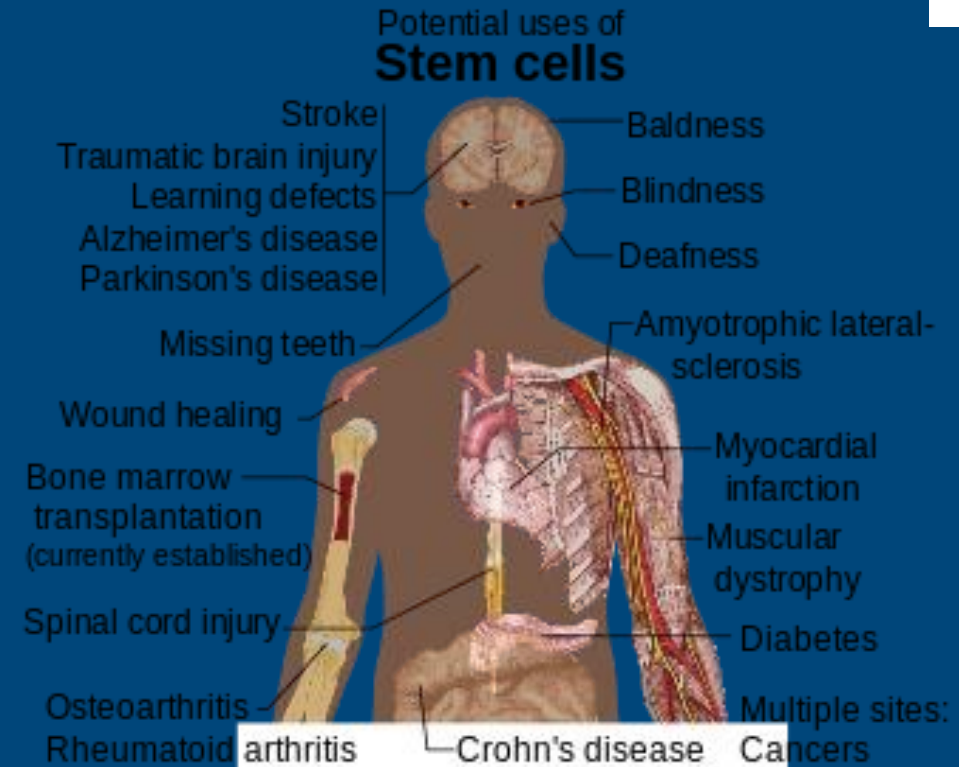
- Achieving large-scale, cost-effective, and reproducible manufacturing of stem cells with the existing devices is challenging. Traditional single-use cell-bag bioreactors, limited by their rigid and single-point sensors, struggle with accuracy and scalability for high-quality cell manufacturing. Here, we introduce a smart bioreactor system that enables multi-spatial sensing for real-time, wireless culture monitoring. This scalable system includes a low-profile, label-free thin-film sensor array and electronics integrated with a flexible cell bag, allowing for simultaneous assessment of culture properties such as pH, dissolved oxygen, glucose, and temperature, to receive **real-time feedback for up to 30 days**. The experimental results show the accurate monitoring of time-dynamic and spatial variations of stem cells and myoblast cells with adjustable carriers from a plastic dish to a 2-liter cell bag. These advances open up the broad applicability of the smart sensing system for large-scale, lower-cost, reproducible, and high-quality engineered cell manufacturing for broad clinical use.



Stamcel therapie



- Lichaam bestaat uit >100 miljard cellen
- Voortgekomen uit 1 cel
- Bevruchte eicel is ultieme stamcel
- Embryonic stem cells
- Adult stem cells => veilig
- Induced pluripotent stem cells



Stamcel Nobel 2012

John B. Gurdon and Shinya Yamanaka
(Nobel al binnen 10 jaar na ontdekking!)

Mature cells can be reprogrammed (iPS)
to become pluripotent

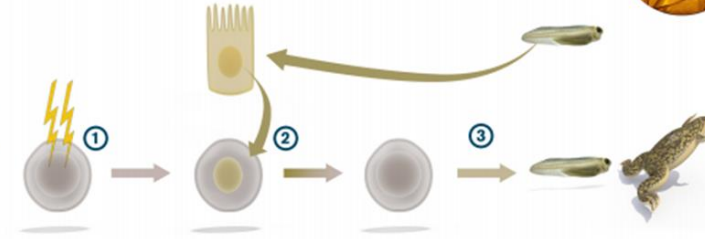
Elke cel heeft nog al het DNA

Patient levert eigen materiaal voor
therapie !

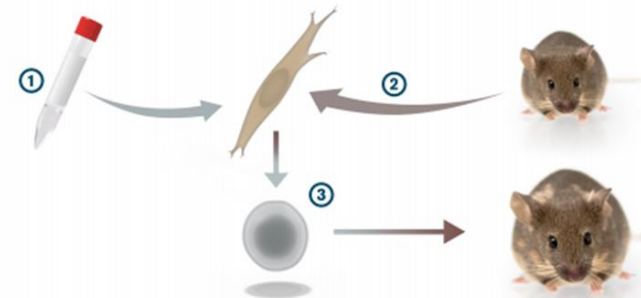
The Nobel Prize in Physiology or Medicine 2012



John B. Gurdon

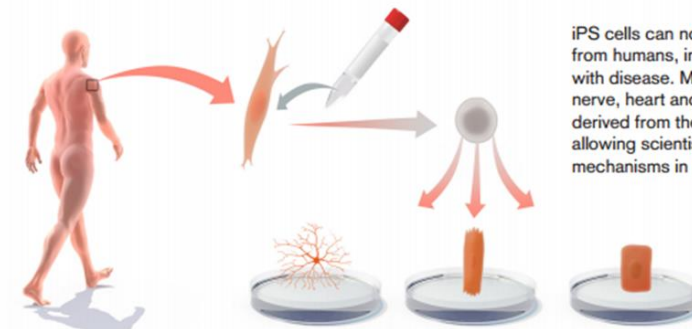


John B. Gurdon eliminated the nucleus of a frog egg cell (1) and replaced it with the nucleus from a specialised cell taken from a tadpole (2). The modified egg developed into a normal tadpole (3). Subsequent nuclear transfer experiments have generated cloned mammals (4).

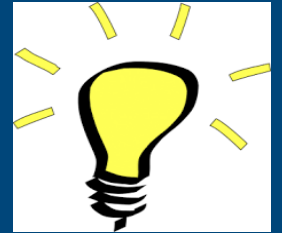


Shinya Yamanaka

Shinya Yamanaka studied genes that are important for stem cell function. When he transferred four such genes (1) into cells taken from the skin (2), they were reprogrammed into pluripotent stem cells (3) that could develop into all cell types of an adult mouse. He named these cells induced pluripotent stem (iPS) cells.

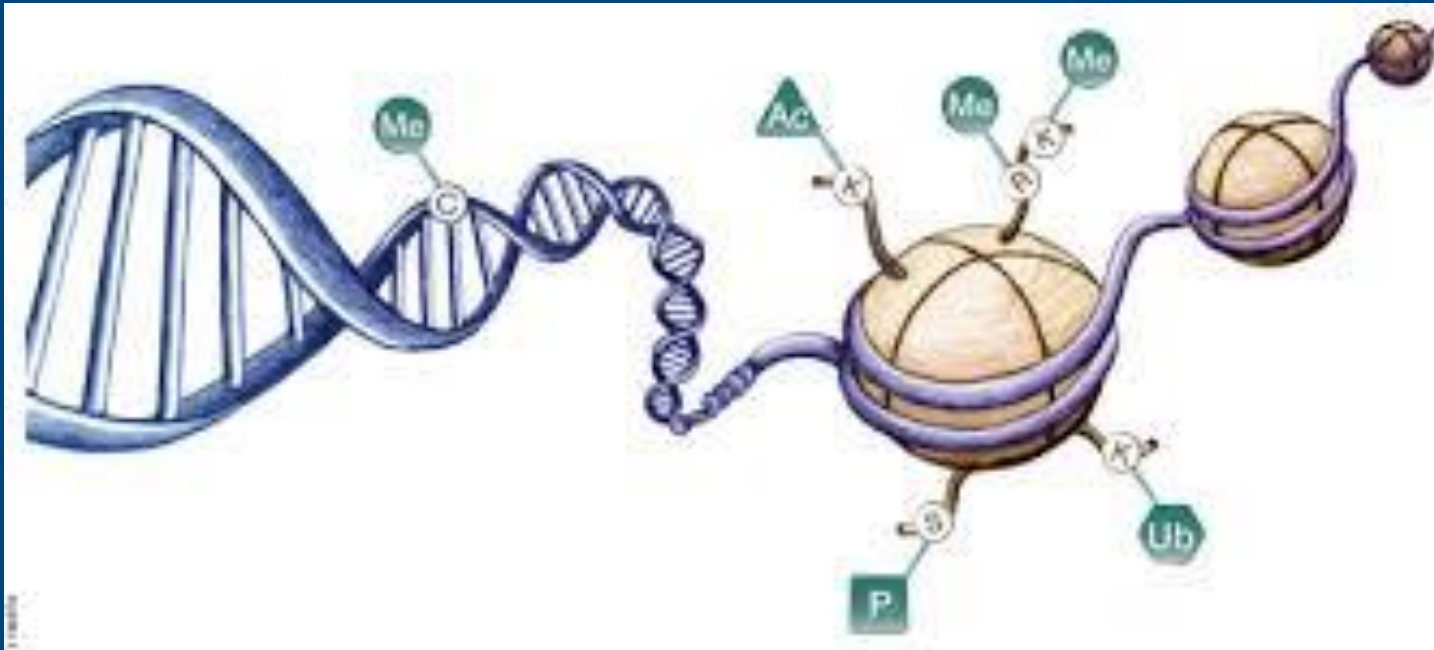
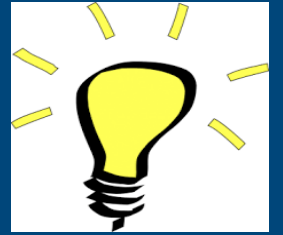


iPS cells can now be generated from humans, including patients with disease. Mature cells including nerve, heart and liver cells can be derived from these iPS cells, thereby allowing scientists to study disease mechanisms in new ways.



Celbio 1:

Epigenetische modificatie



<https://www.youtube.com/watch?v=mHak9EZjySs&list=PL761BC3F8B2447983>

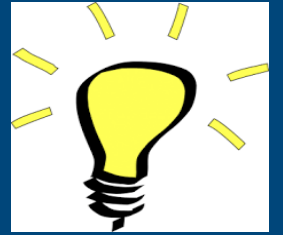
- **Differentiatie** van cellen: van stamcel tot weefsel

=> Kanker, Veroudering

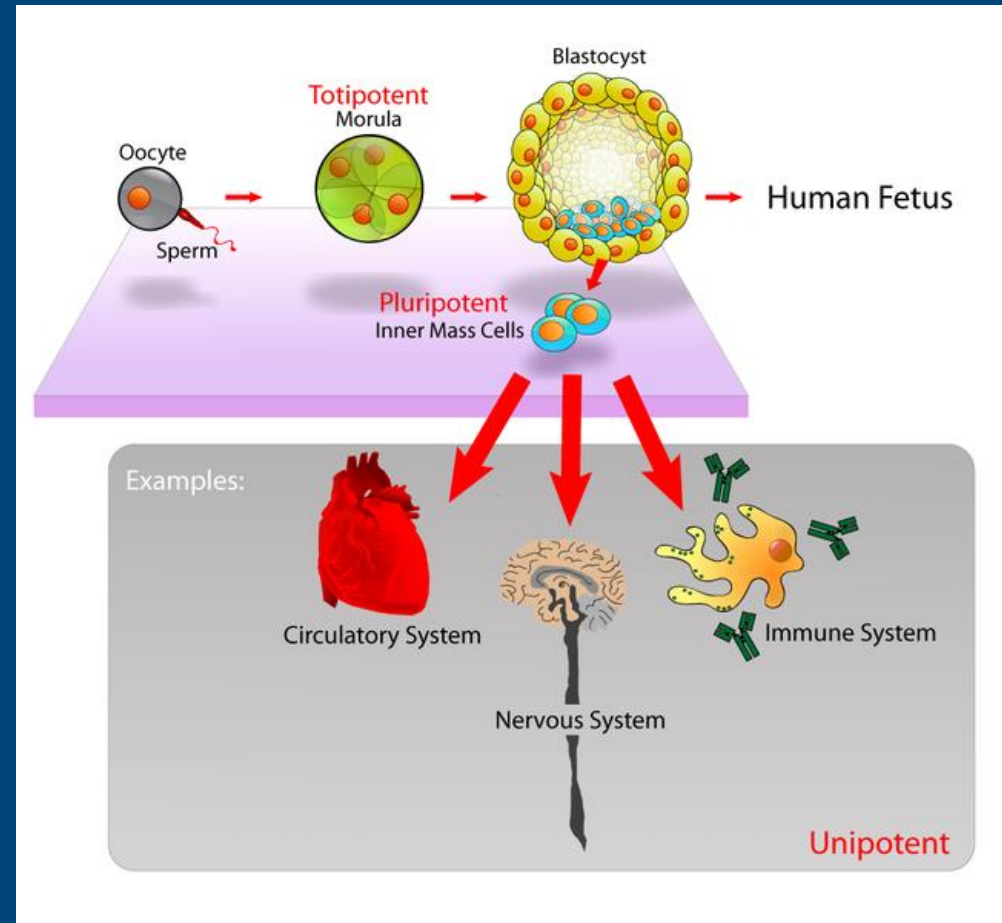
=> Non coding RNA

MCB H.18, p.309

Epigenetica en cel differentiatie



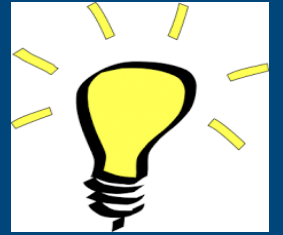
Meercellig => differentiatie
=> genen uit/aan



