

Johns Hopkins Engineering

Immunoengineering

Module 1/Lecture 1B

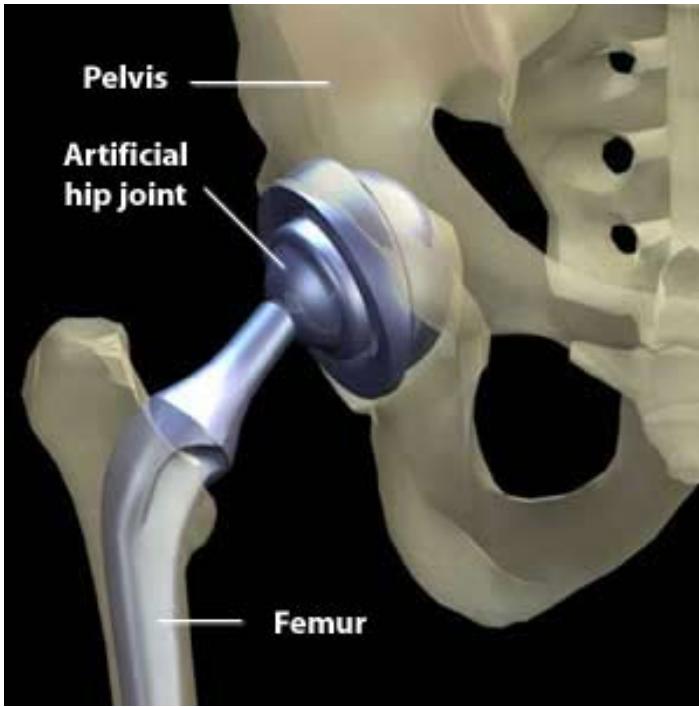
Immunoengineering: A New Frontier

Opportunities and Challenges

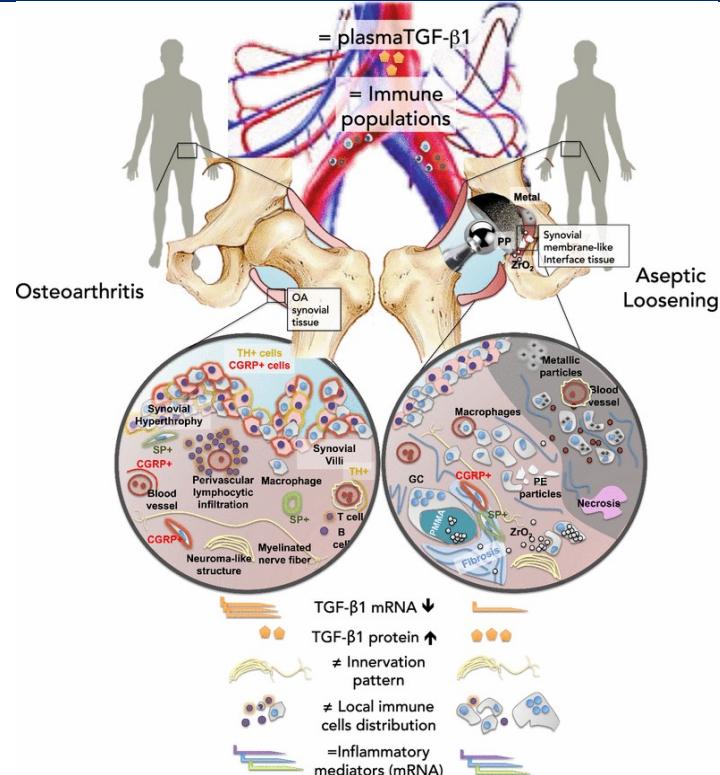
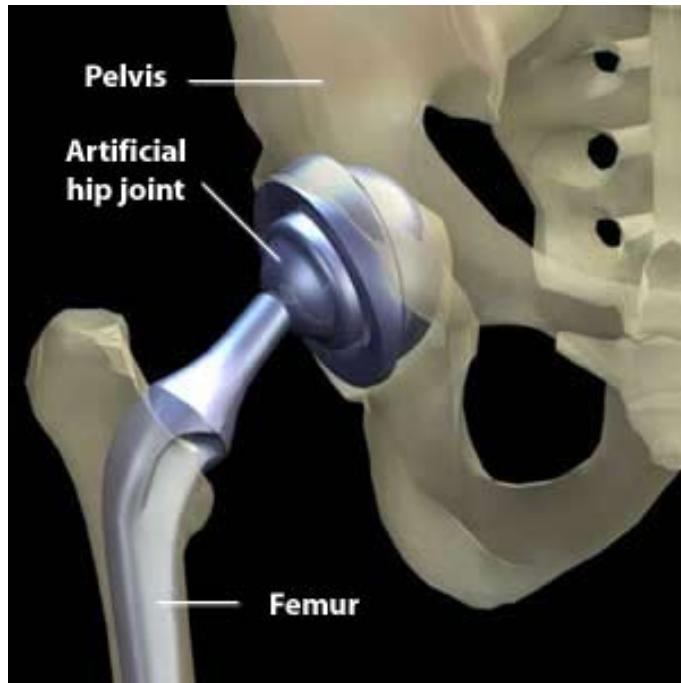


