ORGANI ARTIFICIALI e MEDICINA RIGENERATIVA

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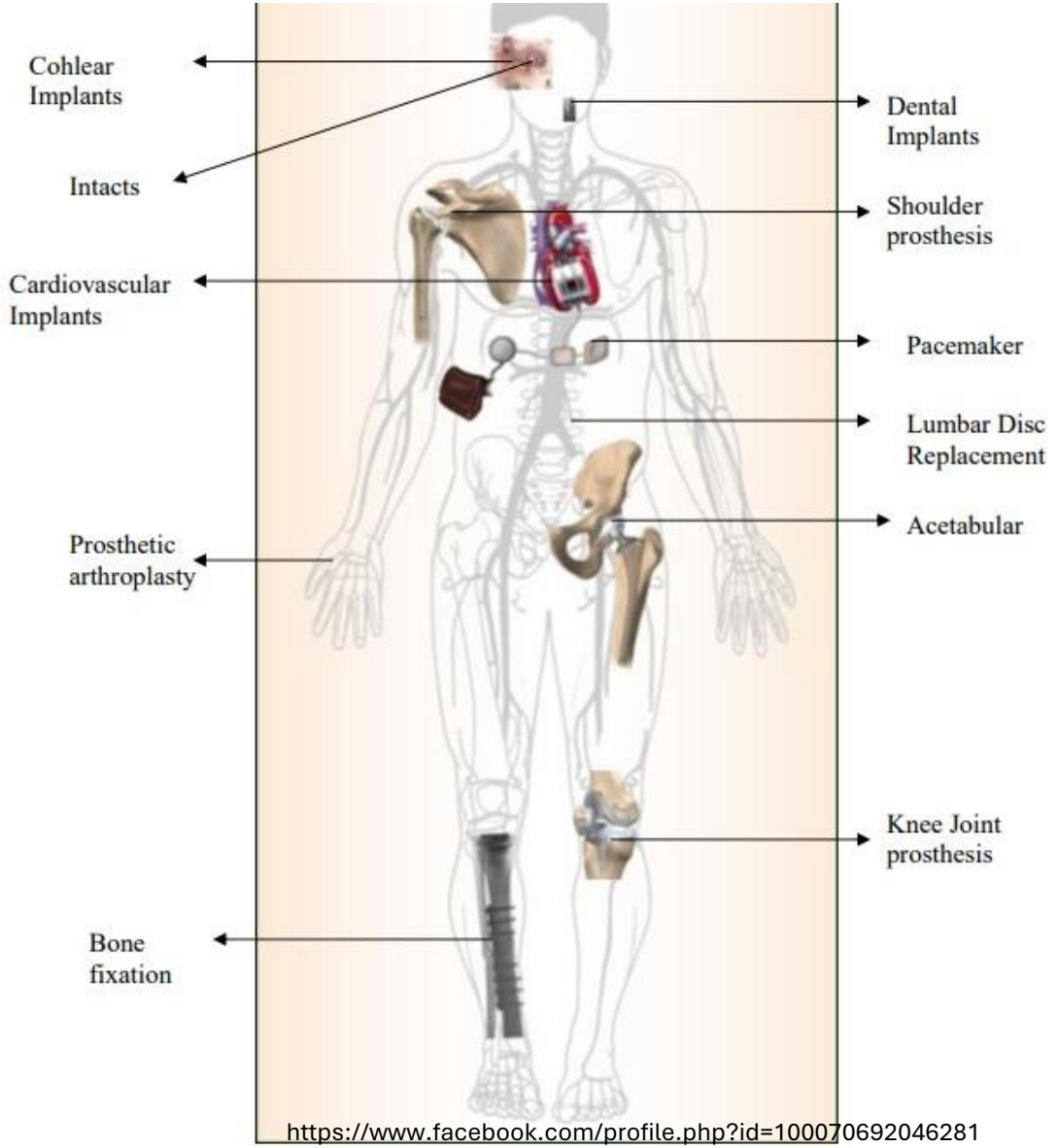
Ingegnere Biomedico

ORGANO ARTIFICIALE – CHE COS'È

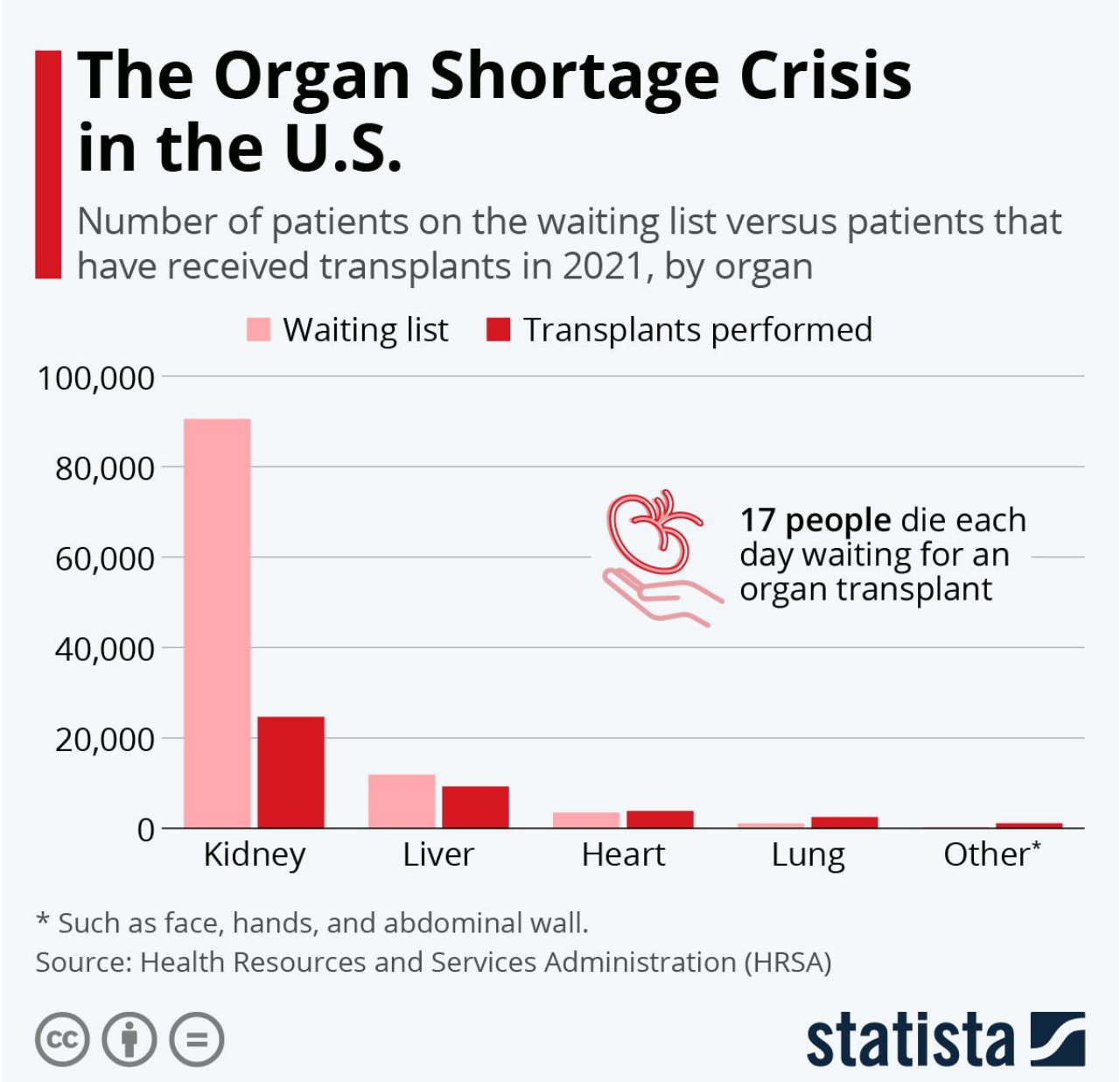
...Un dispositivo creato dall'uomo progettato per sostituire, duplicare o aumentare, funzionalmente o esteticamente, una parte mancante, malata o altrimenti incompetente del corpo, temporaneamente o permanentemente, e che richiede un'interfaccia materiale non biologica con tessuto vivente



P.M. Galletti, Prostheses and artificial organs, in: J.D. Bronzino (Ed.), The Biomedical Engineering Handbook, CRC Press, Boca Raton, 1995, p. 1836.

https://www.facebook.com/profile.php?id=100070692046281

ORGANO ARTIFICIALE – PERCHE'



-AUTOTRAPIANTO

-ALLOTRAPIANTO

-XENOTRAPIANTO

TRAPIANTO DI ORGANI e TESSUTI

Quali organi e tessuti possono essere trapiantati? ***(*) da vivente***

ORGANI

- ***Rene (*)***
- ***Fegato (*)***
- *Polmone (*)*
- *Pancreas (*)*
- *Intestino (*)*
- *Cuore*

-Sostituzione di un organo malato con un organo sano prelevato da un donatore.
- Può essere **terapia salva-vita**.
- Il trapianto restituisce le funzioni perdute ed i pazienti trapiantati riprendono una vita normale.

TESSUTI:

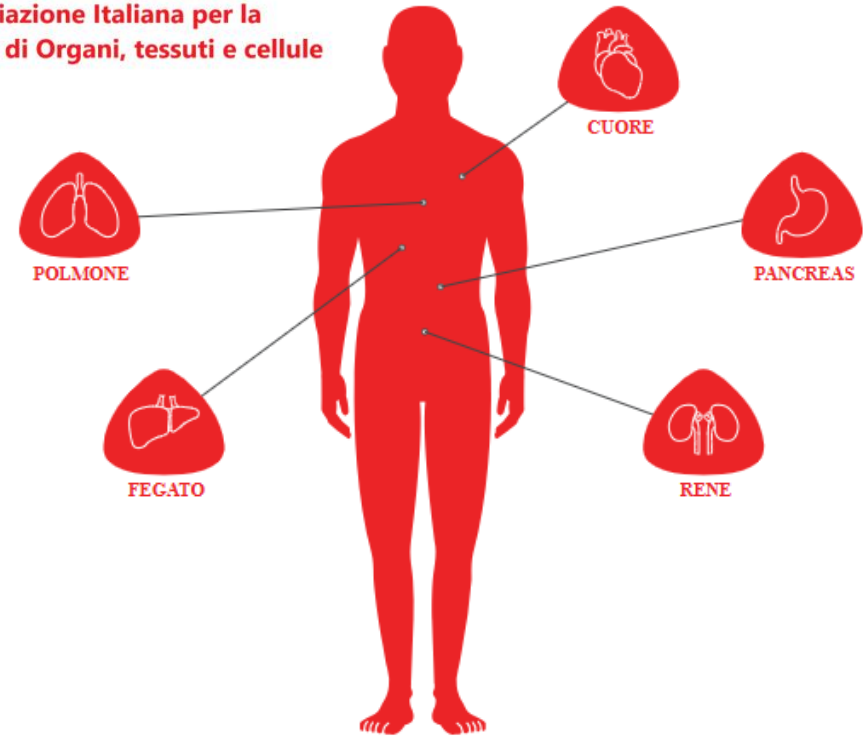
- ***Sangue (*)***
- ***Cute (*)***
- ***Segmenti osteo-tendinei (*)***
- ***Placenta e cordone ombelicale (*)***
- *Ossa e cartilagini*
- *Cornee*
- *Valvole cardiache*
- *Vasi sanguigni*

- Ruolo **salva-funzione**, può essere salva-vita
- chirurgia vascolare
- chirurgia ricostruttiva
- chirurgia ortopedica
- oculistica
- cardiochirurgica