<https://www.youtube.com/watch?v=i9a-ru2ES6Y>

Organoids

Growing new tissues outside the body => ex vivo

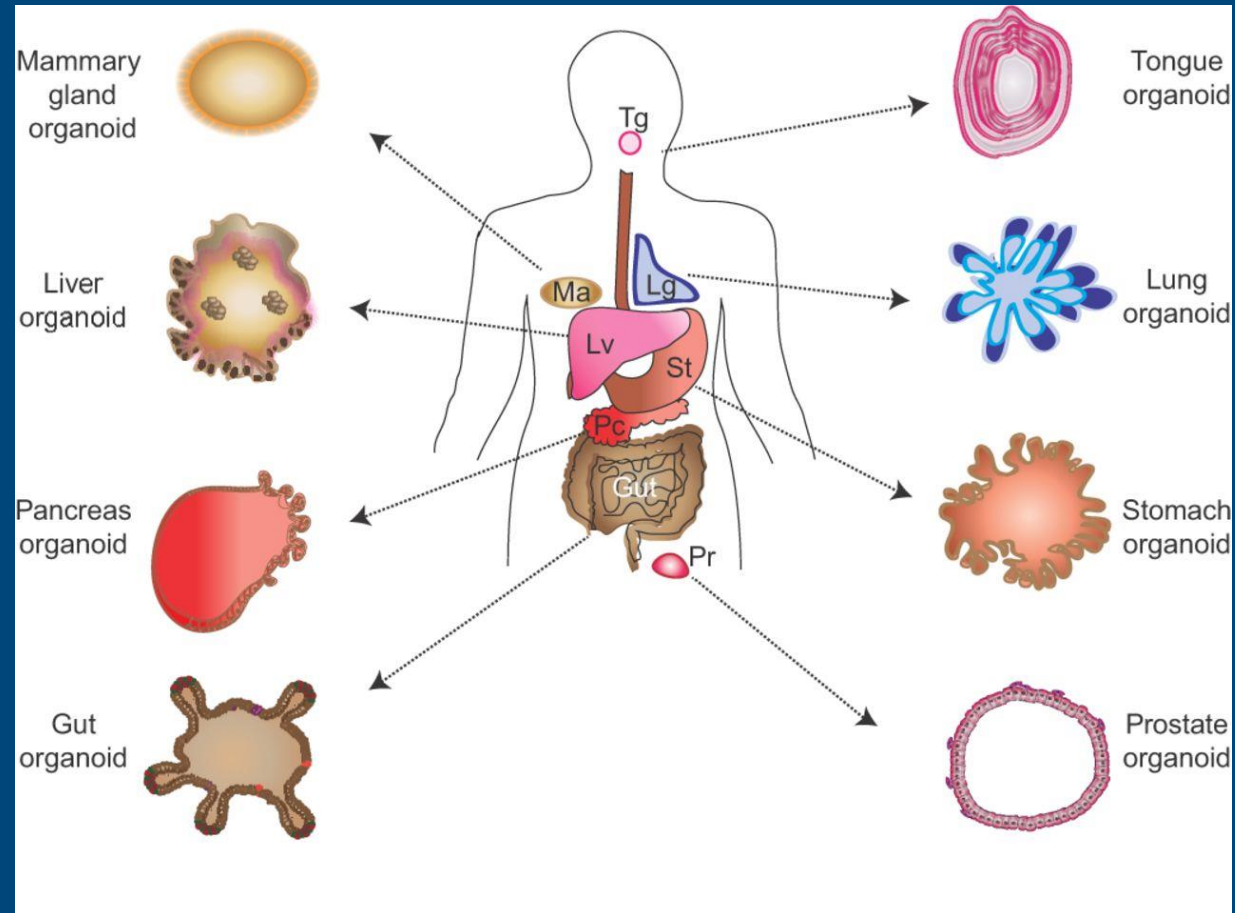


(Stam)cellen uit het lichaam van een patients worden in het lab (via iPS) gestimuleerd en opgekweekt tot mini-orgaantjes

=> Volledige differentiatie

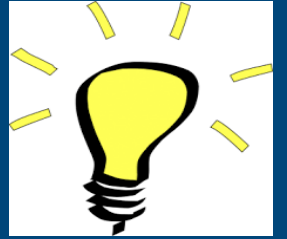
Die kunnen dan worden gebruikt voor onderzoek, en therapie

=> Individuele geneeskunde

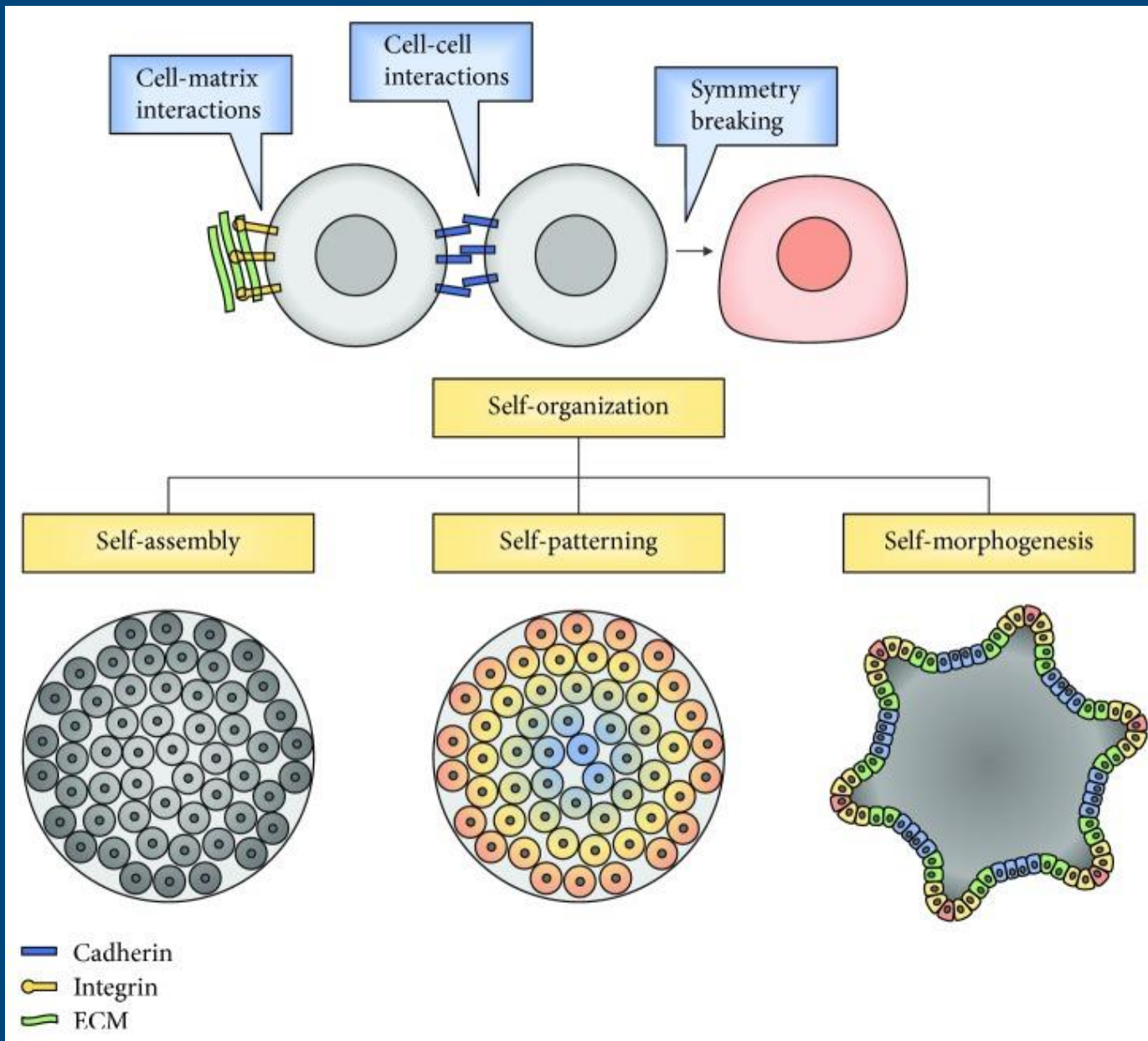


NB iPS cellen zijn nu in principe volledig gedifferentieerd, maar er hoeft maar 1 cel van een organoid zich niet aan de spelregels te houden => kanker. Veiligheid is dus nog een issue.

Organoids and self-organisation



=> Life is self organizing



<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6501244/>
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6784492/>

Celbio 2



- Lex Fridman podcast
- <https://youtu.be/TiFKLK-ycBk>

=> bioelectricity

=> biological computation

=> cells have agency

(reageren op hun omgeving)

=> cel is een (levende) basis bouwsteen

=> degrees of freedom (controle!?)

Informatie in het netwerk



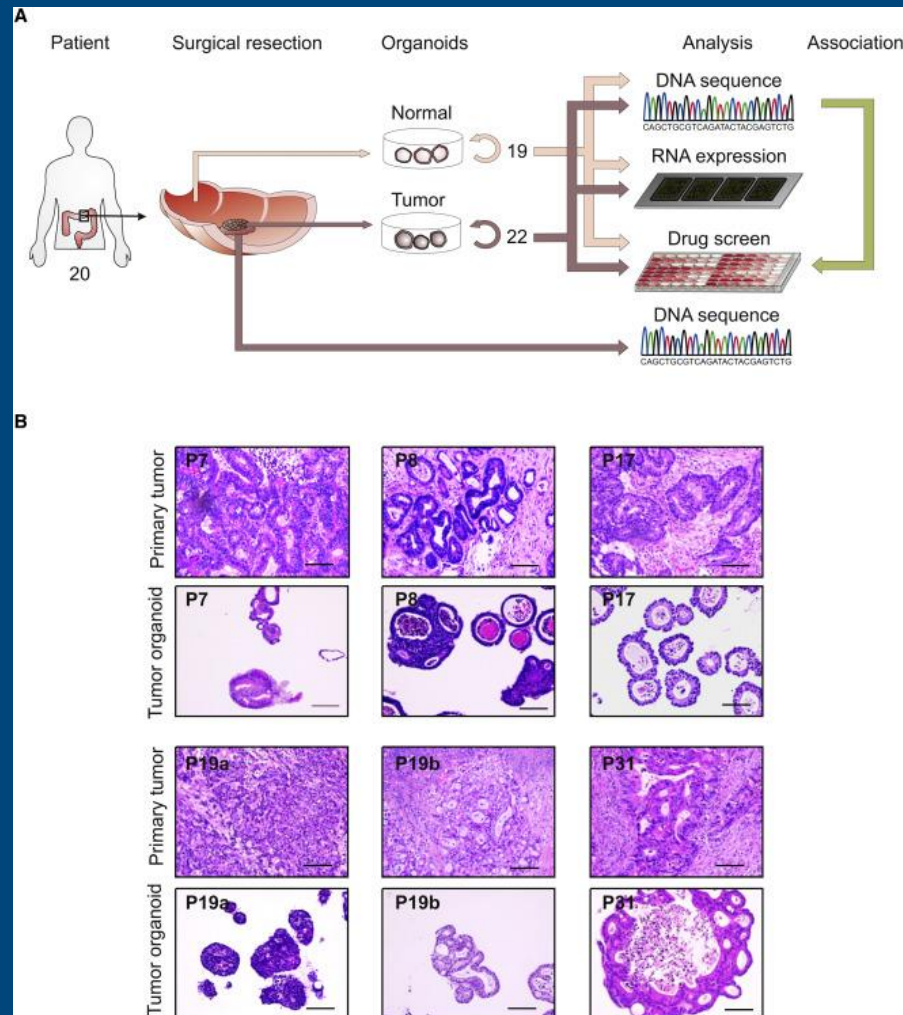
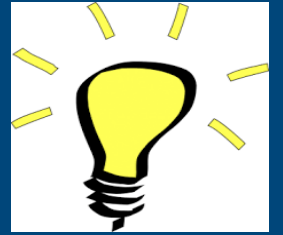
Leven is..