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WHITING SCHOOL
of ENGINEERING

Immune Response to Biomaterials

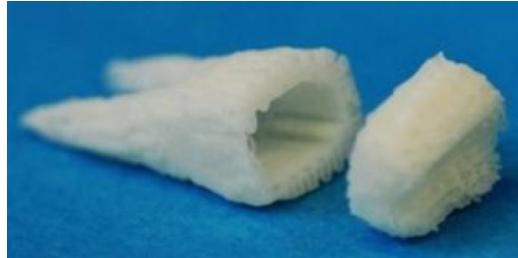


Immune Response to Biomaterials: Material Properties

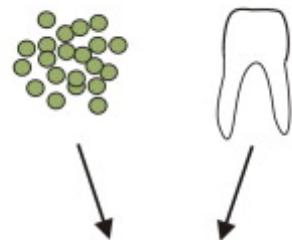


Vasconcelos, Daniel M., et al. "Immune response and innervation signatures in aseptic hip implant loosening." Journal of translational medicine 14.1 (2016): 20

Immune Response to Biomaterials



A. stem cells scaffold



stem cell-populated scaffold



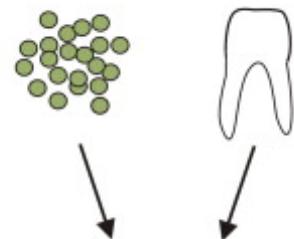
<http://thefutureofthings.com/4335-growing-dental-implants-in-place/>,

Steindorff, Marina M., et al. "Innovative approaches to regenerate teeth by tissue engineering." *Archives of oral biology* 59.2 (2014): 158-166.,

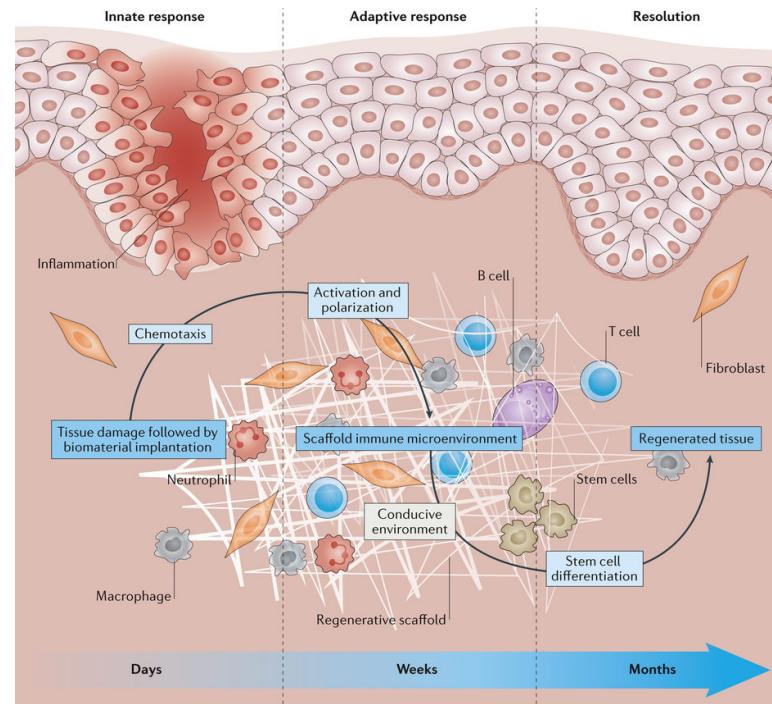
Immune Response to Biomaterials: Tissue Regeneration



A. stem cells scaffold



stem cell-populated scaffold



Nature Reviews | Materials

Sadtler, Kaitlyn, et al. "Design, clinical translation and immunological response of biomaterials in regenerative medicine." *Nature Reviews Materials* 1 (2016): 16040.