AIDO – statistiche 2020

aido

Associazione Italiana per la Donazione di Organi, tessuti e cellule



Trapianti

ORGANI

3.441

Trapianti di Organi

(donatori deceduti e viventi)

295

Trapianti di Organi
da viventi

TESSUTI

13.790

Trapianti di Tessuti

(donatori deceduti e viventi)

133

Trapianti pediatrici

CELLULE STAMINALI EMOPOIETICHE

875

Trapianti di Cellule staminali emopoietiche

(da donatori non familiari)

https://www.aido.it/

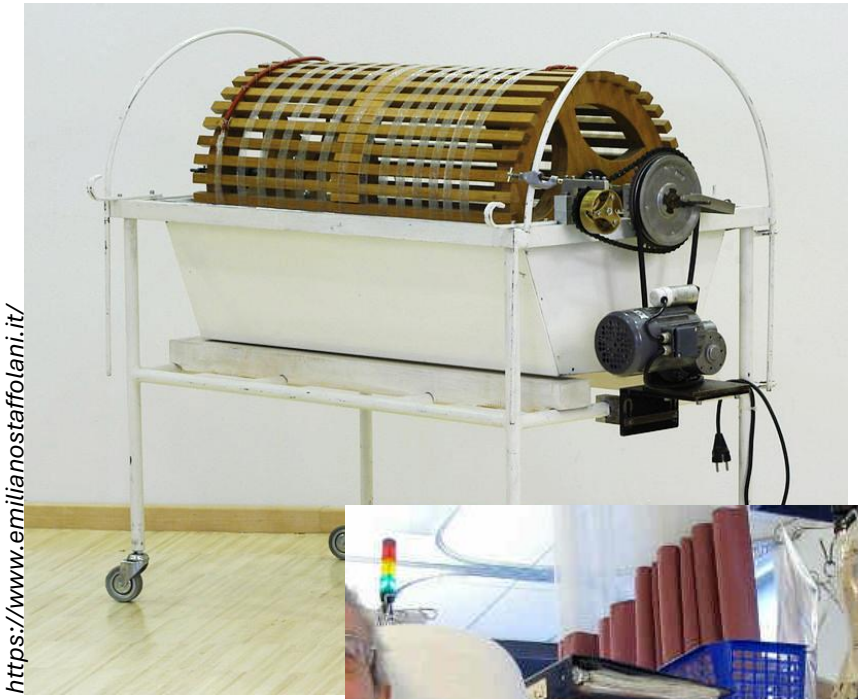
LA PROTESI PIÙ ANTICA DELLA STORIA

«Cairo Toe»,
circa 1500-2000 a.C.

FIG. 7.1 Wooden prosthesis attached to the forefoot by a textile lace. *Reprinted with permission from reference A.G. Nerlich, A. Zink, U. Szeimies, H.G. Hagedorn, Lancet 356 (9248) (2000) 2176–2179. Copyright 2000, Elsevier.*

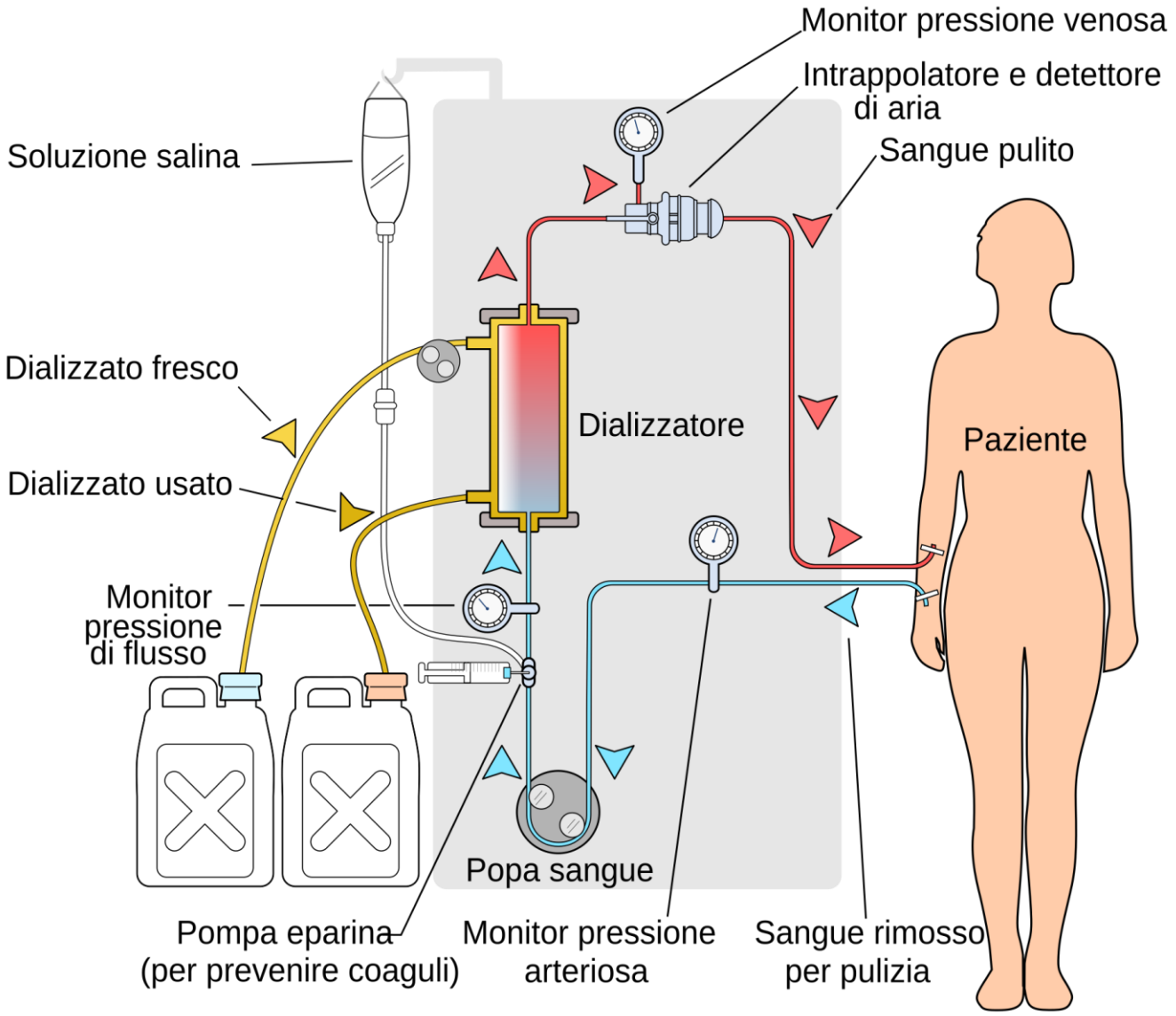
Tashiro et al, Biomechatronics, 2019, Pages 175-199