- Een informatie systeem
- Manipuleerbaar met informatietechnologie
- Modulair
- Self-organizing



Hans Clevers

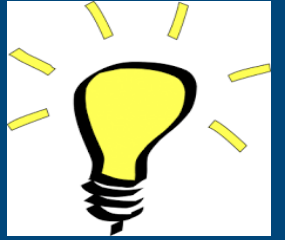
Darm stamcellen => organoids



https://nl.wikipedia.org/wiki/Hans_Clevers

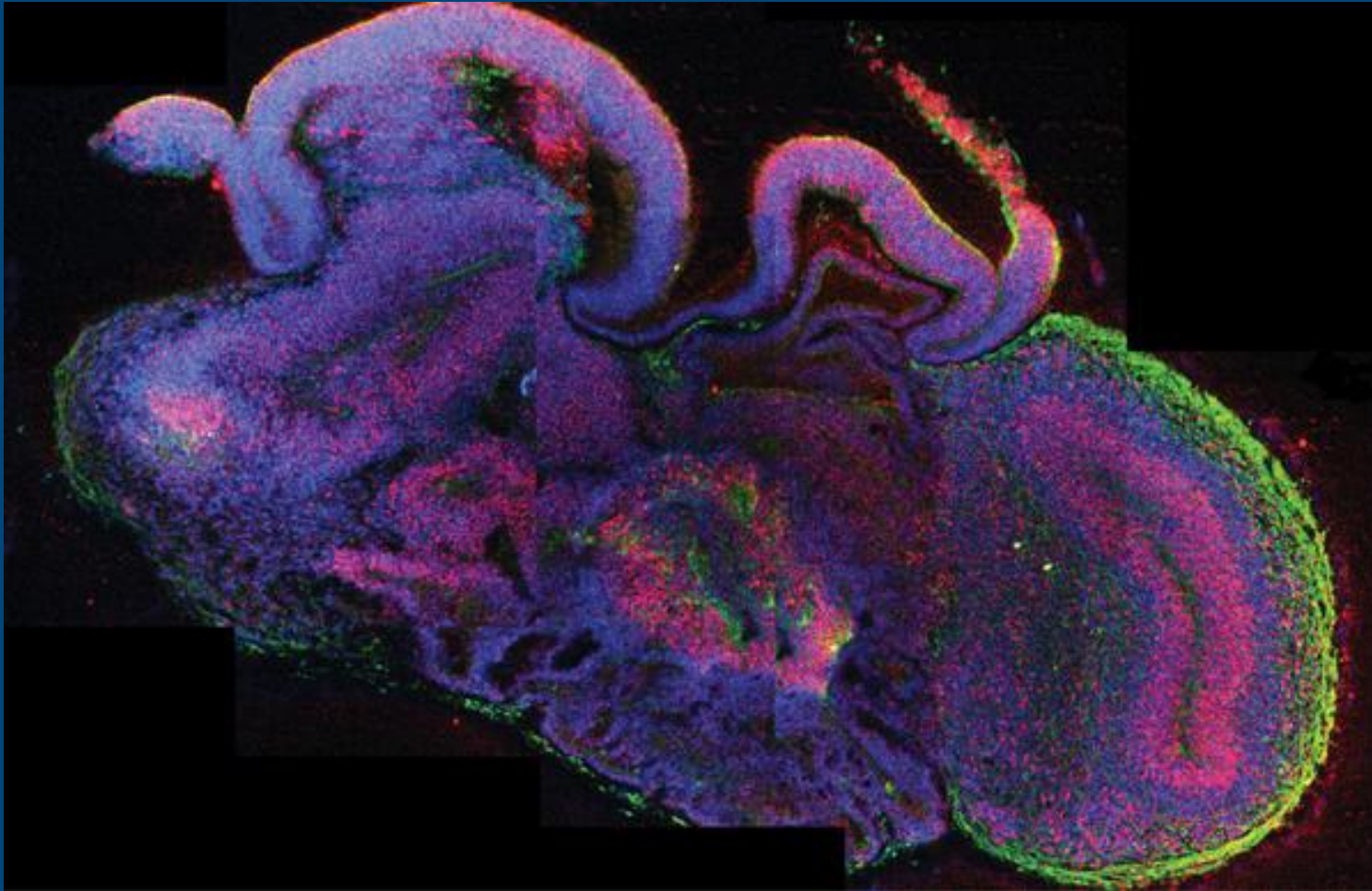
[http://www.cell.com/cell/fulltext/S0092-8674\(15\)00373-6?_returnURL=http%3A%2F%2Flinkinghub.elsevier.com%2Fretrieve%2Fpii%2FS0092867415003736%3Fshowall%3Dtrue](http://www.cell.com/cell/fulltext/S0092-8674(15)00373-6?_returnURL=http%3A%2F%2Flinkinghub.elsevier.com%2Fretrieve%2Fpii%2FS0092867415003736%3Fshowall%3Dtrue)

Organs-on-chips go mainstream 'Homo chippiens'



<http://www.nature.com/news/organs-on-chips-go-mainstream-1.17977>

Brain Organoids



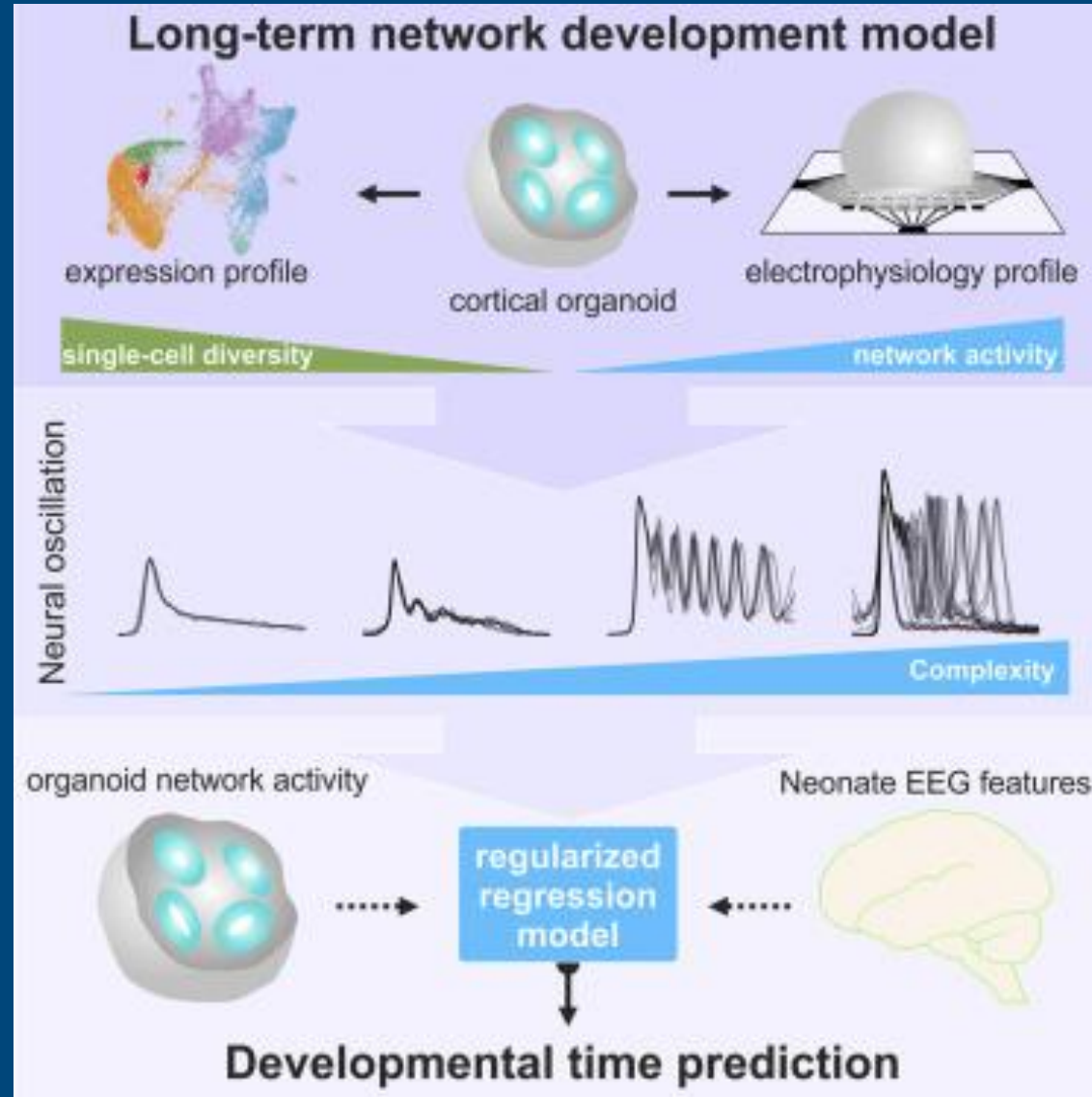
Vooral onderzoek, patientspecifiek
Ook hier is de kliniek nog ver weg
ivm veiligheid

- <https://www.youtube.com/watch?v=76CQ1kLGbNs>
- <http://hub4organoids.eu/organoid-technology/>

Complex Oscillatory Waves Emerging from Cortical Organoids
Model Early Human Brain Network Development (2019.08)

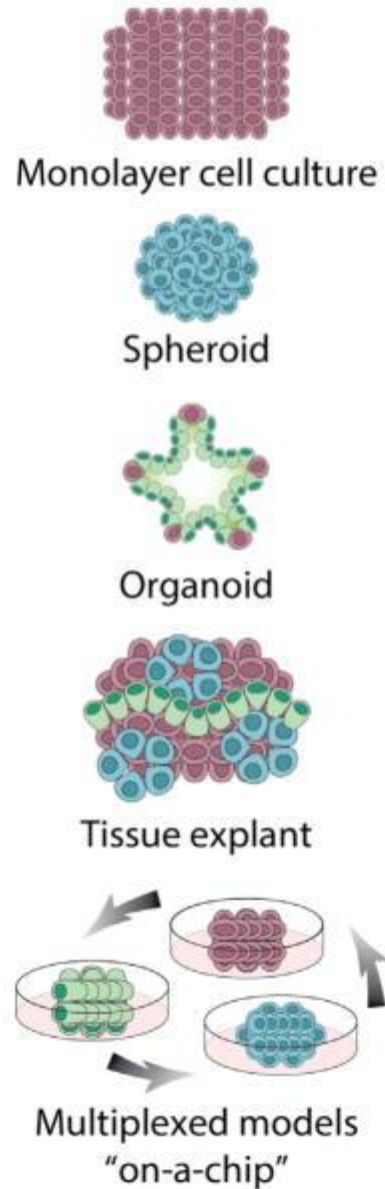
Toekomst:
Medijnen
(bijv. antidepressiva)
testen op organoids
van individuele patient.

NB Eenvoudiger inzicht
in de werking van
organen (niet uit een
lichaam hoeven halen,
of in een lichaam
bekijken

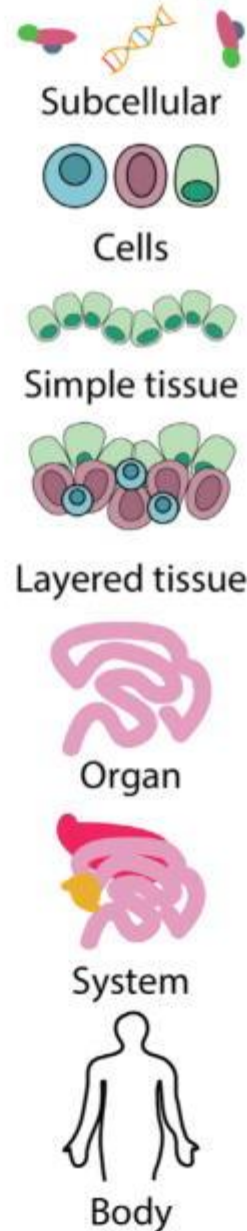




Model systems in life sciences



Organization of the body



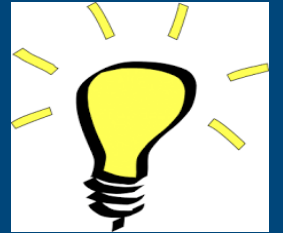
Scale

Tissue-engineering
kan op elk niveau

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4728053/>



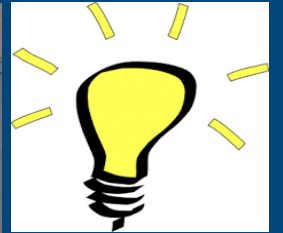
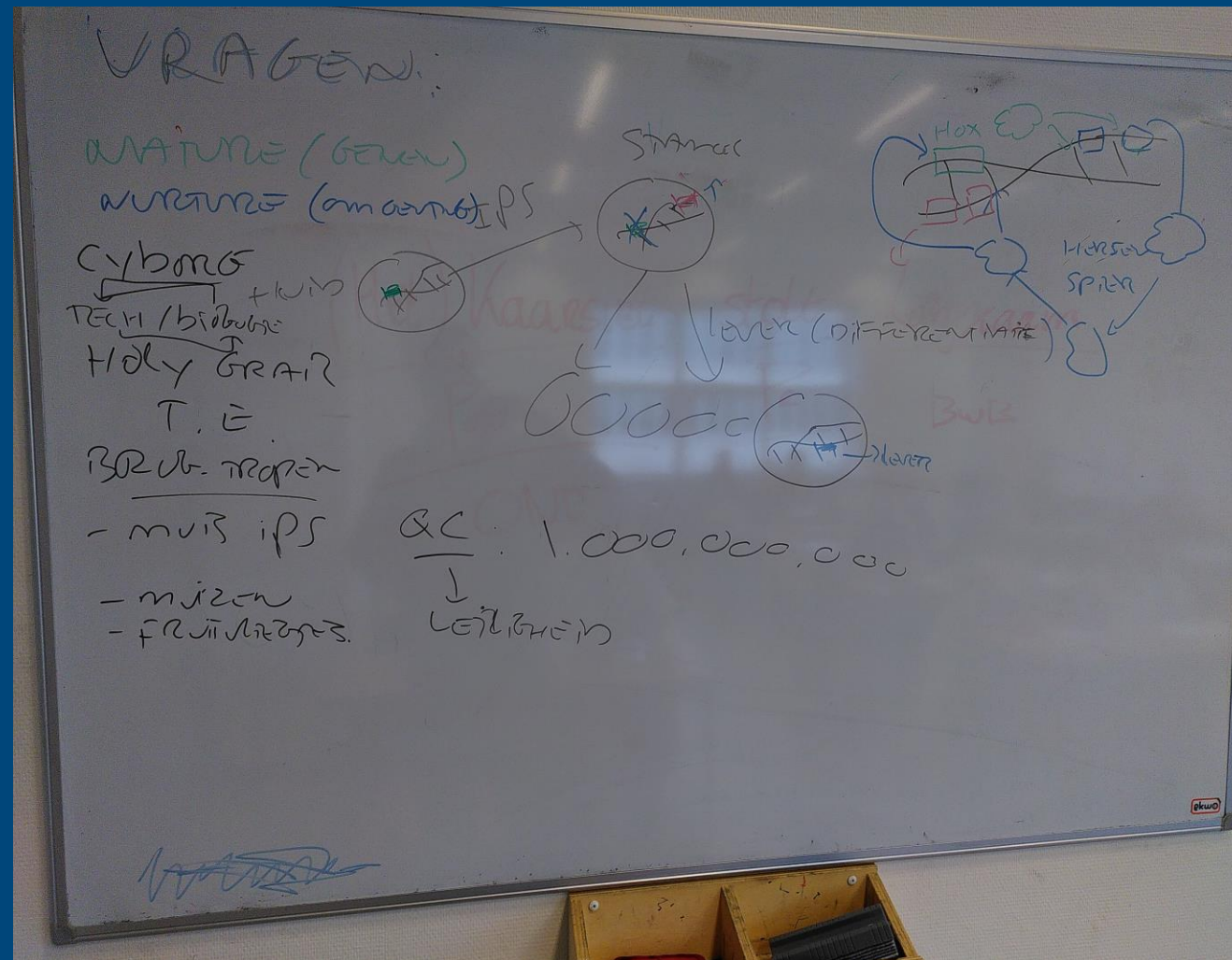
Leven is..