Allergy Immune Response

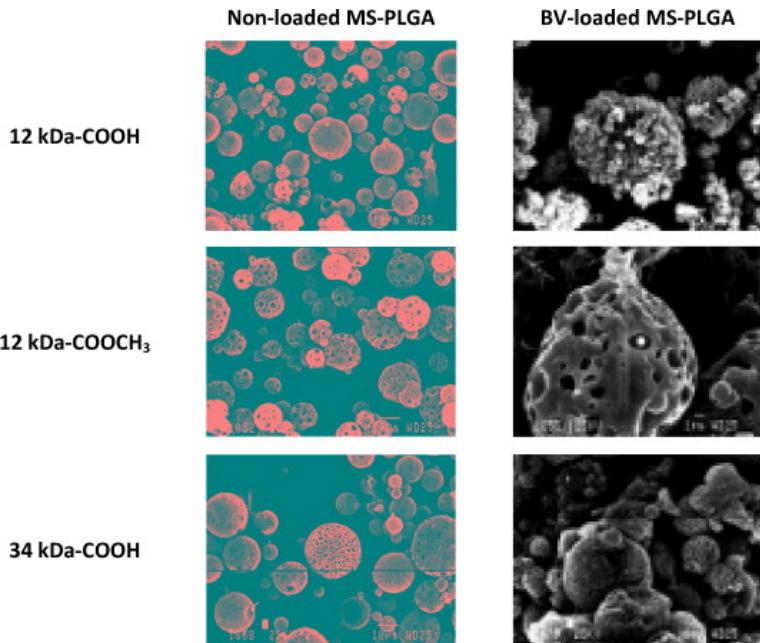


Wasp sting with a droplet of venom

Allergy Immune Response



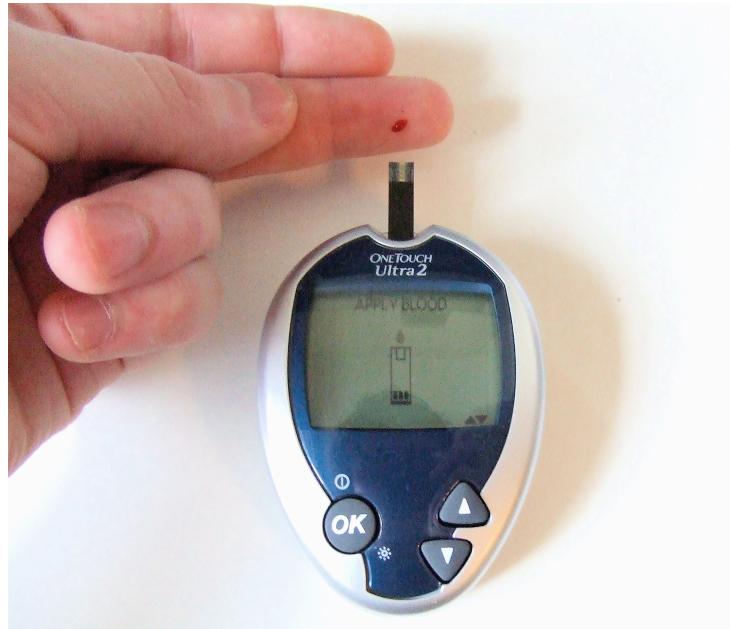
Wasp sting with a droplet of venom



Effect of molecular mass and carboxy-terminal (free or methylated) on the morphology of MS-PLGA by SEM (1000 \times)