RENE



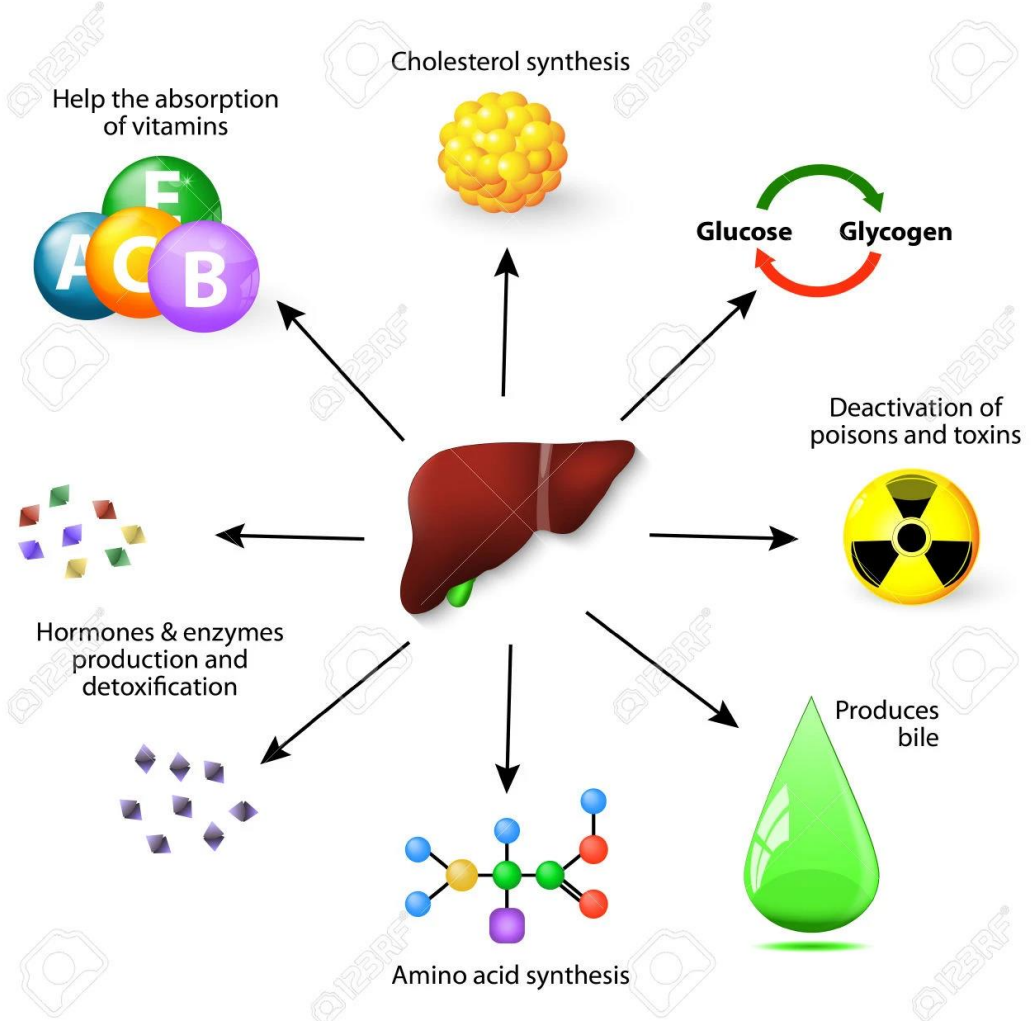
https://www.emilianostaffolani.it/

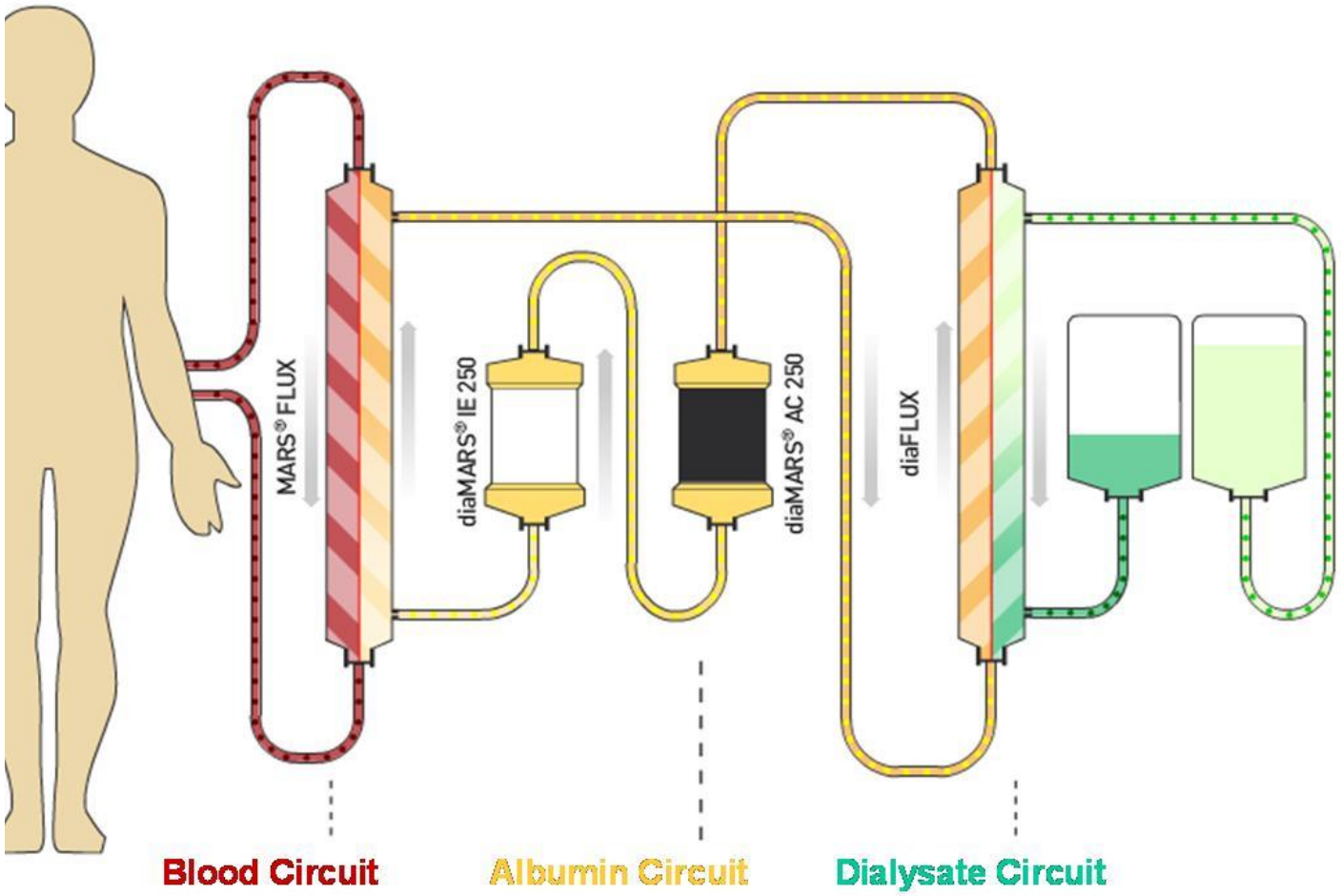
https://www.nurse24.it/



https://it.wikipedia.org/wiki/Emodialisi

FEGATO

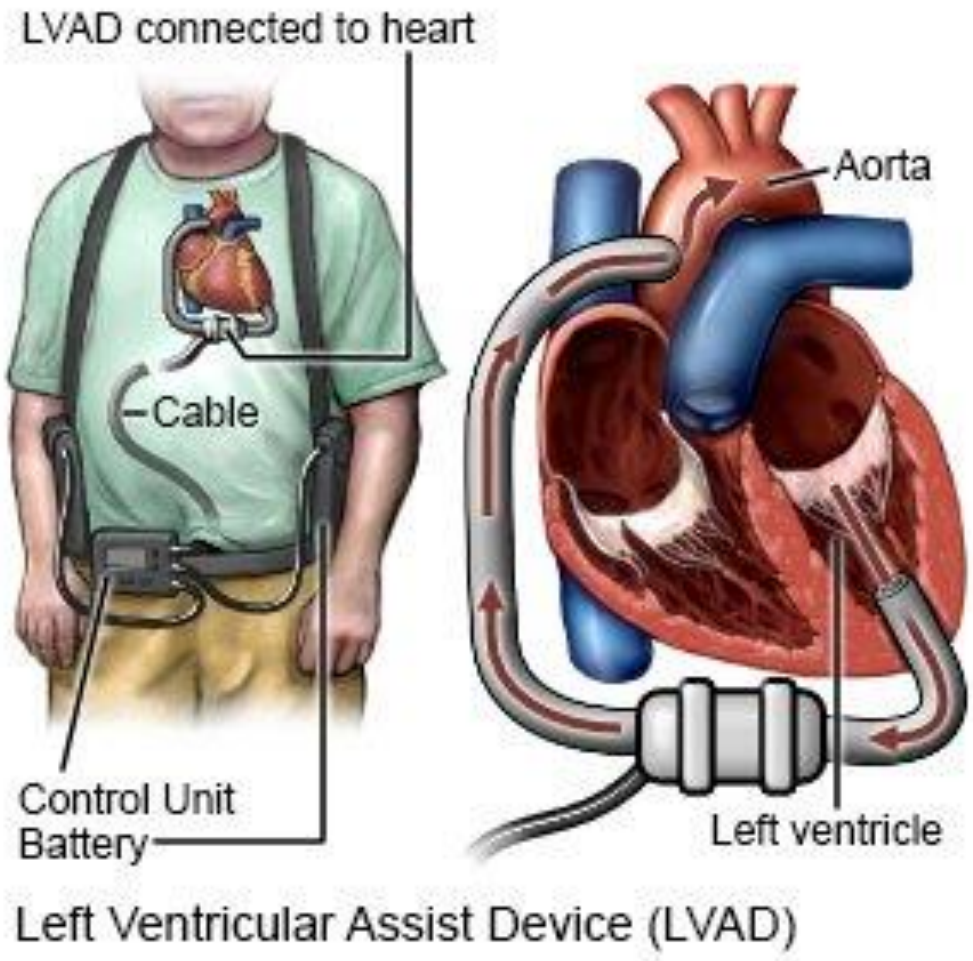




https://www.dreamstime.com/

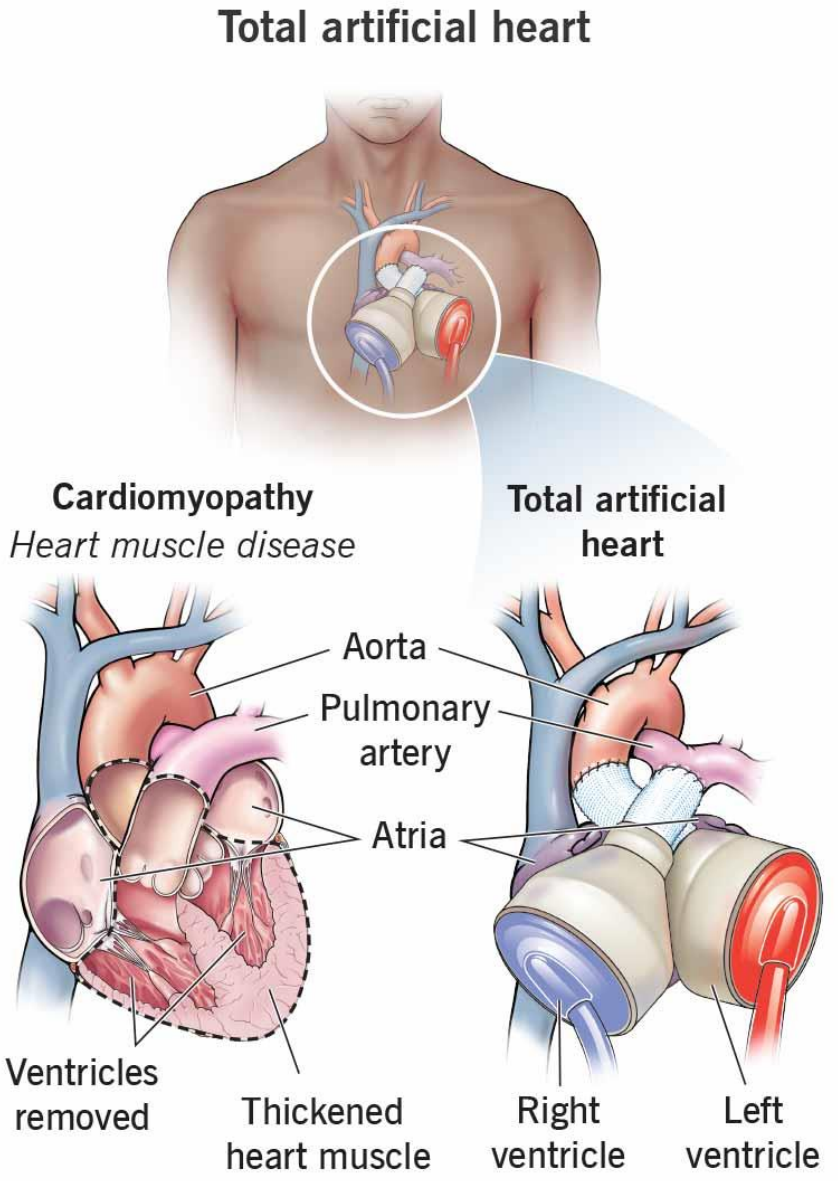
https://en.wikipedia.org/wiki/Liver_support_system

CUORE

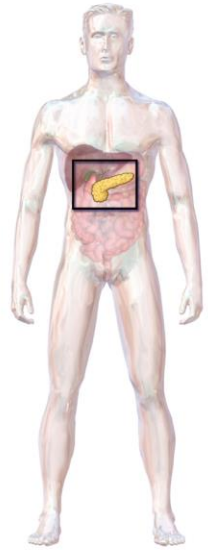


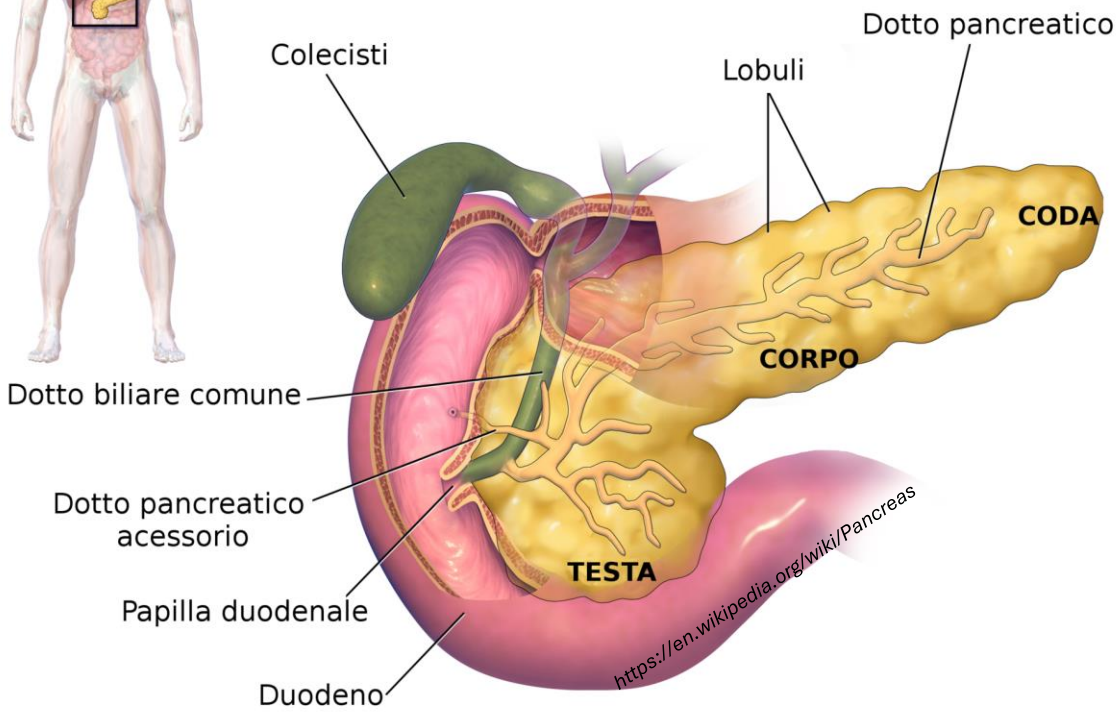
Left Ventricular Assist Device (LVAD)