- Een informatie systeem
 - Manipuleerbaar met informatietechnologie
 - Modulair
 - Self-organizing
 - Heeft een pauze knop
-
- Niet voorbij met de dood (van een meercellig individu)
 - Levende individuen bevatten “dood” materiaal

Vragen

- Embryonale ontwikkeling
 - Fruitvliegjes
 - In vivo TE
 - Muis iPS
 - Levende brug
 - Cyborg
- => college 4

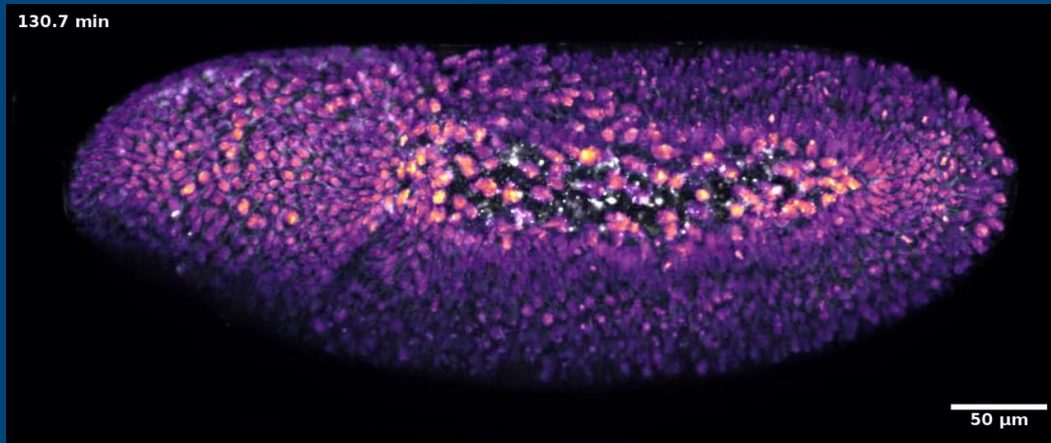
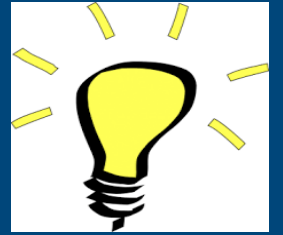


Mastergenes (Homeobox)



- The development of an organism — from a fertilized egg, through embryonic and juvenile stages, to adulthood — requires the coordinated expression of sets of genes at the proper times and in the proper places. **Studies of several bizarre mutations in the fruitfly, *Drosophila*, provided keys to understanding the molecular basis of large-scale developmental plans.** Early embryonic genes express proteins that set up the orientation and define the body segments of the fly embryo. Then "homeotic" genes act on the segments to make the body parts distinct to each segment.
- Sequence analysis showed that homeotic genes from *Drosophila* and vertebrate animals share a 180-nucleotide region, called the **homeobox**. These homeobox proteins have structures highly similar to the regions of regulatory proteins that bind to DNA promoters and enhancers. Thus, a homeotic protein elicits coordinated expression when the protein binds to a specific promoter or enhancer sequence shared by a number of genes involved in the development of body region or segment.
- <https://www.dnafb.org/37/>

Fruitvliegjes: Volledige embryonale ontwikkeling is te volgen

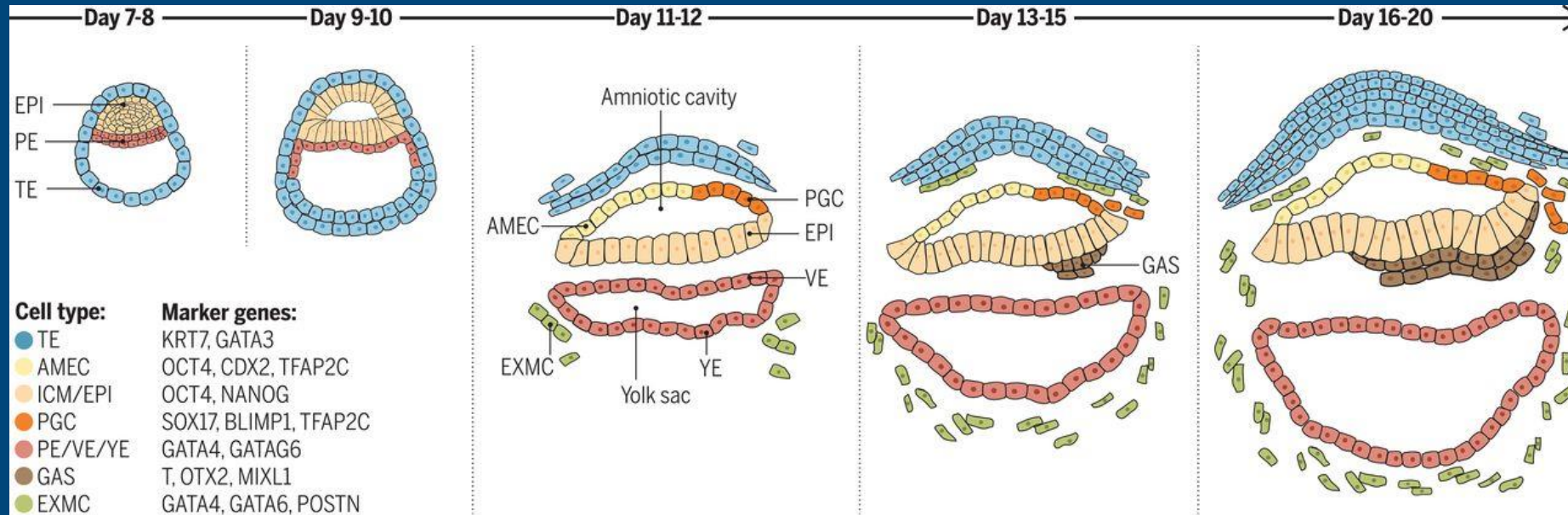
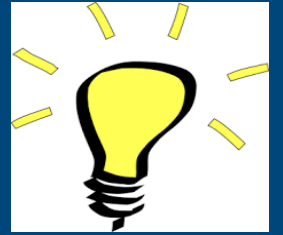


- https://en.wikipedia.org/wiki/Drosophila_embryogenesis



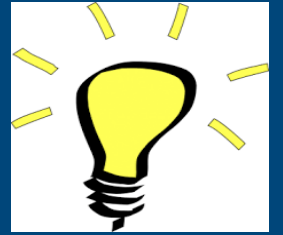
<https://youtu.be/h9RfeU5u85k>

Monkey embryos cultured in vitro recapitulate primate postimplantation embryogenesis in vivo.
=> culture beyond 14 days

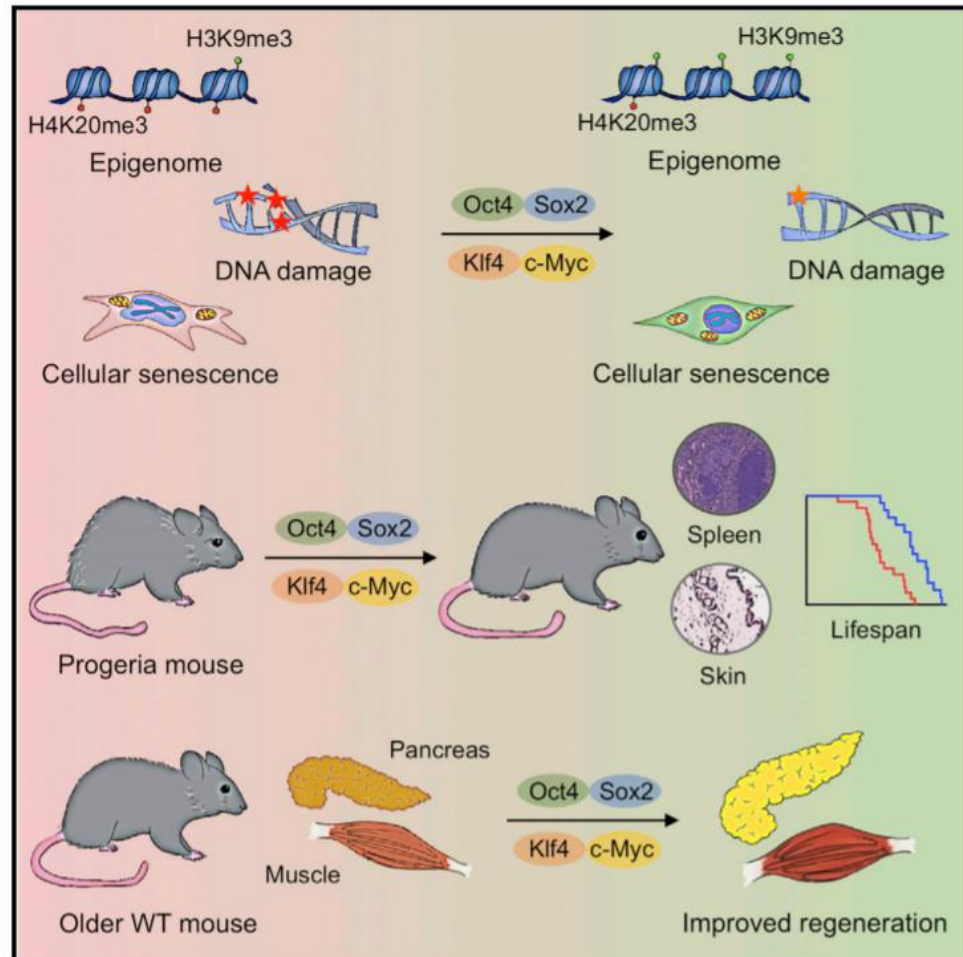


- Scheme of monkey postimplantation embryogenesis cultured in vitro. ICM, inner cell mass; EPI, epiblast; PE, primitive endoderm; TE, trophectoderm; AMEC, amniotic epithelium cell; PGC, primordial germ cell; VE, visceral endoderm; YE, yolk-sac endoderm; EXMC, extra-embryonic mesenchyme cell; and GAS, gastrulating cell.
- <https://science.sciencemag.org/content/366/6467/eaaw5754>

In Vivo Amelioration of Age-Associated Hallmarks by **Partial** Reprogramming => in vivo TE



Graphical Abstract



Authors

Alejandro Ocampo, Pradeep Reddy,
Paloma Martinez-Redondo, ...,
Isabel Guillen, Pedro Guillen,
Juan Carlos Izpisua Belmonte

Correspondence

belmonte@salk.edu

In Brief

Cellular reprogramming by transient expression of Yamanaka factors ameliorates age-associated symptoms, prolongs lifespan in progeroid mice, and improves tissue homeostasis in older mice.

In Vivo TE
Muis iPS

Tissue engineering: Levende brug



- <https://www.bnnvara.nl/3opreis/artikelen/natste-plek-ter-wereld-boom-bruggen-india-cherrapunji>



DARPA Seeks to Create Software Systems That Could Last 100 Years

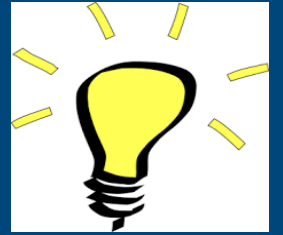
Life is resilient !