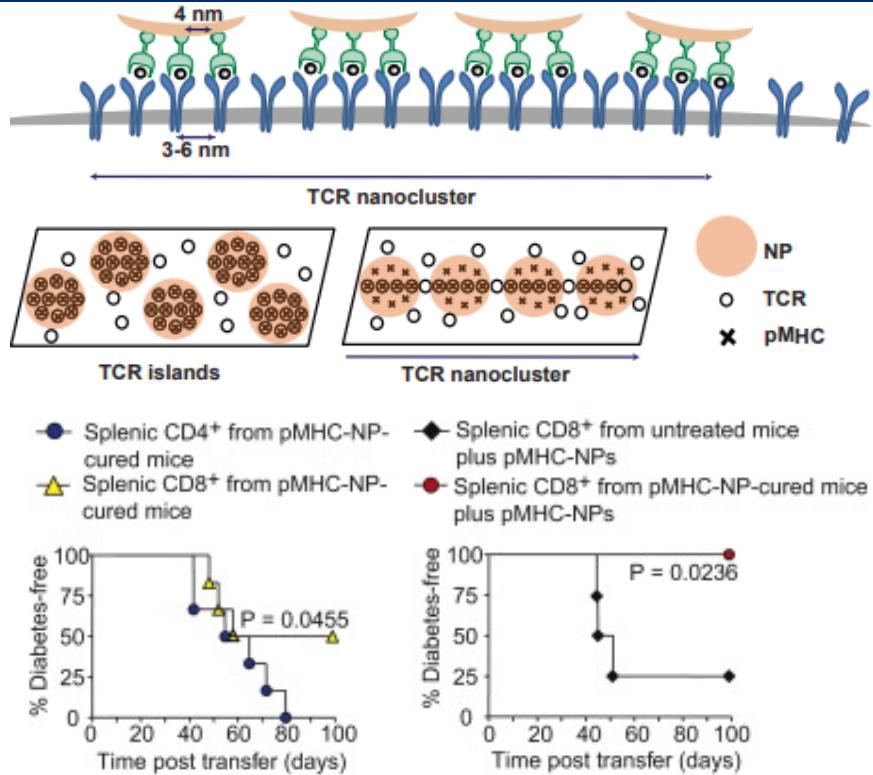
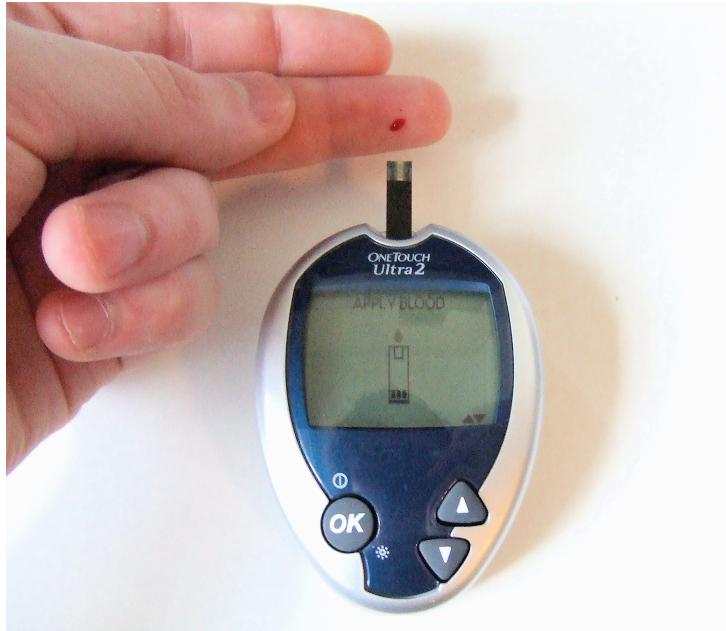
Trindade, Reginaldo A., et al. "PLGA microspheres containing bee venom proteins for preventive immunotherapy." *International journal of pharmaceutics* 423.1 (2012): 124-133.

Autoimmune Response



Glucose monitoring

Autoimmune Response: Cell Engineering

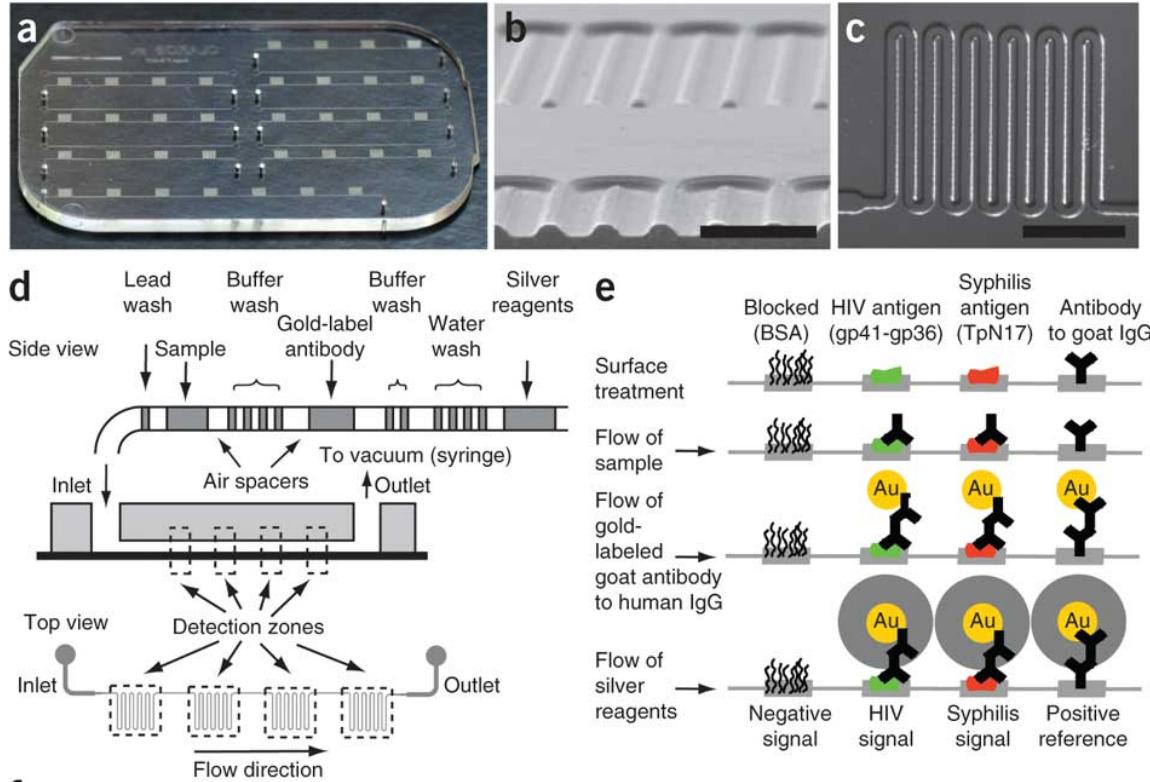


Singha, Santiswarup, et al. "Peptide-MHC-based nanomedicines for autoimmunity function as T-cell receptor microclustering devices." *Nature Nanotechnology* 12 (2017): 701-710