https://www.drugs.com/



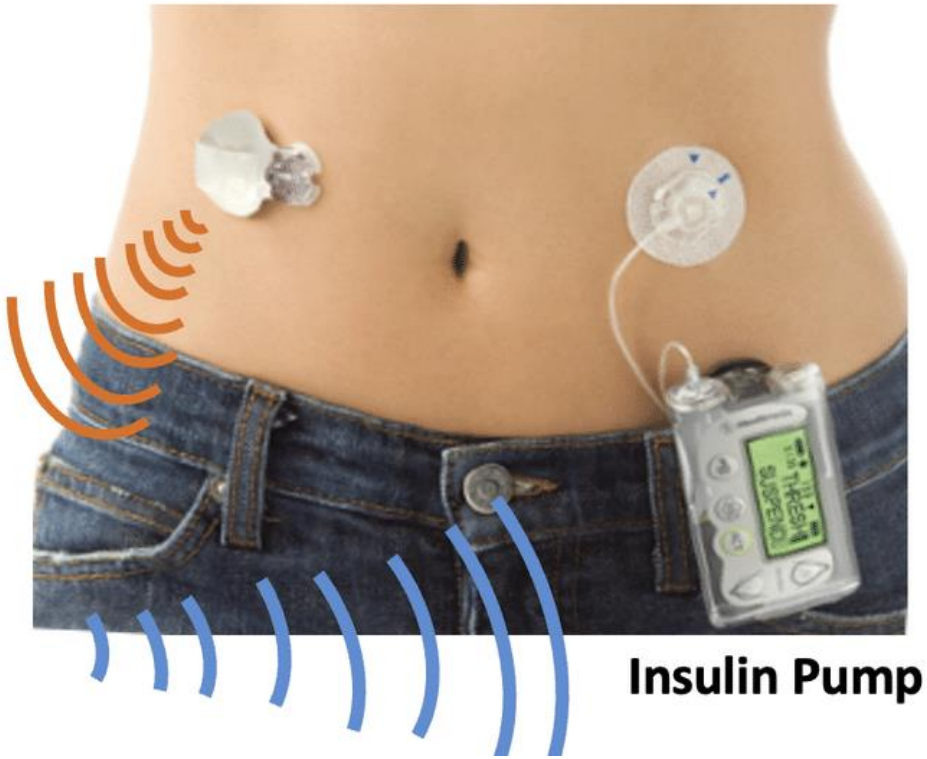
PANCREAS





Controller

Continuous
Glucose Monitor



Insulin Pump

10.48550/arXiv.2208.06479

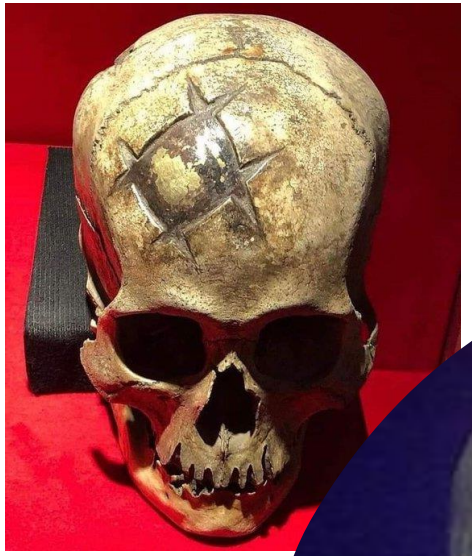
OSSO

PROTESI

https://www.ior.it/

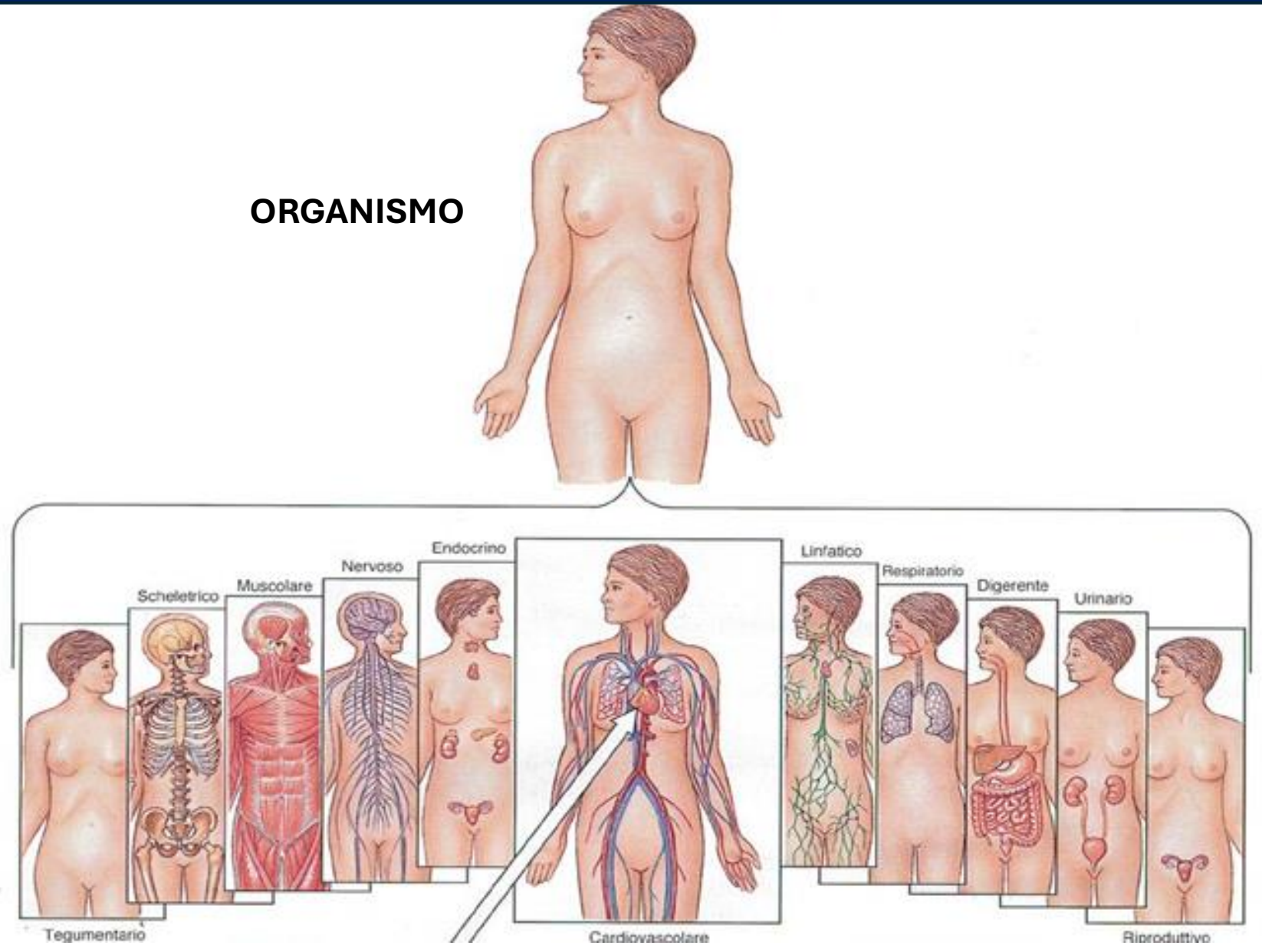
https://ortopediaborgotaro.it/

SCAFFOLDS



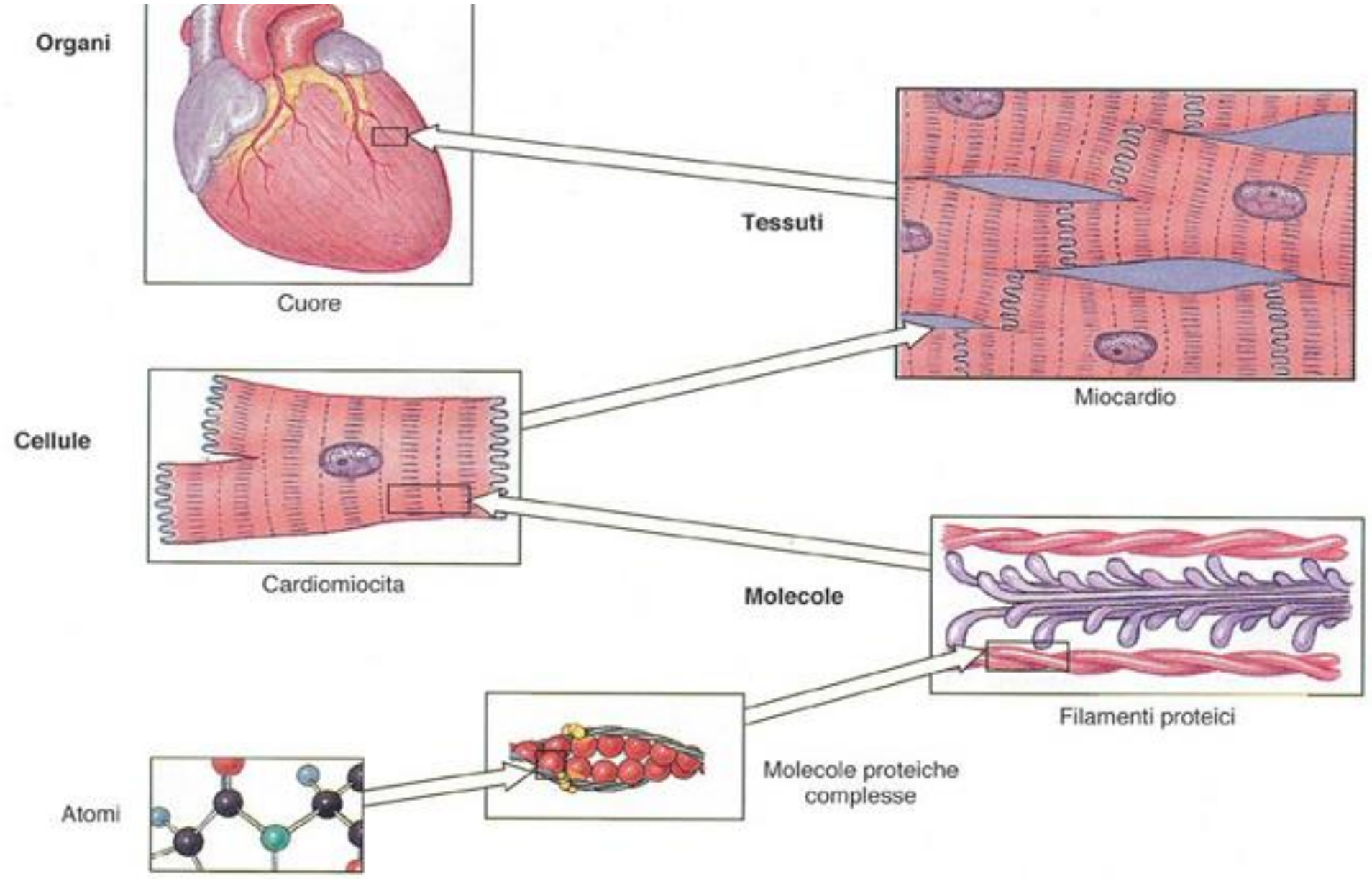
ORGANISMO…APPARATI…

ORGANISMO

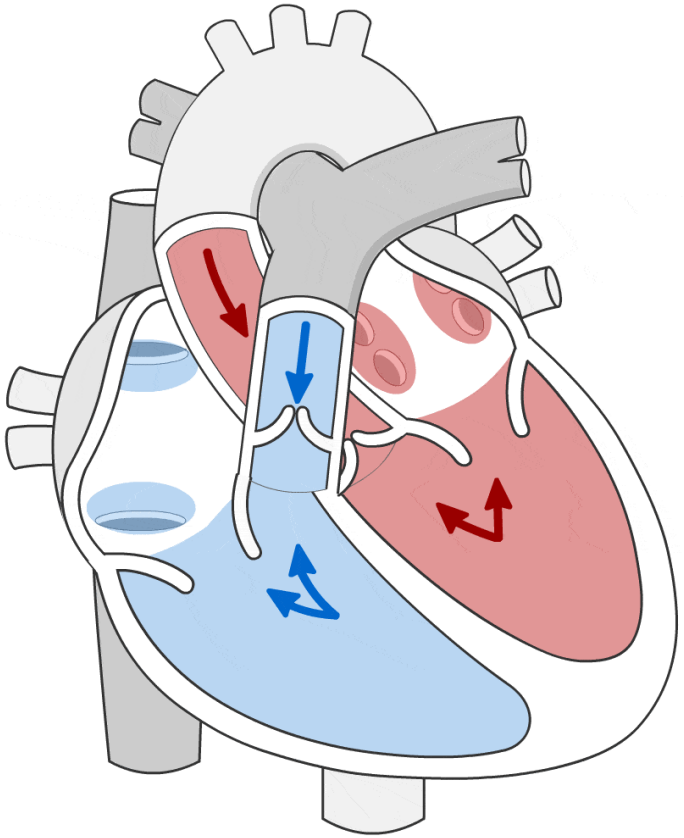


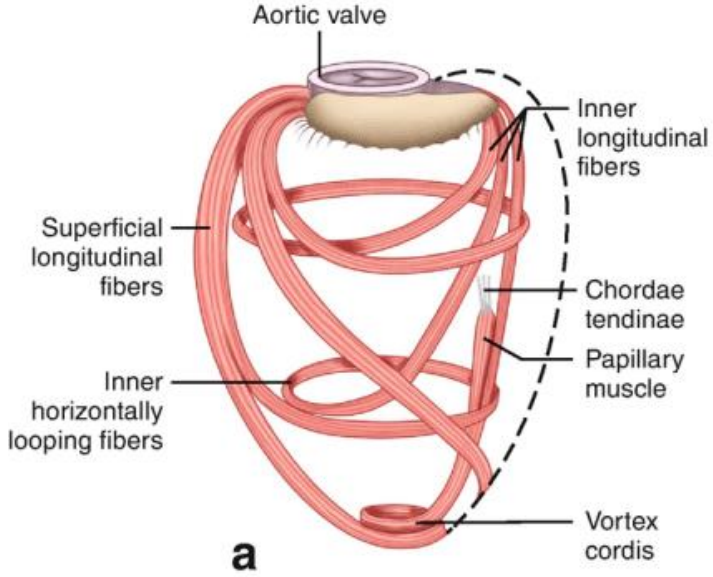