A system lasting 4 billion years

=> Valt een hoop van te leren



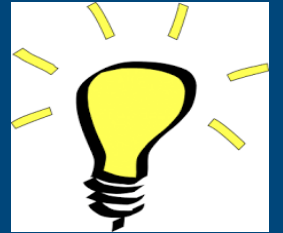
Probleempunten in discussie over GM



- Kaas komt niet voor in de natuur, mensen met een bril ook niet (we staan al lang buiten de evolutie)
- Veredeling is ook onnatuurlijk (elstar, hond)
- GM gebruikt ook “natuurlijke” systemen als virussen en DNA.
- Natuurlijk is altijd goed? => er is niets zo dodelijk als de natuur.
- GM systemen hebben extra risico's, maar voordelen zijn immens (10 miljard mensen voeden) => onvermijdelijk?
- Vertroebeling door religieuze kijk; Ouderwets is beter, leven is heilig.
- Angst voor nieuwe technologie (gebrek aan kennis)
- partnerkeuze? => ons willen verbeteren is natuurlijk
- Biologie is technologie => via evolutie wordt de technologie aangepast (verbeteren?)
- Termen: **Wetware** (itt hardware/software)

Julian Savulescu

- A professor of practical ethics at the University of Oxford, Savulescu thinks deeply about the ethics of the biological enhancement of the human race.
- **As a species, we have a moral obligation to enhance ourselves biologically.**
- **Humans have a lot of limitations.** We have limitations in terms of aging, we have cognitive limitations, various physical limitations, and of course moral limitations. When science offers us the opportunity to overcome these limitations, we should ask the ethical question: “should we?” In some cases we shouldn’t, but in many cases we have a moral obligation to overcome those limitations.
- One trivial example: about a billion IQ points are lost around the world each year because salt isn’t iodized. If you’re pregnant and have insufficient iodine, your fetus might lose 10 to 15 IQ points. You may still be “normal” — but it only costs 2-3¢ per person per year to iodize salt. We have an enormous moral obligation to do that because of the value of cognitive ability.
- We also have a moral obligation to overcome our moral limitations. People evolved to form groups of about 150. They care about their **tribal group**, and they tend to be violent to or derogate out-of-group members. They are altruistic to their friends and family, but much less so to other people. They free-ride. They think in the **near term**. All of these are essentially features built into our psychology.
- We’re far from perfect. We’ll never be perfect, but when science offers us the opportunity to understand those limitations and to build policies tailored towards them, or indeed to directly overcome them, we ought to at least do research into it.



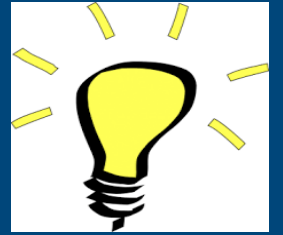
<https://youtu.be/DhtlFTrJQJ4>

New biosecurity group aims to prevent biotech disasters



- Organization hopes to safeguard technology advances from misuse and abuse
- <https://www.science.org/content/article/new-biosecurity-group-aims-prevent-biotech-disasters>

Volgende week



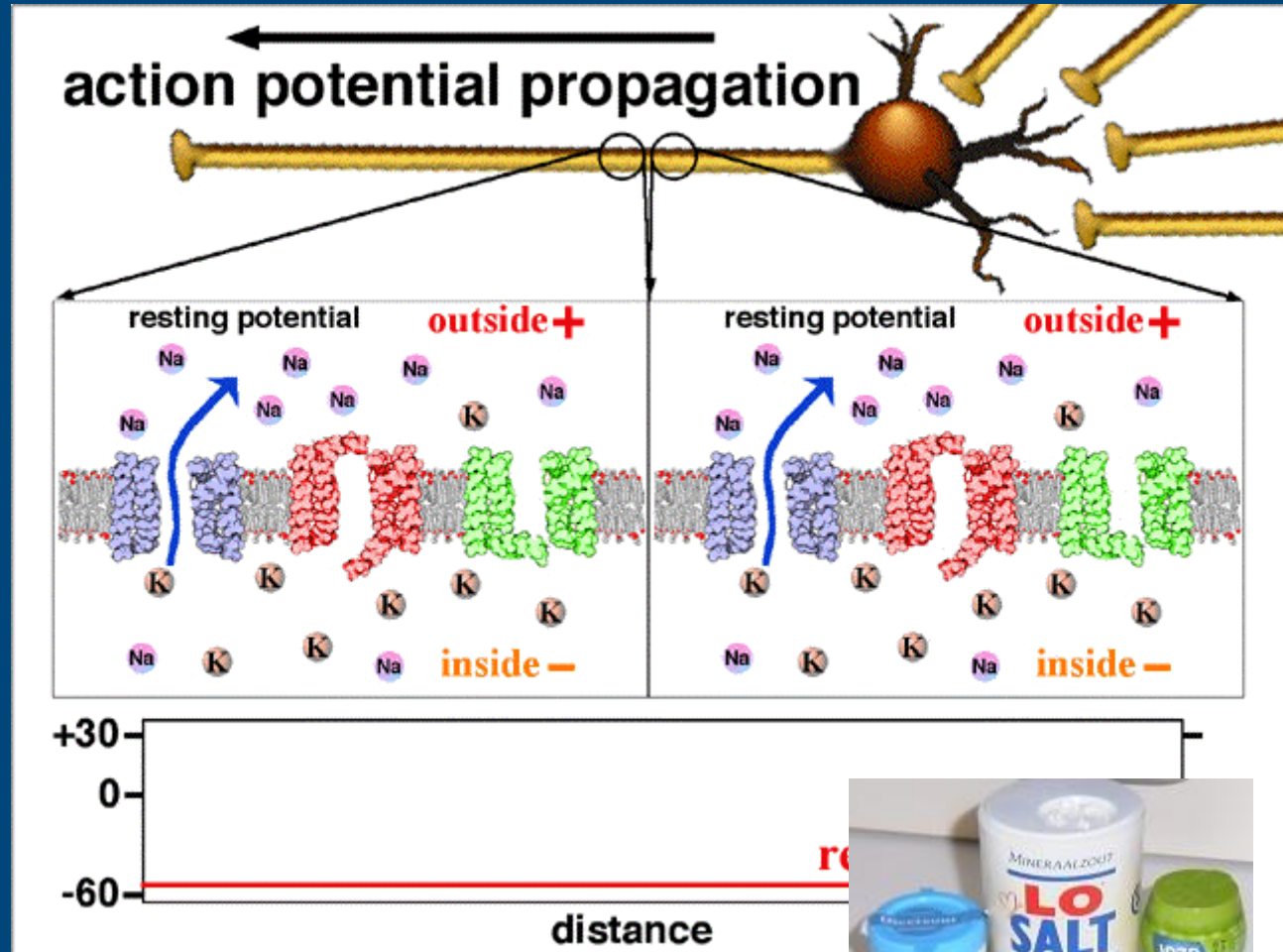
Celbio 3: De zenuwcel

Gemiddelde zenuwcel
vuurt ongeveer 10x
per seconde,
(x86miljard).

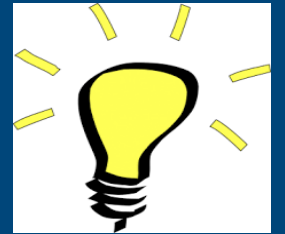
Meeste neuronen
vuren continue, ook al
“denk” je nergens aan!

Maar vooral het
patroon van vuren
(actiepotentialen) is
belangrijk.

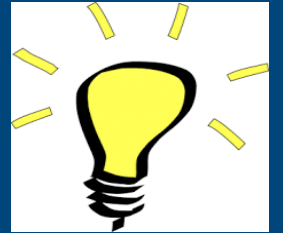
Lokale depolarisatie
leidt tot depolarisatie
verderop via
“Voltage gated **ion
channels**” (=> stuwt
zichzelf voort)



Elektriciteit op basis van ionen, zoals K⁺



Biologie is elektrisch



- Verschillende ionconcentraties => spannings-verschil => stroom => elektrisch veld
- Veld strekt zich uit tot buiten het lichaam

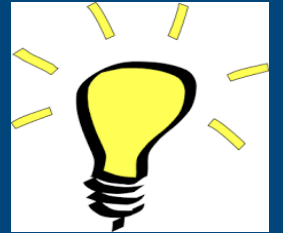
=> EEG

=> Touchscreen

- “Life is the flow of charge”
- Integratie technologie en biologie
op basis van elektriciteit !



Leven is..



- Een informatie systeem
 - En tegelijkertijd een materieel systeem
 - Individuele processen kunnen ook buiten een levend systeem plaatsvinden
 - Modulair
 - Self-organizing
 - Niet voorbij met de dood
 - Levende individuen bevatten “dood” materiaal
-
- Elektrisch

=> verbinding met technologie is eenvoudig

Biotechnologie: Precision electronics in the brain

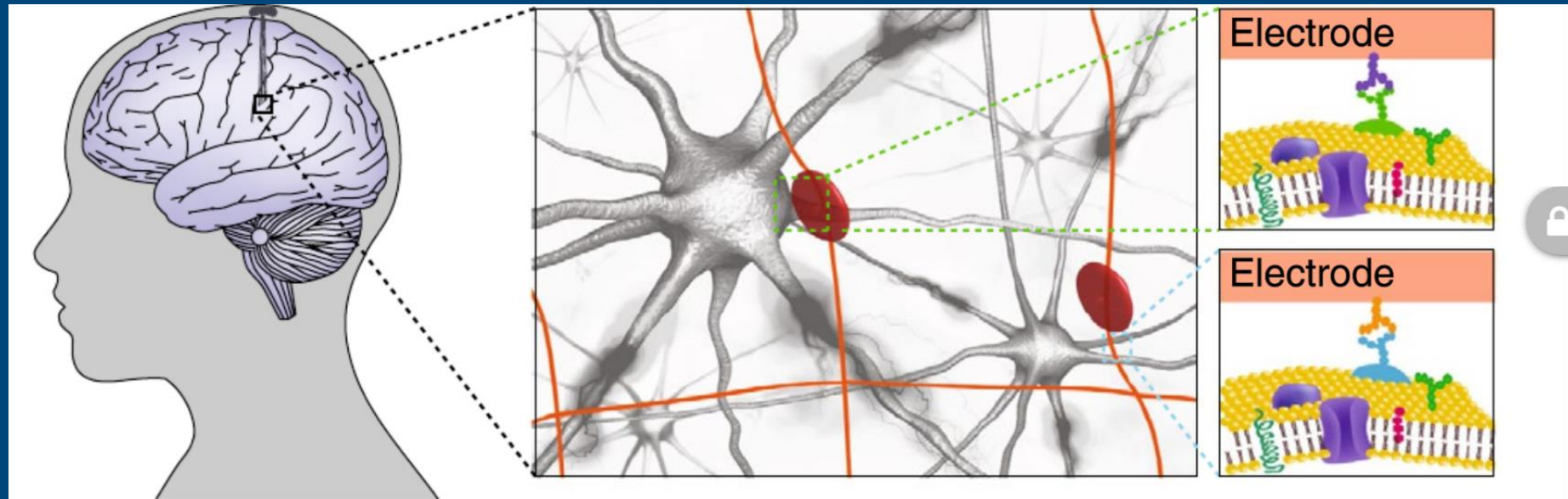
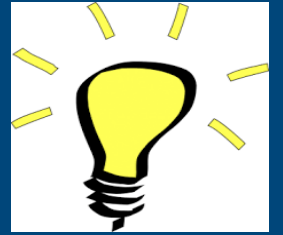


Fig. 3 | Schematic representation of syringe-injectable mesh electronic implant in a human brain. Mesh electronics directly address the structural, mechanical and topological mismatch between probe and host tissue.

<https://www.nature.com/articles/s41587-019-0234-8.epdf>

Using thought to control artificial limbs



Woman with Quadriplegia Feeds Herself Using Mind-Controlled Robot Arm | UPMC

Leerproces, voor
computer en mens.

=> Het was makkelijker
om de hersenen te laten
leren dan een machine..

<https://www.youtube.com/watch?v=76lIQtE8oDY>

<https://youtu.be/76lIQtE8oDY?t=392>

<https://www.youtube.com/watch?v=ogBX18maUiM>

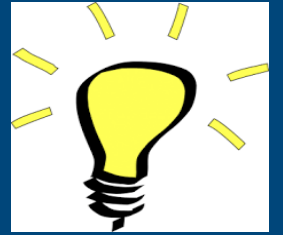
[be.com/watch?v=ogBX18maUiM](https://www.youtube.com/watch?v=ogBX18maUiM)

Mind-reading devices are revealing the brain's secrets



- Implants and other technologies that decode neural activity can restore people's abilities to move and speak — and help researchers to understand how the brain works.

Neuralink



- <https://neuralink.com/>
- ‘We weten he-le-maal niets’ van Neuralink, het hersenimplantaat van Elon Musk
- Al sinds januari zou een patiënt een hersenimplantaat hebben van Elon Musks bedrijf Neuralink. Maar hij brengt geen enkel detail naar buiten.
- [28 februari 2024](#)

'Cyborgweefsel' komt tot leven

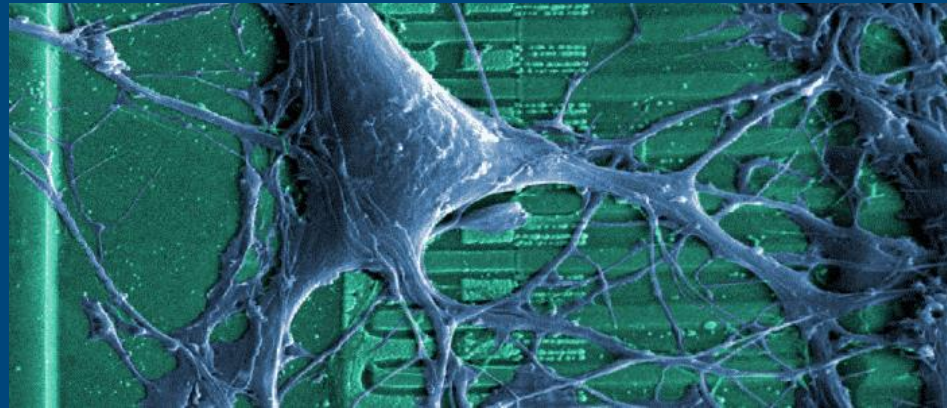
Cyborgs, uit de sciencefictionserie Star Trek.