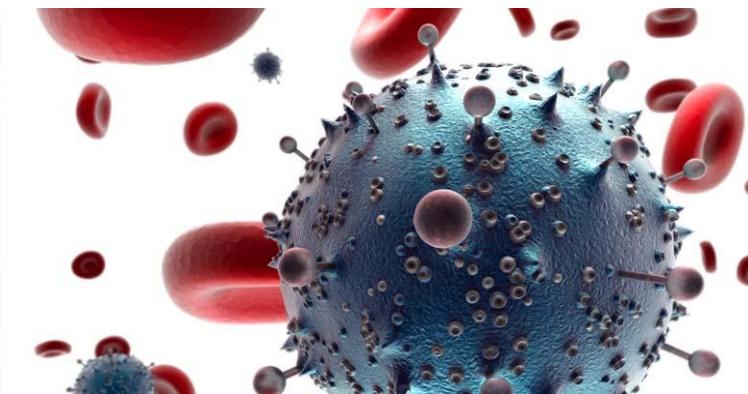
Immune Response to Pathogens



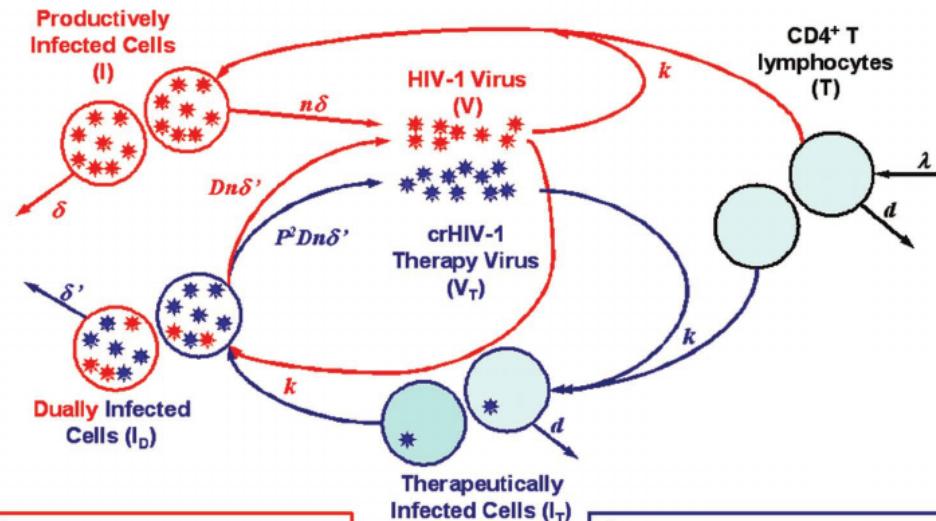
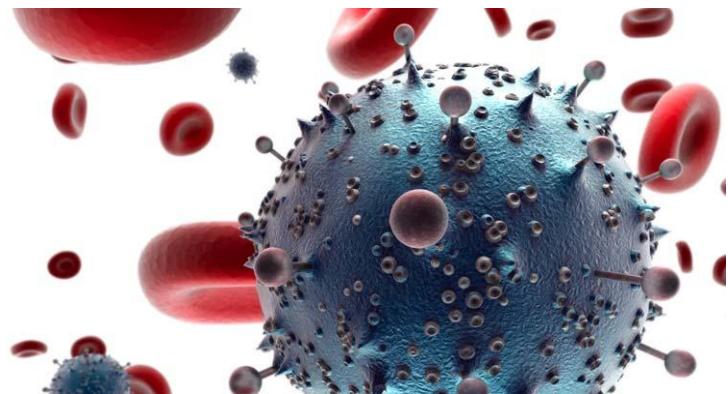
Immune Response to Pathogens: Imaging/Detection