APPARATI (11)

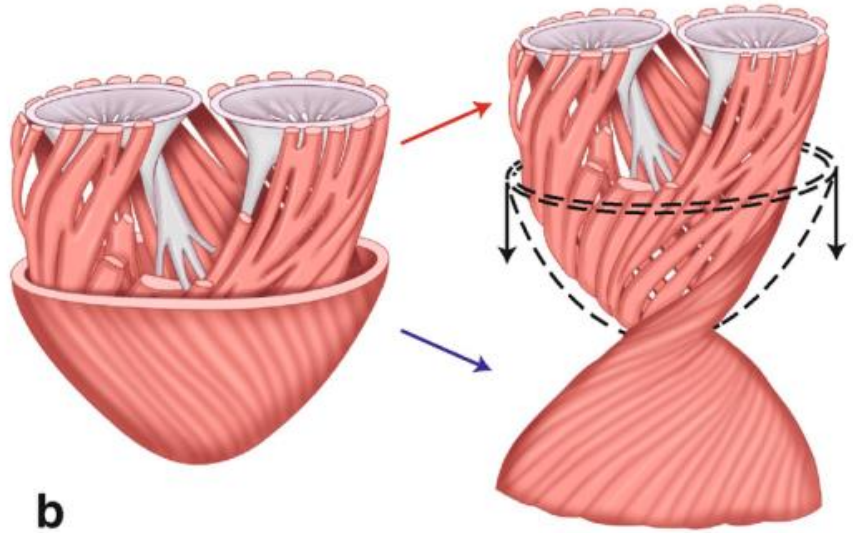
...ORGANI...TESSUTI...CELLULE

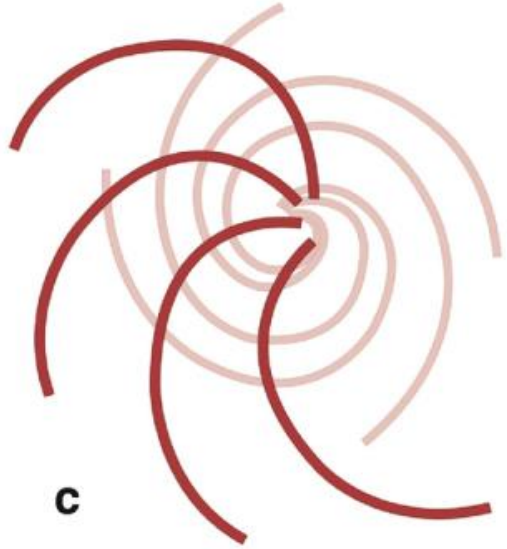


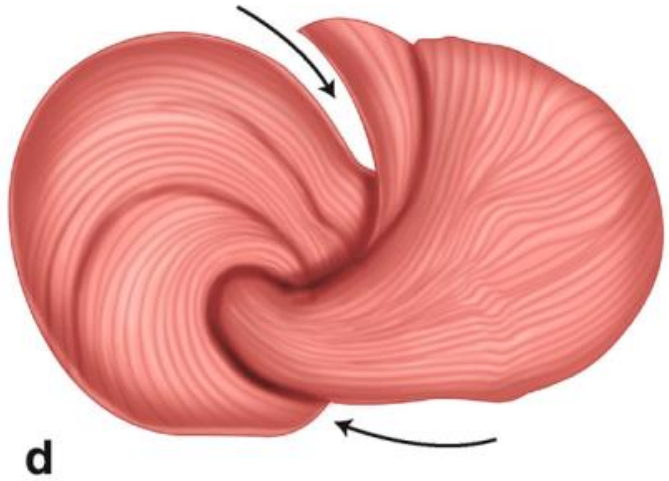
IL CUORE









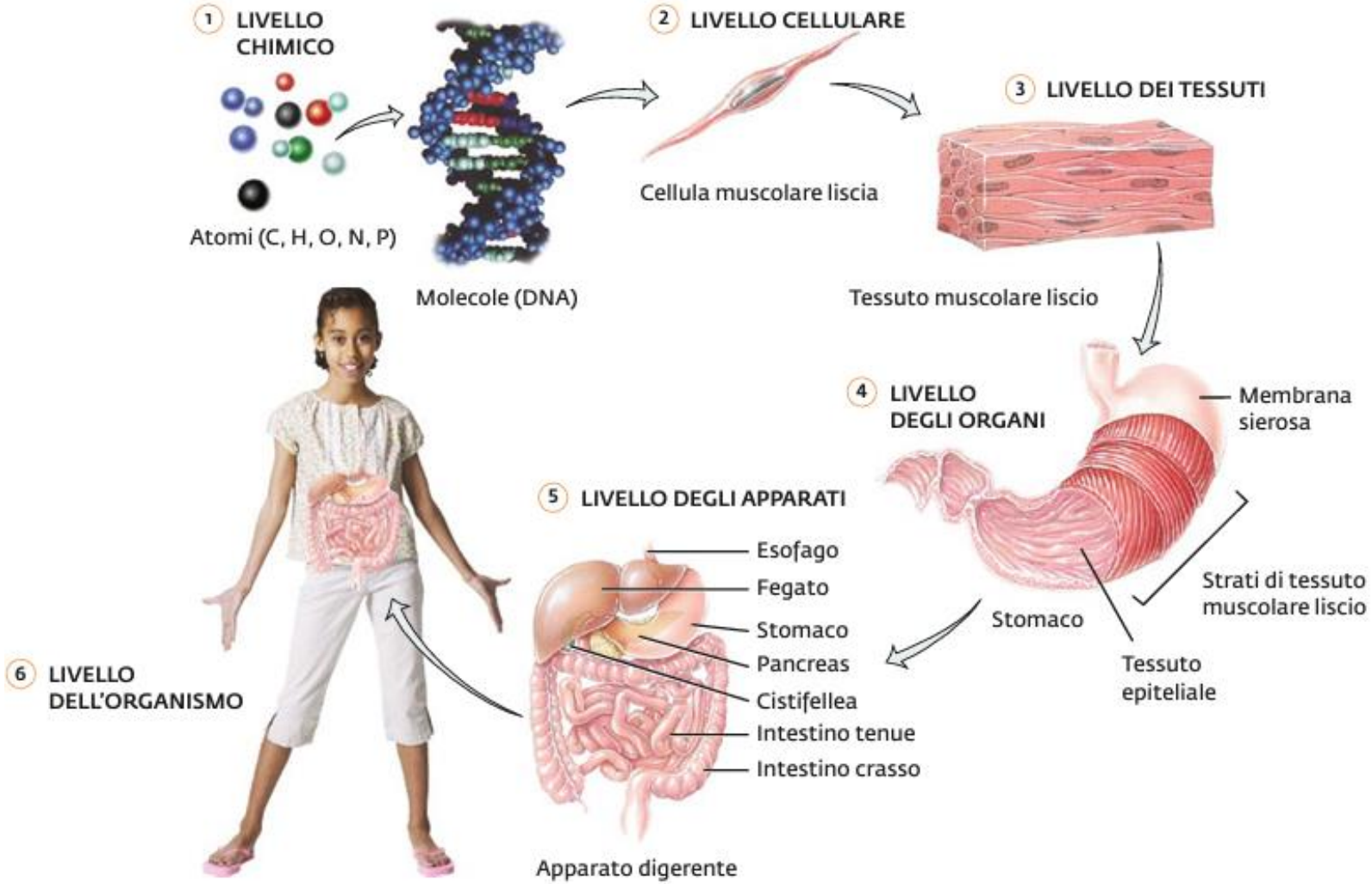


https://www.humanbiomedia.org/

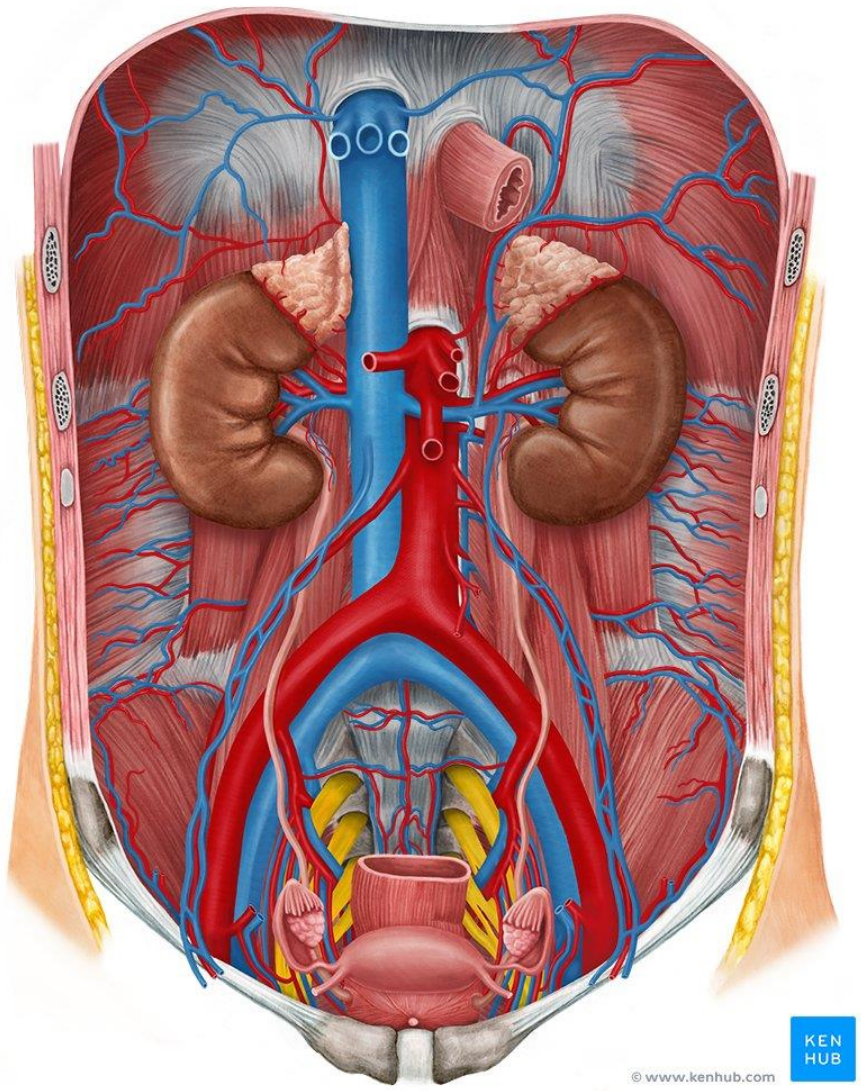
https://doi.org/10.1007/978-3-030-25062-1_13

DALL'ORGANISMO… ALL'ATOMO

I sei livelli di organizzazione strutturale presenti nel corpo umano.