Het kweken van weefsels is niet nieuw. Maar het kweken van weefsels waarin draden en sensoren zitten die van elke individuele cel de elektrische activiteit in het oog houden wel.

In de toekomst kan de elektronica wellicht het gedrag van de cel beïnvloeden.

Biomechatronics is an interdisciplinary field encompassing biology, neurosciences, mechanics, electronics and robotics.



Cybernetica

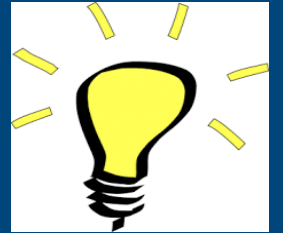


=> Verbinden biologie en technologie

- Bril (al 700 jaar)
- Pacemaker (al 70 jaar)
- Kunstarm
- Telefoon
- AI ?
- Cyborg ?

=> niets nieuws?

We are already cyborgs



- Telefoon

Elon Musk

"People don't realize — we are already a cyborg because we are so well integrated with our phones and our computers. The phone is almost like an extension of yourself. **If you forget your phone, it's like a missing limb.**"

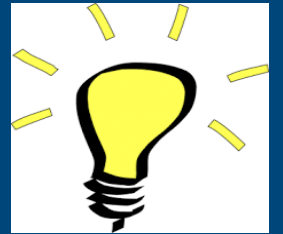
=> Co-evolutie met onze technologie!

=> Outsourcing geheugen

NB Vuur: How cooking made us human



VR toekomst



<http://www.nu.nl/reviews/4379880/eerste-indruk-vr-bril-van-intel-verplaatst-woonkamer-virtuele-wereld.html>

Exoskeleton boots **improve on evolution**

Unpowered mechanical design lowers the energetic costs of walking.



Low tech

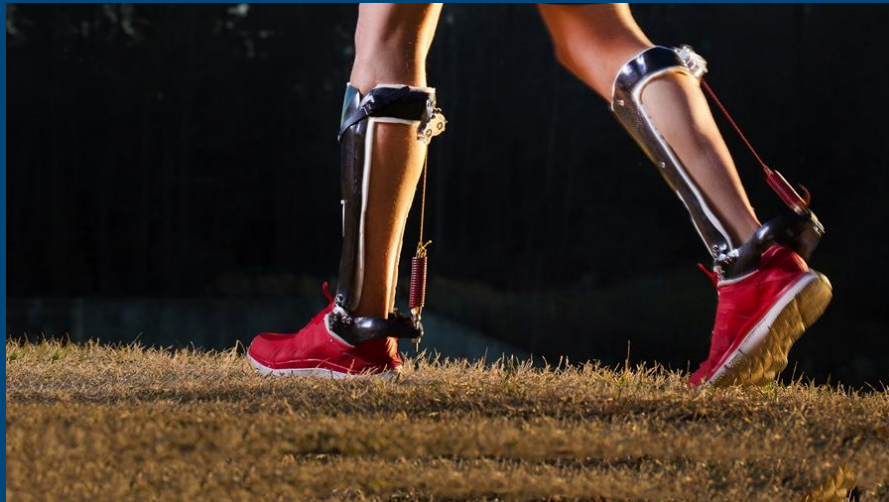
Exoskeleton to ensure an active old age



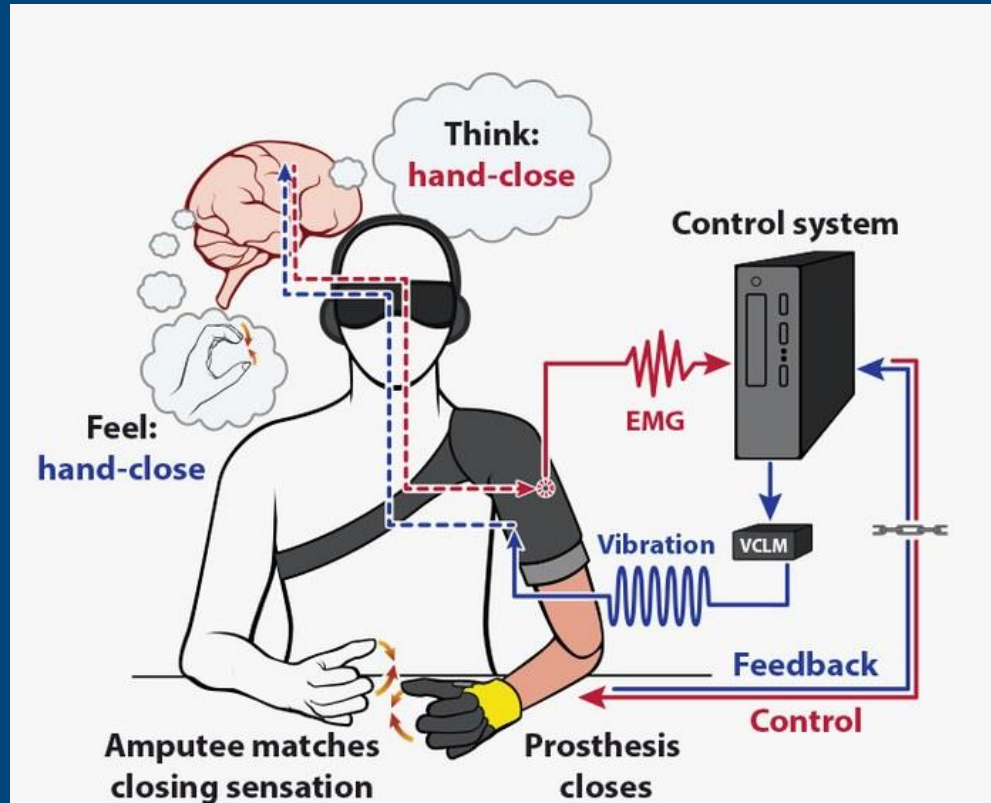
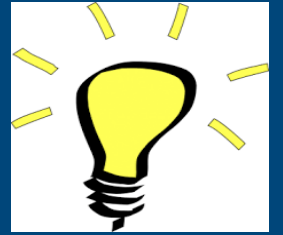
October 14, 2015

Aalborg University

Researchers are creating portable robot skeletons for the elderly so they can continue to be active longer. **Think of it as a tool**, not as a robot, says researcher.



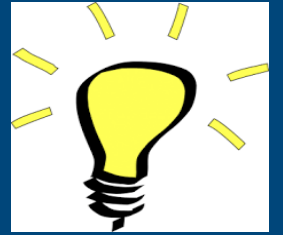
RESTORING FEELING TO LOST LIMBS



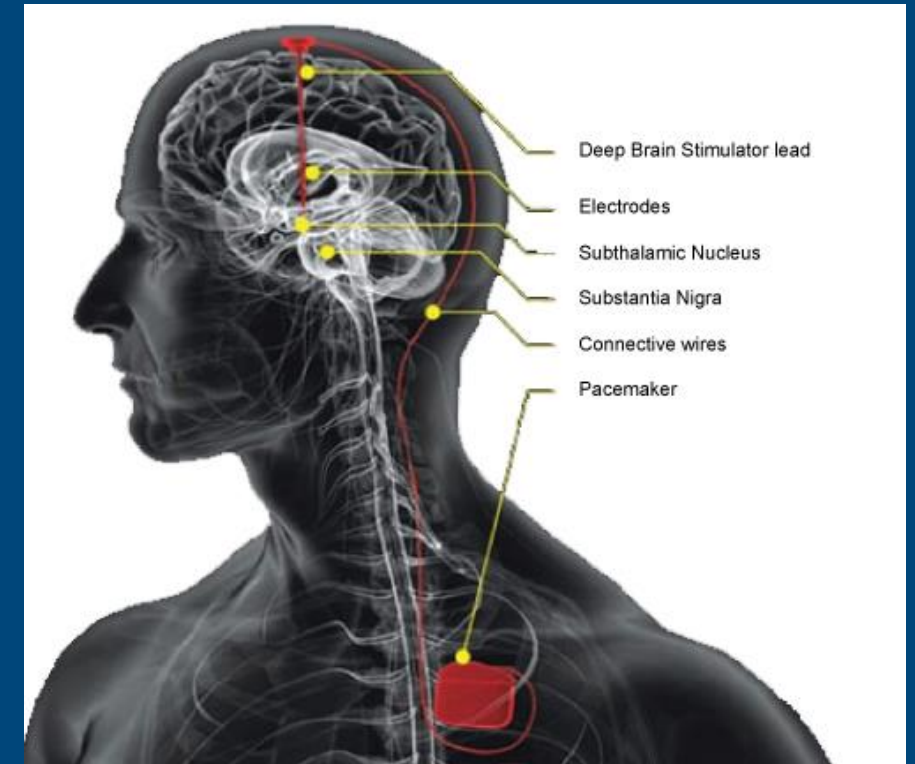
<https://www.wired.com/story/researchers-restore-feeling-to-lost-limbskinda/>

- Neural interface that mimics **kinesthetic feedback** via a prosthesis, restoring the sense in test subjects with upper limb amputations
- The method hinges on an extraordinary phenomenon that neurophysiologists call vibration-induced kinesthetic illusions: Vibrating a tendon at a frequency between 70 and 115 Hz makes you feel like its associated joint is moving.
- These **illusions**, they're incredibly powerful," Marasco says. "They can override your sense of what's real."

Beïnvloeden van hersenactiviteit

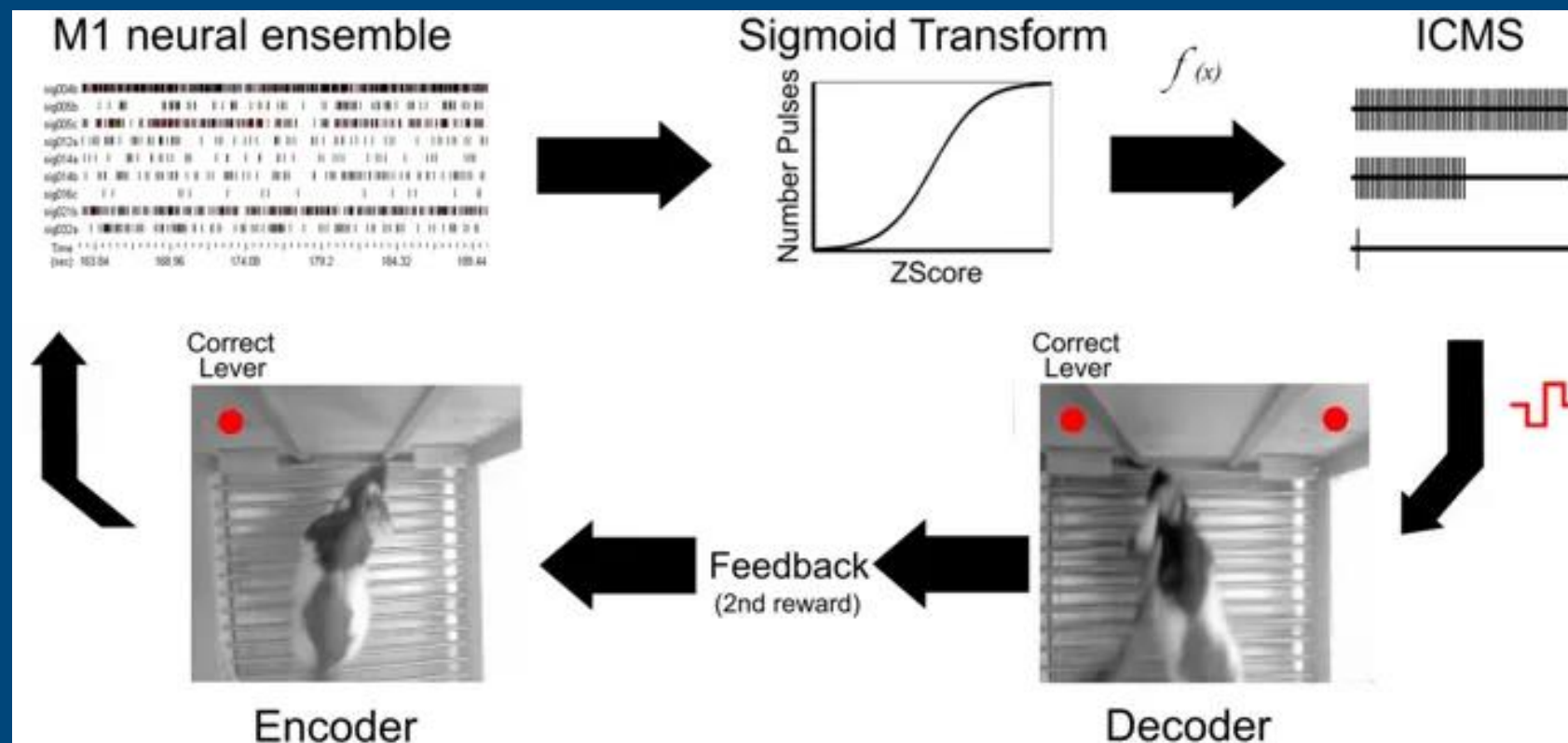


- **Deep brain stimulation (DBS)** is a neurosurgical procedure involving the placement of a medical device called a neurostimulator (sometimes referred to as a "brain pacemaker"), which sends electrical impulses, through implanted electrodes, to specific targets in the brain (brain nuclei) for the treatment of movement disorders, including Parkinson's disease, essential tremor, dystonia,^[1] and other conditions such as obsessive-compulsive disorder and epilepsy. While its underlying principles and mechanisms are not fully understood, DBS directly changes brain activity in a controlled manner.^{[2][3]}
- Vgl met pacemaker voor het hart



https://en.wikipedia.org/wiki/Deep_brain_stimulation

Biotechnologie: Gedachte transplantatie



Ook hogere
hersenfuncties zijn
informatie

=> A Brain-to-Brain
Interface for Real-Time
Sharing of
Sensorimotor
Information

<http://www.nature.com/articles/srep01319>
<https://youtu.be/nNuntbrwXsM>

Uploaden



- Heel veel data
- Dynamisch (tijdsdimensie => 4D)

⇒ big tech

⇒ onsterfelijkheid

⇒ Kloon => nieuw individu?