Immune Response to Pathogens



Immune Response to Pathogens: Mathematical Modeling



$$\dot{T} = \lambda - dT - kVT - kV_T T \quad [1]$$

$$\dot{I} = kVT - \delta I \quad [2]$$

$$\dot{V} = n\delta I - cV + Dn\delta' I_D \quad [3]$$

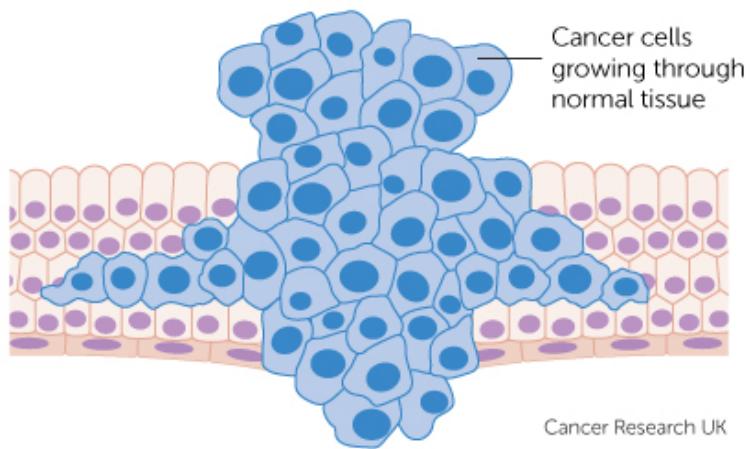
$$\dot{I}_T = kV_T T - dI_T - kVI_T \quad [4]$$

$$\dot{I}_D = kVI_T - \delta' I_D \quad [5]$$

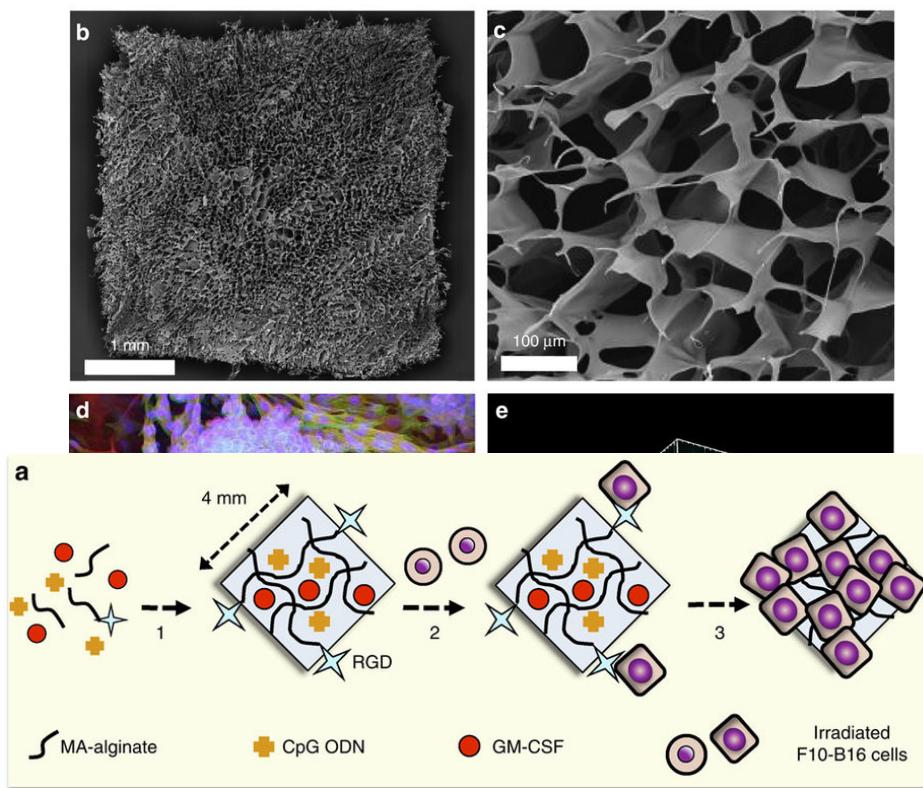
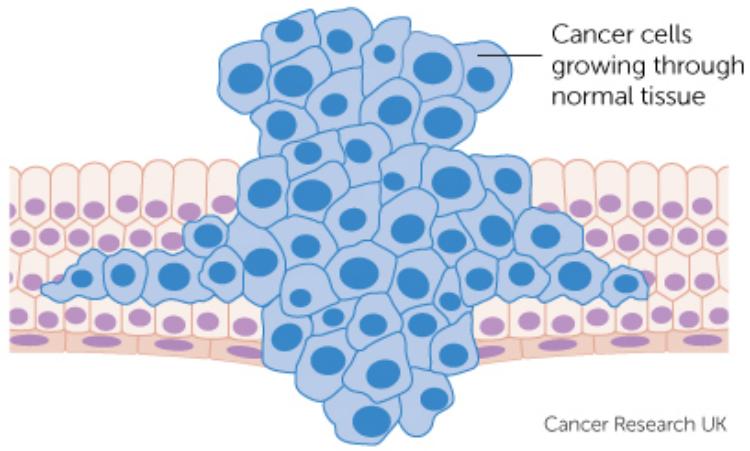
$$\dot{V}_T = P^2 Dn\delta' I_D - cV_T \quad [6]$$

Weinberger, Leor S., David V. Schaffer, and Adam P. Arkin. "Theoretical design of a gene therapy to prevent AIDS but not human immunodeficiency virus type 1 infection." *Journal of virology* 77.18 (2003): 10028-10036.