IL RENE e le sue FUNZIONI



FUNCTIONS OF THE KIDNEY:

A WET BED

A : Acid-Base Balance

W : Water Removal

E : Erythropoiesis

T : Toxin Removal

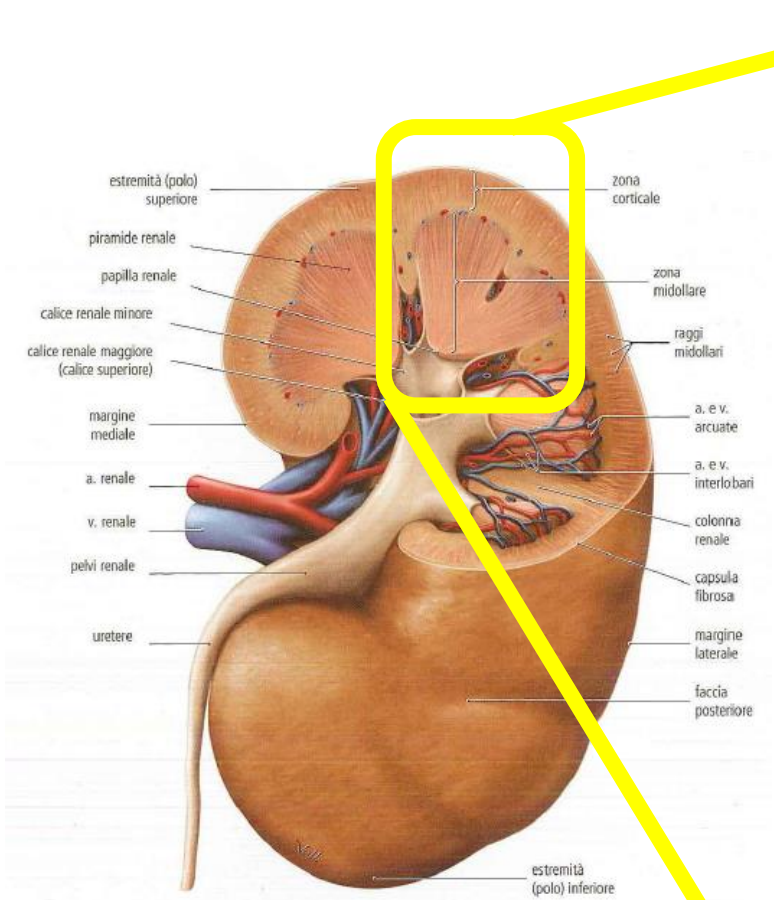
B : Blood Pressure Control

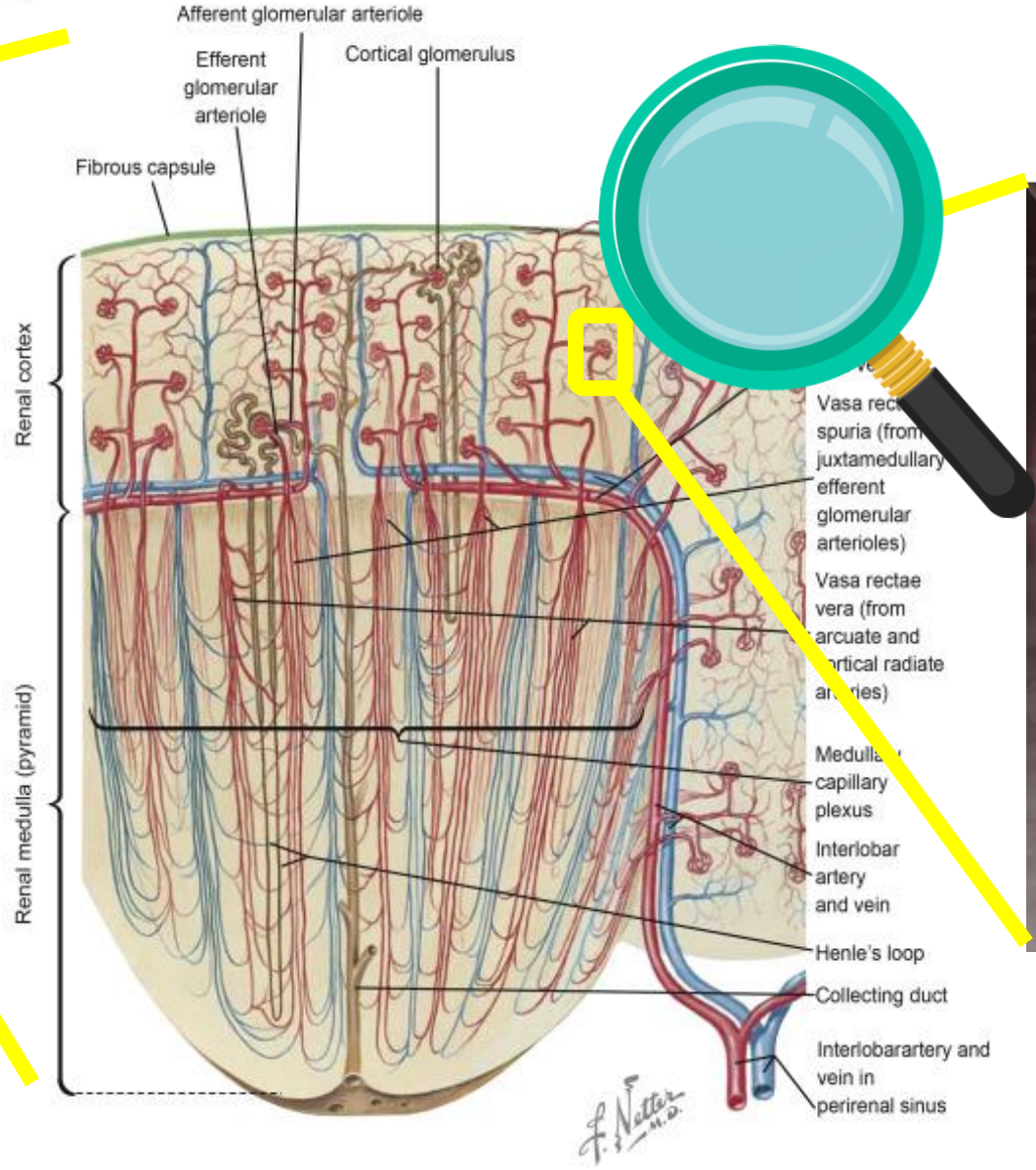
E : Electrolyte Balance

D : Vitamin D Activation

qd nurses

FUNZIONI DEL RENE - Il nefrone





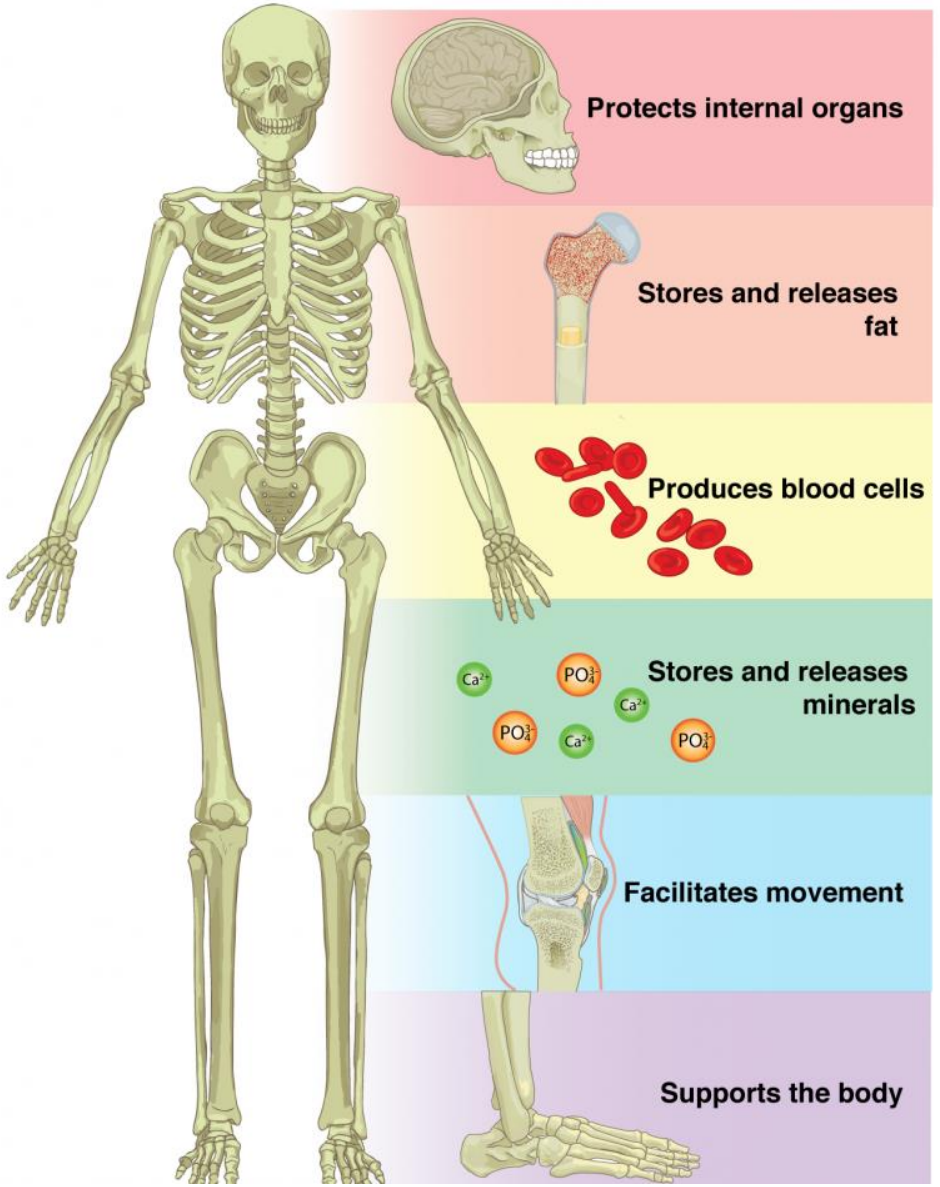
www.instagram.com/audragerasbiomedicalart