Ja, zodra die kloon zijn eigen ervaringen heeft

⇒ Plutarchus. Ben jij nog dezelfde persoon

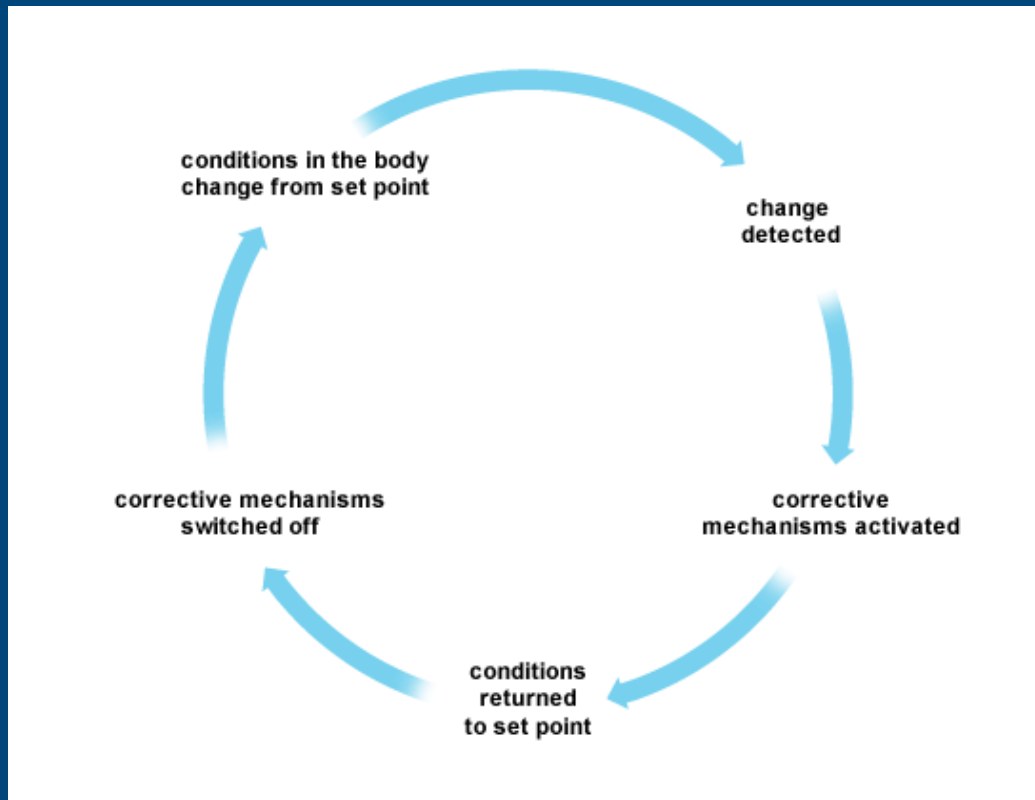
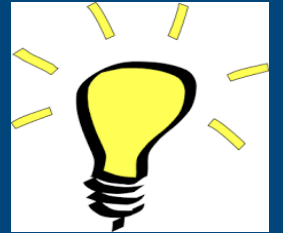
⇒ Dezelfde Input => andere output => dus ander persoon

Interface kunst en echt weefsel => Biologie is informatie



Een interface zet **informatie** van het ene systeem om in begrijpelijke en herkenbare informatie van een ander systeem

Celbio 4: Feedback is continuous



For example: Biological clock, or Nerve cell firing, where input generates output, which generates input, which generates output...

Analogie is een stad:

Beetje centrale aansturing maar eigenlijk gevolg van activiteit van individuele onderdelen.

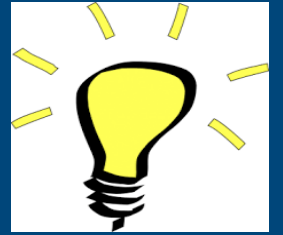
Bottom-up ipv top-down (vgl spons)

En, er is altijd iets dat het evenwicht verstoort (al is het maar entropie), dus er is continue correctie

Behoud van ordening mbv feedback (kost energie).
Proces is metastabiel, maar bestaat al 4 miljard jaar

https://www.youtube.com/watch?v=AZUeKoD_3y0

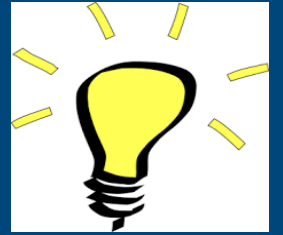
Emerging properties Voorbij **reductionisme**



- http://www.npo.nl/de-volmaakte-mens/10-06-2015/VPWON_1231937

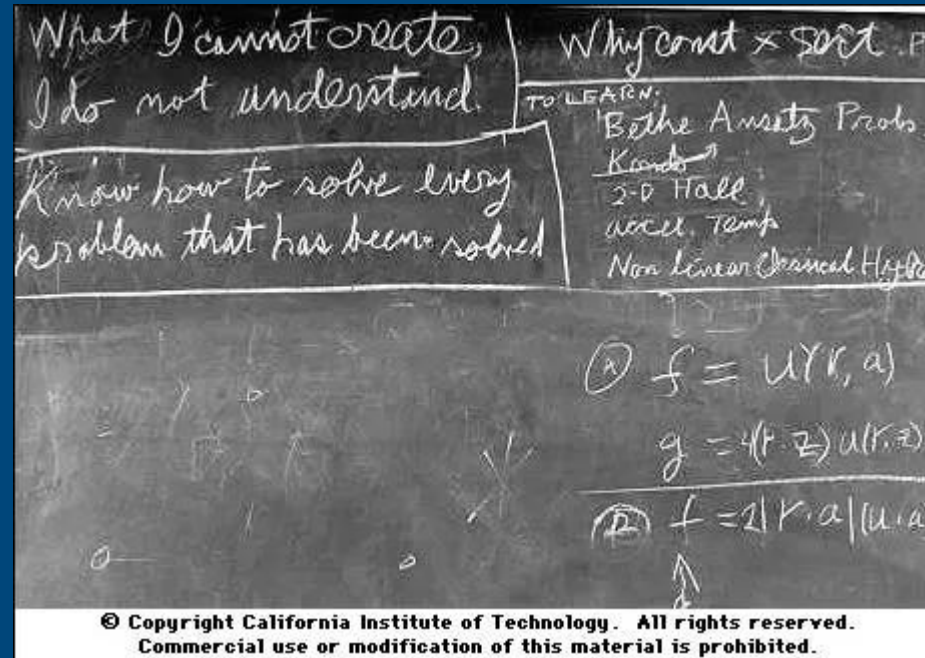


HOW TO BUILD A SELF-CONSCIOUS MACHINE



Leven en bewustzijn zijn niet
alleen meer filosofisch
⇒ Spannende tijden

What I cannot create,
I do not understand.
(Richard Feynman)



- <https://www.wired.com/story/how-to-build-a-self-conscious-ai-machine/>
- <http://www.nature.com/nature/journal/v550/n7676/full/nature24270.html>

1 The accelerating pace of change ...



2 ... and exponential growth in computing power ...

Computer technology, shown here climbing dramatically by powers of 10, is now progressing more each hour than it did in its entire first 90 years

COMPUTER RANKINGS

By calculations per second per \$1,000



Analytical engine
Never fully built, Charles Babbage's invention was designed to solve computational and logical problems



Colossus

The electronic computer, with 1,500 vacuum tubes, helped the British crack German codes during WW II



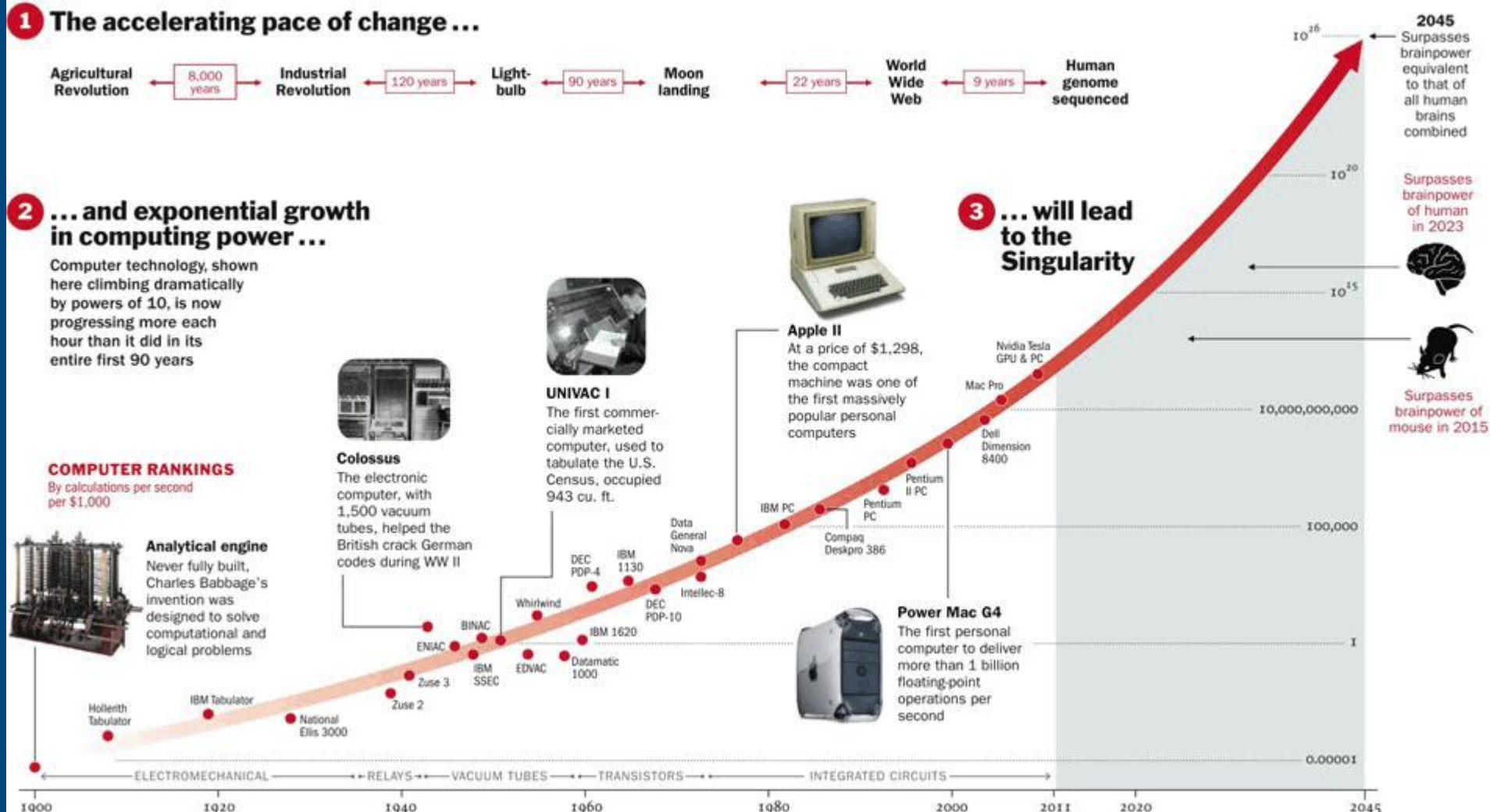
UNIVAC I

The first commercially marketed computer, used to tabulate the U.S. Census, occupied 943 cu. ft.