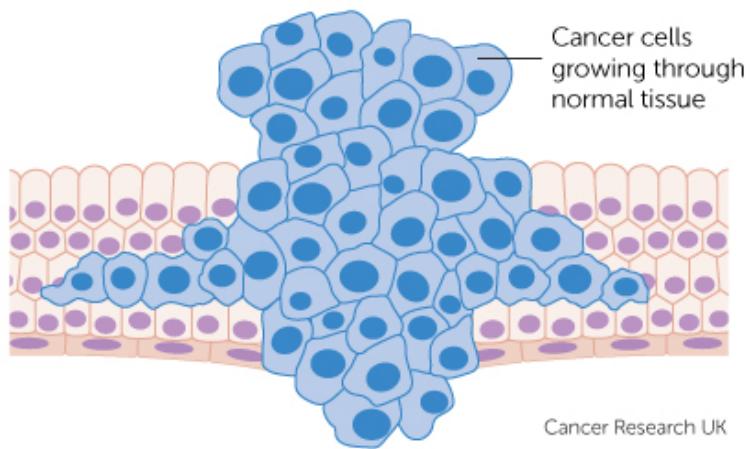
Immune Response to Cancer



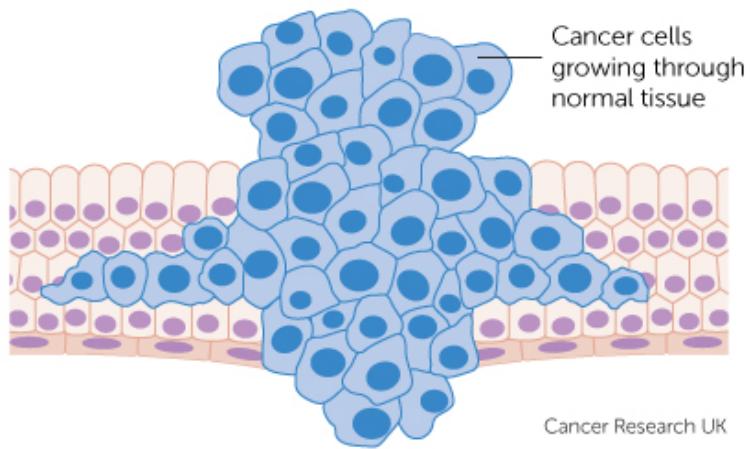
Immune Response to Cancer: Materials Science



Immune Response to Cancer



Immune Response to Cancer: Protein Engineering



10 Breakthrough Technologies

Boom Times

Immune-engineering startups have gone public, raising large sums for human trials.

Company	Amount Raised in IPO	Date
Kite Pharma	\$134 million	June 2014
Juno Therapeutics	\$304 million	December 2014
Bellicum Pharmaceuticals	\$160 million	December 2014
Celllectis	\$228 million	March 2015



Challenges Facing Immunoengineering



Challenges Facing Immunoengineering

■ Overengineering the immune response

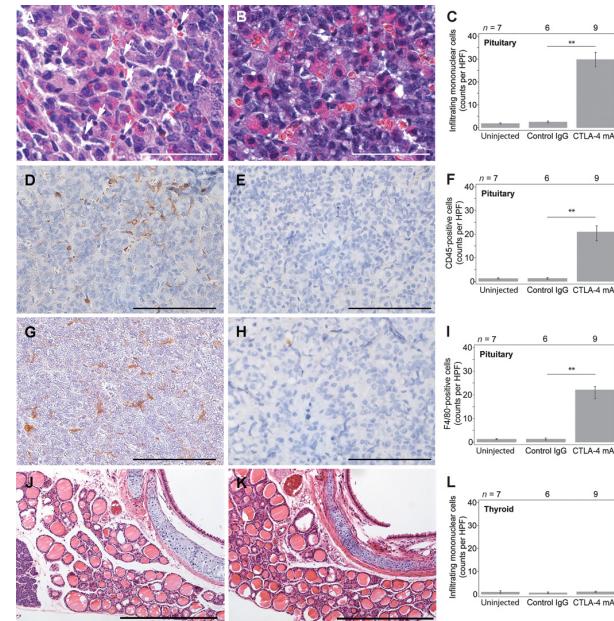
NATURE BIOTECHNOLOGY | NEWS

CAR-T death strikes Kite

Nature Biotechnology 35, 492 (2017) | doi:10.1038/nbt0617-492
Published online 07 June 2017