SCHELETRO E OSSO

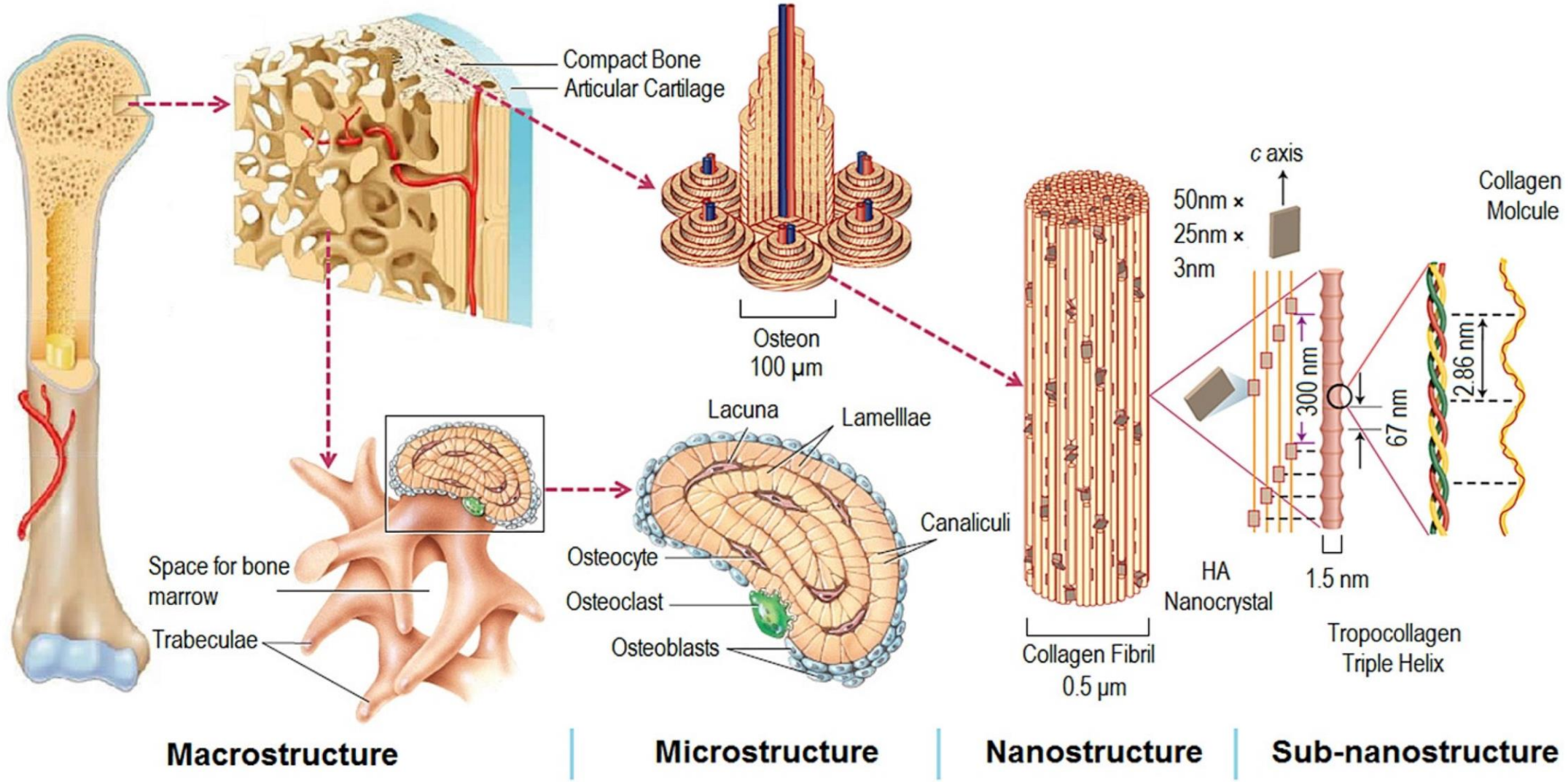
Nell’adulto:

- 206 ossa
- 68 articolazioni

https://ita.grandado.com/



OSSO - *La struttura*



https://encyclopedia.pub/entry/22033

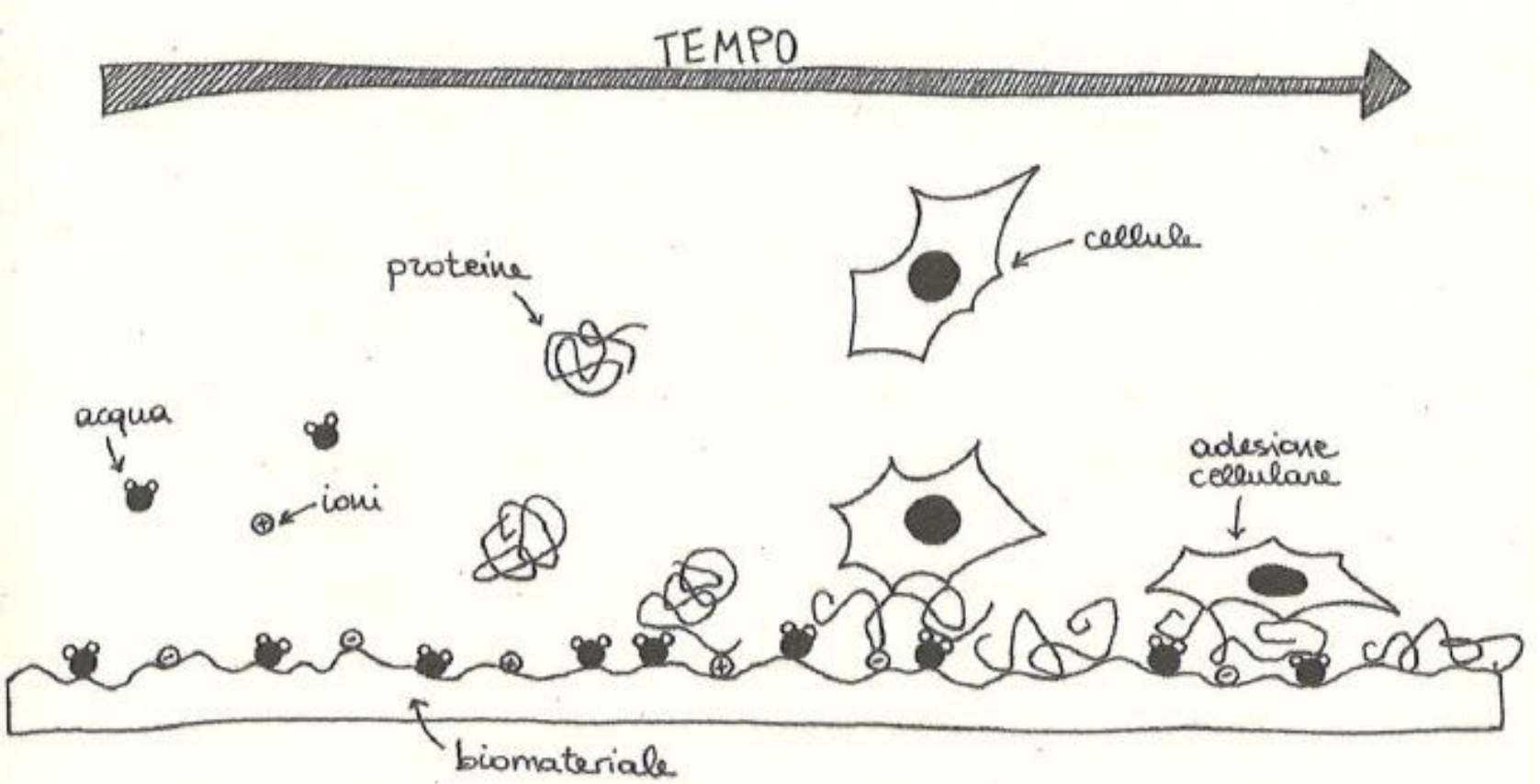
BIOMATERIALI

Sostanza (o combinazione di sostanze), non vivente, naturale o artificiale – farmaci esclusi – che può essere impiegata per un qualunque periodo di tempo, da sola o come parte di un sistema, per trattare, migliorare o sostituire un qualunque tessuto, organo o funzione del corpo.

https://www.journals.elsevier.com/biomaterials

- *POLIMERI*
- *METALLI*
- *CERAMICA*

INTERAZIONE BIOMATERIALI-TESSUTI

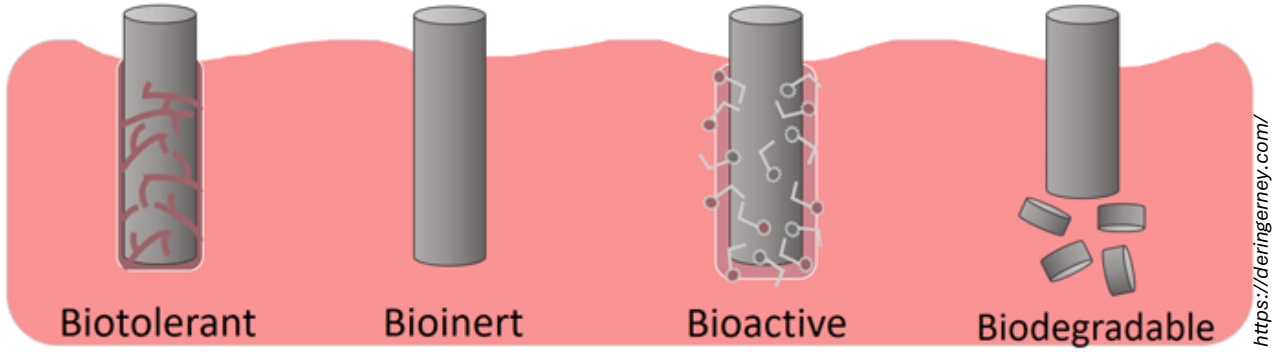


La sequenza semplificata degli eventi che avvengono all'interfaccia tra un biomateriale impiantato e il mondo biologico.