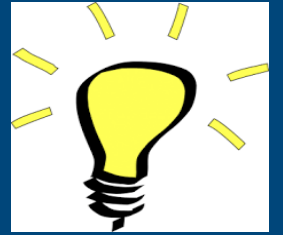


Apple II

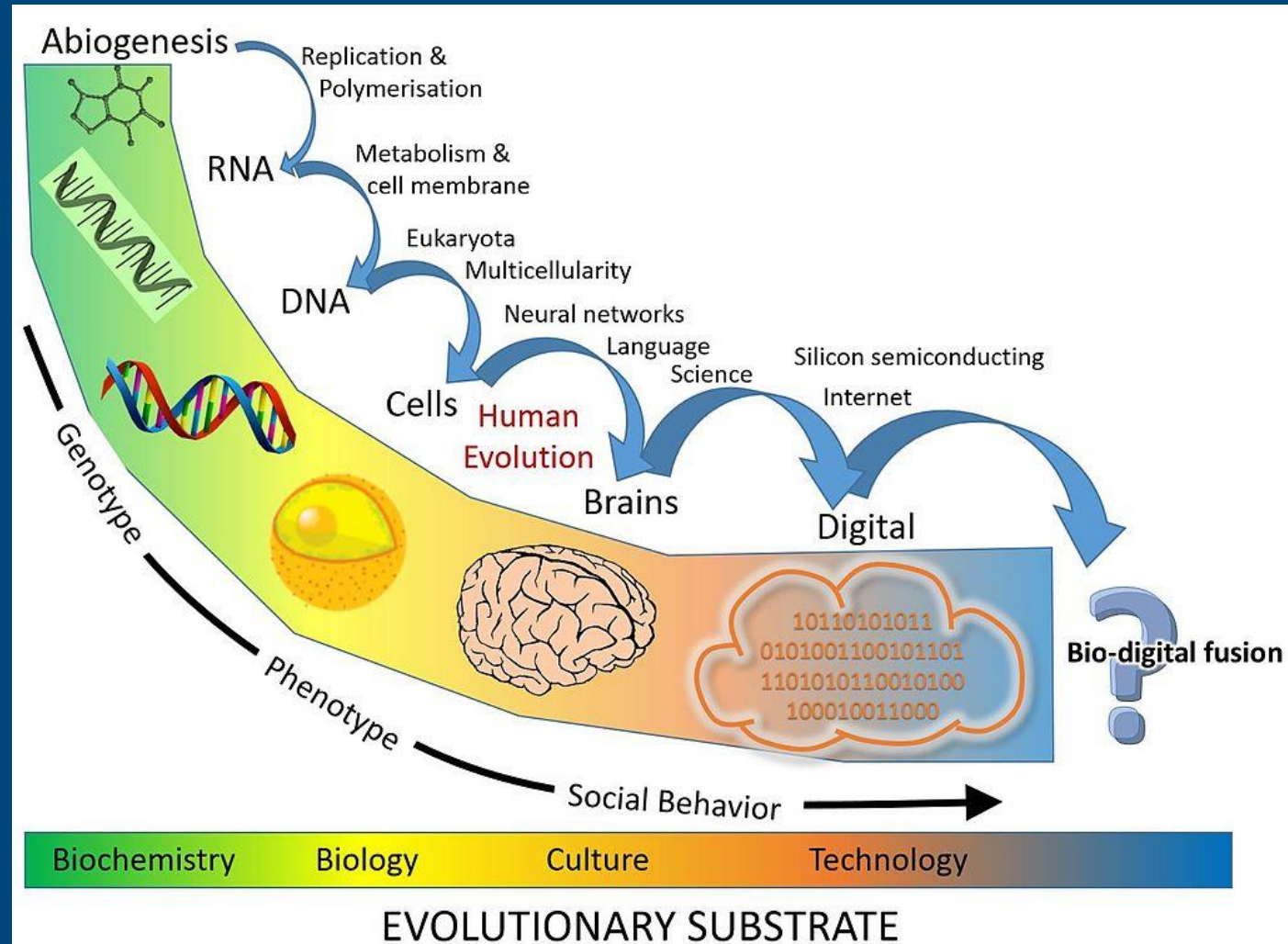
At a price of \$1,298, the compact machine was one of the first massively popular personal computers



Evolution of Information



- https://en.wikipedia.org/wiki/Technological_singularity



based on: Gillings, M. R., Hilbert, M., & Kemp, D. J. (2016). Information in the Biosphere: Biological and Digital Worlds. *Trends in Ecology & Evolution*, 31(3), 180–189. <http://escholarship.org/uc/item/38f4b791>

Biotechnologie: Leven (intelligentie/bewustzijn) namaken, en dan verbeteren

Kunstmatige intelligentie (AI):

Het is al gelukt om slimmer te zijn dan sommige mensen (cambridge analytica, facebook)

Wat gaat AI ons vertellen over onszelf?

Is intelligentie gekoppeld aan bewustzijn?

Wat is goed, en wat slecht. En wie bepaalt dat

SUPERHUMAN POWERS

Electronics that can stretch (elastronics), from circuits and batteries to sensors and screens, will extend our senses and abilities. Devices within our clothes and accessories, attached to our skin and implanted in our bodies will establish a new technology platform — the bodyNET. It will allow us to interact with digitally networked objects and individuals using our bodies, and perceive physical and biological signals that were once invisible.

1 IMPLANTS

Monitor brain activity for therapy, or to control devices; blood glucose levels to manage insulin doses; or antibody levels to trigger treatment for severe allergic reactions, for example.

3 PERIPHERALS

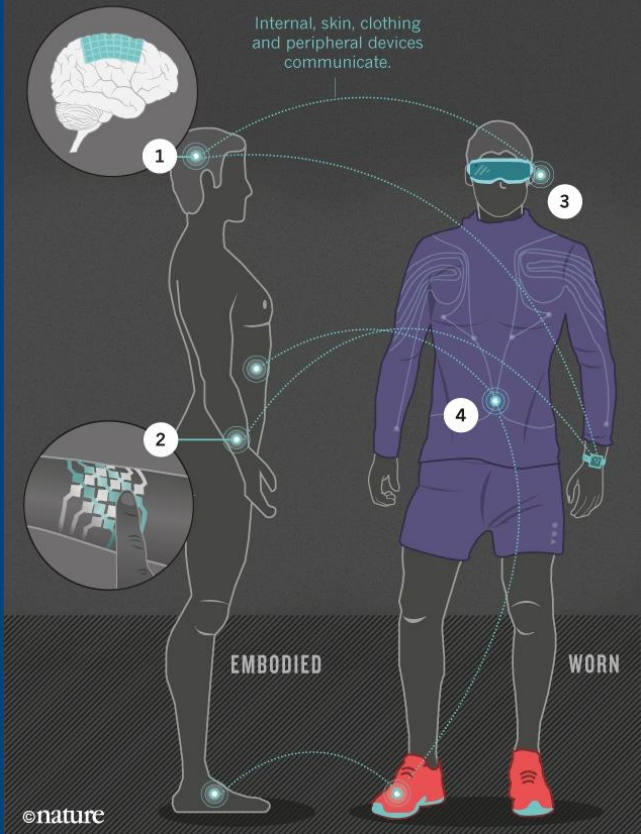
Include virtual- and augmented-reality glasses; smart athletic shoes that prevent injury; and other next-generation wearables that source, display and act on data from networked devices.

2 SKIN DEVICES

Track biometrics such as temperature, heart rate and muscle activity. Also provide touch controls, displays and tactile feedback.

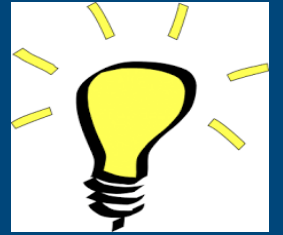
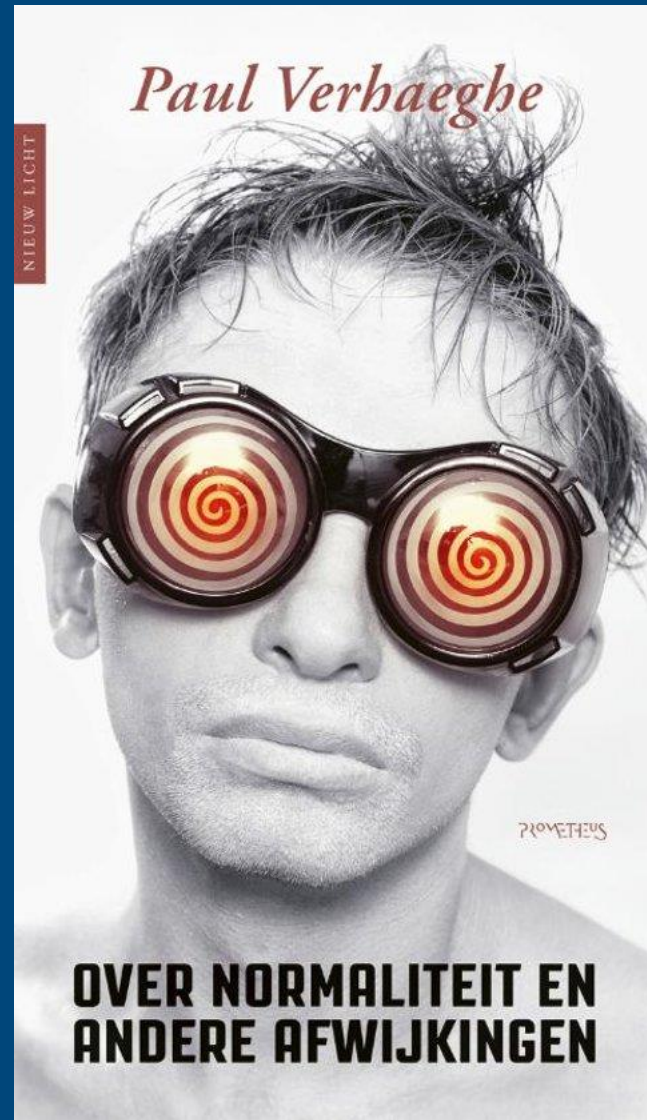
4 SMART CLOTHING HUB

Hosts the bodyNET's central processing and power-management system, including energy harvesting, storage and distribution.



Wat is normaal ?

- Auteur: Paul Verhaeghe
- Uitgever: Prometheus
- Nederlands
- 9789044643220
- november 2019



Normaal is variabel



- Beter

=> nieuwe normaal

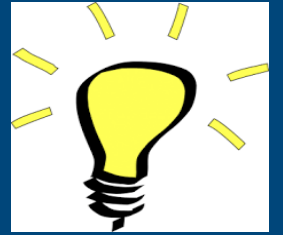
- Normaal

- Slechter

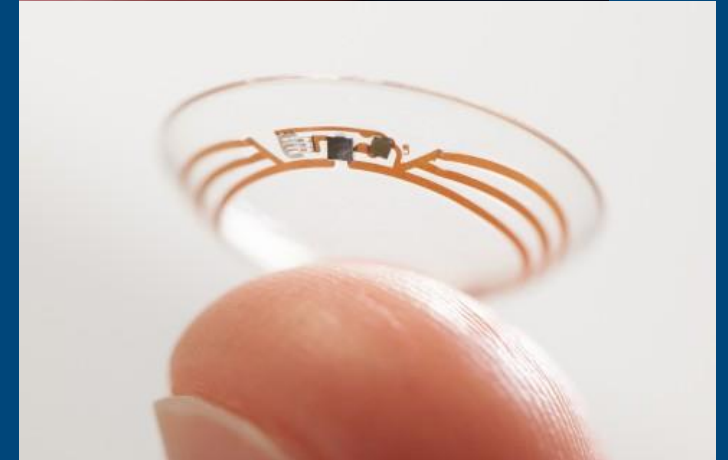
NB Slechter dan normaal repareren is OK. Van normaal naar beter is vaak niet OK

Toch streven we allemaal naar beter (Instagram)?

Technologie en biologie

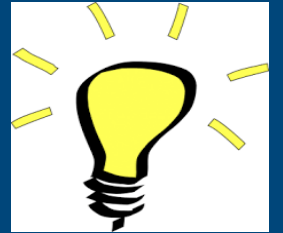


- “Verbetering” van de mens (beperkt => normaal => verbeterd)
- Lens-implantaat
=> Aandoening (staar)
=> Militair
=> Iedereen?
- Exoskelet
http://www.ted.com/talks/eythor_bender_demos_human_exoskeletons
- Outsourcing (geheugen) => telefoon! => verdwijnen interface
- <https://www.youtube.com/watch?v=ogBX18maUiM>
- Enhanced reality, Virtual reality



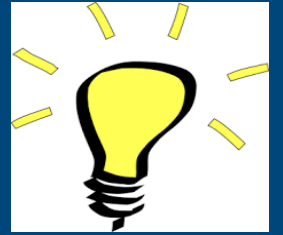
Julian Savulescu

- A professor of practical ethics at the University of Oxford, Savulescu thinks deeply about the ethics of the biological enhancement of the human race.
- **As a species, we have a moral obligation to enhance ourselves biologically.**
- **Humans have a lot of limitations.** We have limitations in terms of aging, we have cognitive limitations, various physical limitations, and of course moral limitations. When science offers us the opportunity to overcome these limitations, we should ask the ethical question: “should we?” In some cases we shouldn’t, but in many cases we have a moral obligation to overcome those limitations.
- One trivial example: about a billion IQ points are lost around the world each year because salt isn’t iodized. If you’re pregnant and have insufficient iodine, your fetus might lose 10 to 15 IQ points. You may still be “normal” — but it only costs 2-3¢ per person per year to iodize salt. We have an enormous moral obligation to do that because of the value of cognitive ability.
- We also have a moral obligation to overcome our moral limitations. People evolved to form groups of about 150. They care about their **tribal group**, and they tend to be violent to or derogate out-of-group members. They are altruistic to their friends and family, but much less so to other people. They free-ride. They think in the **near term**. All of these are essentially features built into our psychology.
- We’re far from perfect. We’ll never be perfect, but when science offers us the opportunity to understand those limitations and to build policies tailored towards them, or indeed to directly overcome them, we ought to at least do research into it.



<https://youtu.be/DhtlFTrJQJ4>

Probleempunten in discussie over GM



- Kaas komt niet voor in de natuur, mensen met een bril ook niet. (we staan al lang buiten de evolutie)
- Veredeling is ook onnatuurlijk (elstar, hond)
- GM gebruikt ook “natuurlijke” systemen als virussen en DNA.
- Natuurlijk is altijd goed? => er is niets zo dodelijk als de natuur.
- GM systemen hebben extra risico's, maar voordelen zijn immens (10 miljard mensen voeden) => onvermijdelijk?
- Vertroebeling door religieuze kijk; Ouderwets is beter, leven is heilig.
- Angst voor nieuwe technologie (gebrek aan kennis)
- partnerkeuze? => **ons willen verbeteren is natuurlijk**
- Biologie is technologie => via evolutie wordt de technologie aangepast (verbeteren?) Termen: Wetware (itt hardware/software)