[PDF](#) [Citation](#) [Rights & permissions](#) [Article metrics](#)

Kite Pharma's shares plunged on May 8 after news spread that a patient in a safety study testing a chimeric antigen receptor (CAR)-T cell therapy to treat non-Hodgkin's lymphoma (NHL) had died. The patient in the phase 2 ZUMA-1 study testing axicabtagene ciloleucel (KTE-19) developed fatal cerebral edema, a situation resembling a setback experienced last year by rival CAR-T cell therapy developer Juno, when five patients treated with its candidate product JCAR015, a CD19-targeted CAR-T product for treating relapsed refractory acute lymphoblastic leukemia (*Nat. Biotechnol.* 35, 6–7, 2017), died. The deaths led Juno to drop the program. Investors may have been rattled by Kite's news, because there are similarities between the two treatments: both Kite's KTE-19 and JCAR015 target CD19 and use the CD28 co-stimulatory domain. Kite has informed the US Food and Drug Administration of the event and all studies of the candidate drug will continue as planned. Kite's chief medical officer David Chang said the patient had "explosive disease and was rapidly progressing" at the time of enrollment, and that this was the only death in 300 patients treated with KTE-19. In March, Kite completed a Biologics License Application for this therapy in relapsed or refractory aggressive NHL. Basel, Switzerland-based Novartis also submitted a biologics license application under priority review for another



Senior, Melanie. "CAR-T death strikes Kite." *Technology Review* (2017)., Iwama, Shintaro, et al. "Pituitary expression of CTLA-4 mediates hypophysitis secondary to administration of CTLA-4 blocking antibody." *Science translational medicine* 6.230 (2014): 230ra45-230ra45.,

Challenges Facing Immunoengineering

- Overengineering the immune response
- Ineffective cross-communication

A screenshot of a Google search results page. The search bar at the top contains the query "immunoengineering conference". Below the search bar are navigation links for "All", "News", "Videos", "Maps", "Images", and "More", along with "Settings" and "Tools" buttons. The main search results area shows a snippet for the "Center for Immunoengineering" followed by three other conference listings from AIChE, UCLA, and CMBE.

About 15,100 results (0.65 seconds)

Center for Immunoengineering

immunoengineering.gatech.edu/ ▾

Georgia Institute of Technology Center for Immunoengineering ... Visitor Resources; Campus Visits · Georgia Tech Hotel & Conference Center · Georgia Tech ...

2nd Bioengineering & Translational Medicine Conference | AIChE

<https://www.aiche.org/sbe/conferences/translational-medicine-and...conference/2017> ▾

The conference will feature cutting edge advances in biopharmaceuticals, gene and drug delivery, immunoengineering, biomanufacturing, stem cells, ...

Translational Medicine and Bioengineering Conference | AIChE

<https://www.aiche.org/sbe/conferences/translational-medicine-and...conference/2016> ▾

The conference will feature cutting edge advances in the translation of biopharmaceuticals, gene and drug delivery, immunoengineering, biomanufacturing, ...

18th Annual UC Systemwide Bioengineering Symposium – UCLA ...

www.bioeng.ucla.edu/.../18th-annual-uc-systemwide-bioengineering-symposium-june... ▾

Jun 28, 2017 - ... Bioengineering Symposium – UCLA Luskin Conference Center. Jun 28 ... and regenerative medicine; Drug delivery and immunoengineering ...

2017 CMBE Conference - BMES

www.bmes.org/cmbe%20conference ▾

A screenshot of a Google search results page. The search bar at the top contains the query "immunoengineering textbook". Below the search bar are navigation links for "All", "Shopping", "Images", "News", "Maps", and "More", along with "Settings" and "Tools" buttons. The main search results area shows a snippet for "Georgia Tech Bookstore - Barnes & Noble College Books" followed by three other textbook-related results from SpringerLink, Hopkins Engineering Applications & Research Tutorials, and Immunoengineering Archives.

About 10,900 results (0.81 seconds)

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Immuno-engineering | SpringerLink

https://link.springer.com/chapter/10.1007/978-0-387-09655-1_2

by J Timmis - 2008 - Cited by 41 - Related articles

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Challenges Facing Immunoengineering

- Overengineering the immune response
- Ineffective cross-communication
- Lack of uniformity

NATURE REVIEWS IMMUNOLOGY | PERSPECTIVES | ESSAY

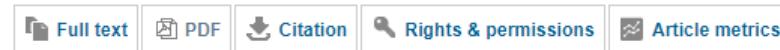


Immunity by equilibrium

Gérard Eberl

Nature Reviews Immunology 16, 524–532 (2016) | doi:10.1038/nri.2016.75

Published online 11 July 2016



Abstract

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