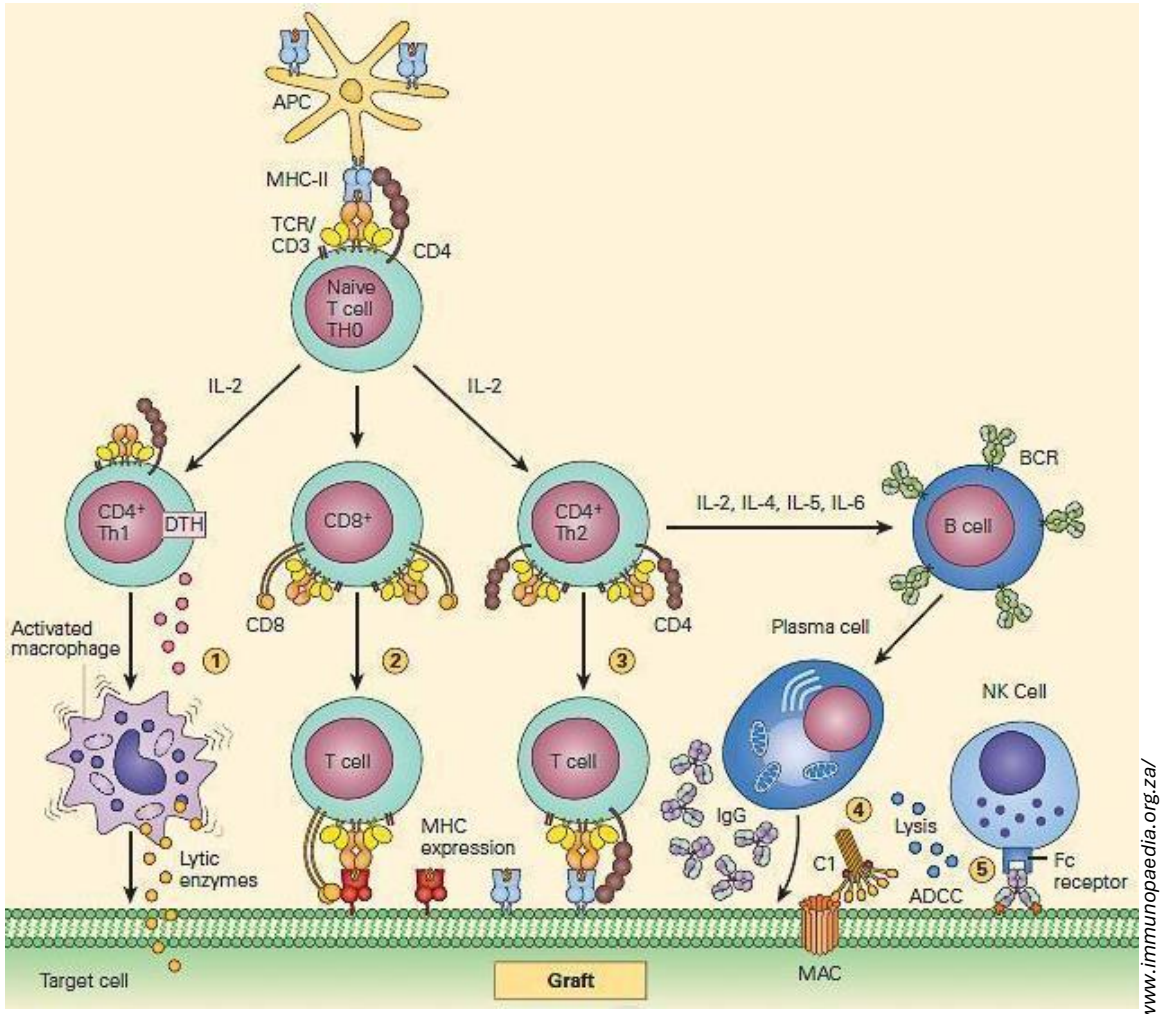
Bellucci D., Materiali per la Vita, Bollati Boringhieri, 2022

REAZIONE DA CORPO ESTRANEO e RIGETTO

https://www.theserendipityperiodical.it/

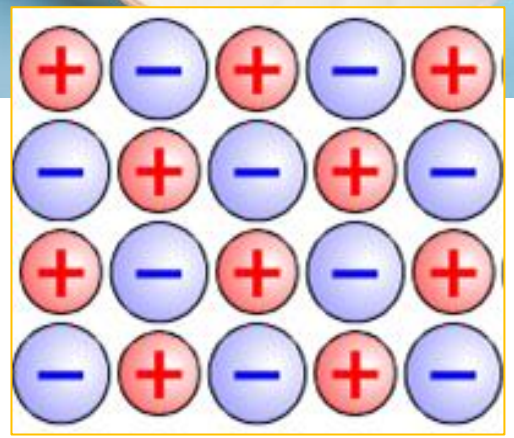


https://deringerney.com/

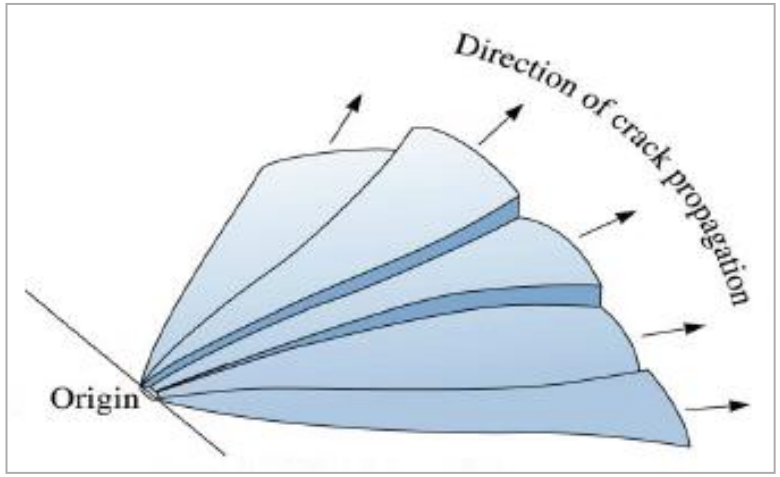


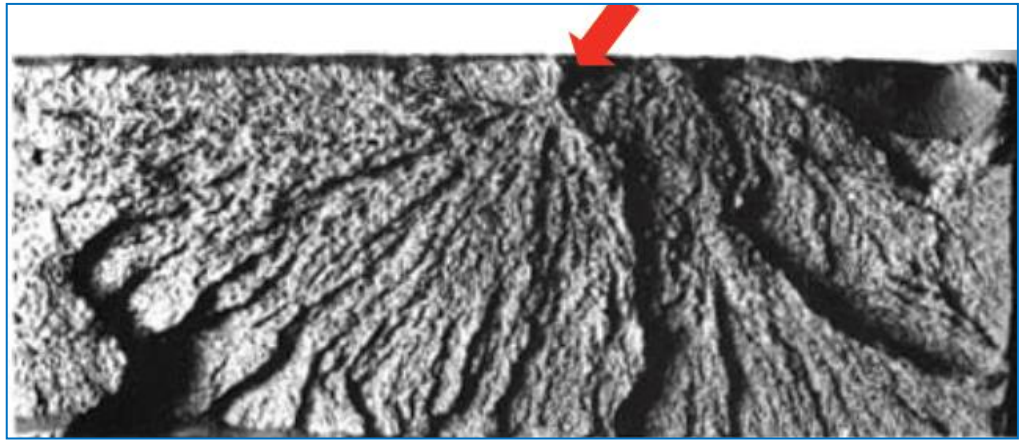
https://www.immunopaedia.org.za/

LA CERAMICA

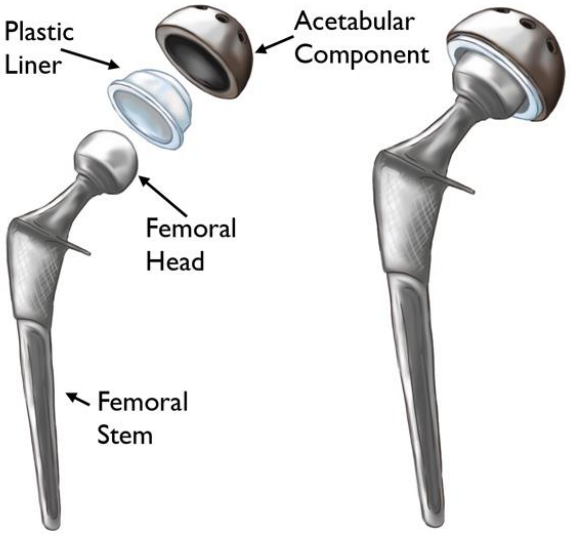


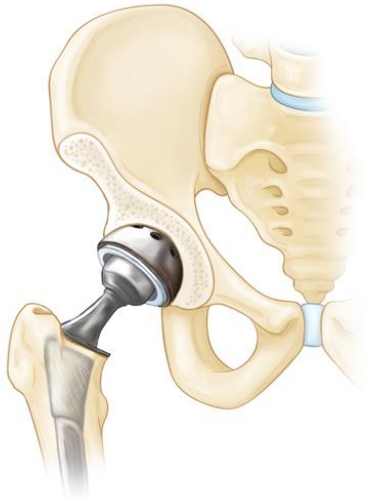

FRATTURA
SOLLECITAZIONE CONCENTRATA
PIANO DI FRATTURAZIONE

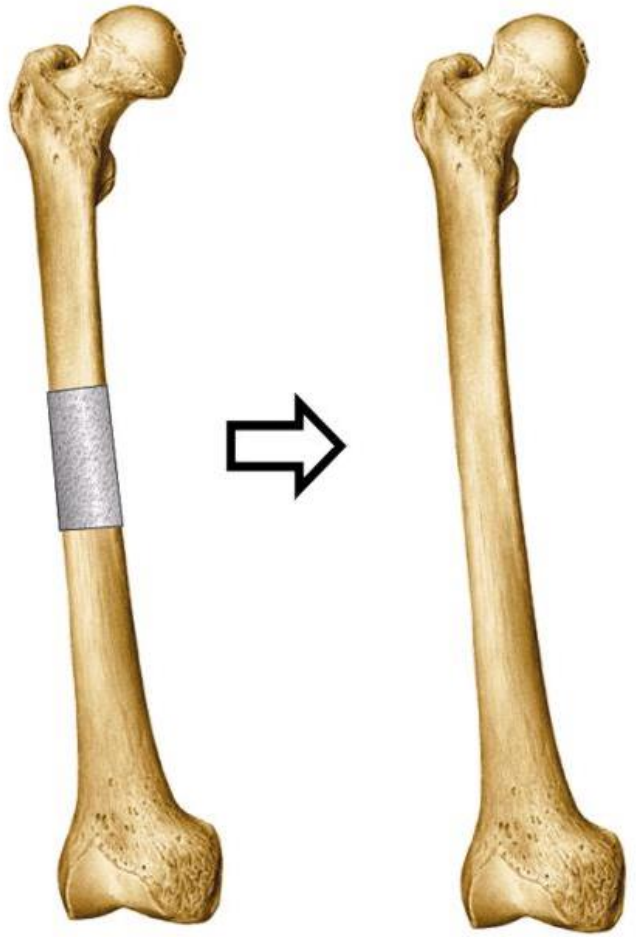

Direction of crack propagation
Origin



DALLE PROTESI AGLI SCAFFOLDS







https://www.mech.kuleuven.be/en/bme/research/mechbio

LO SCAFFOLD IDEALE: Biomimesi

CHIMICA

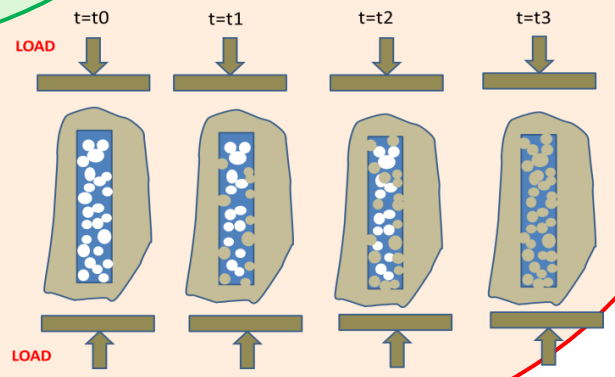
Fosfati di Calcio

- Idrossiapatite (HA)

- **Bioattivi**
- **Bioriassorbibili**
- **Sostituzioni ioniche**

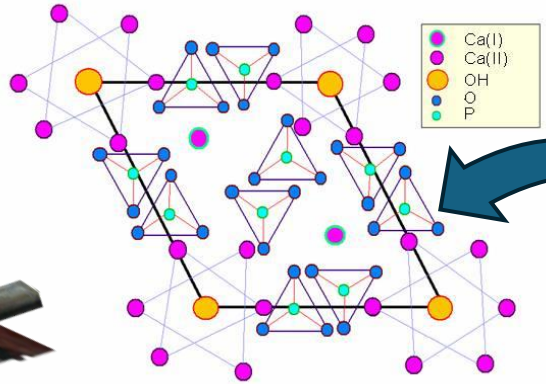
POROSITA'

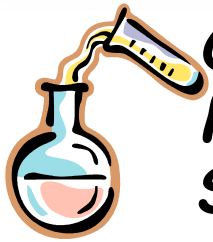
PROPRIETA' MECCANICHE



Idrossiapatite

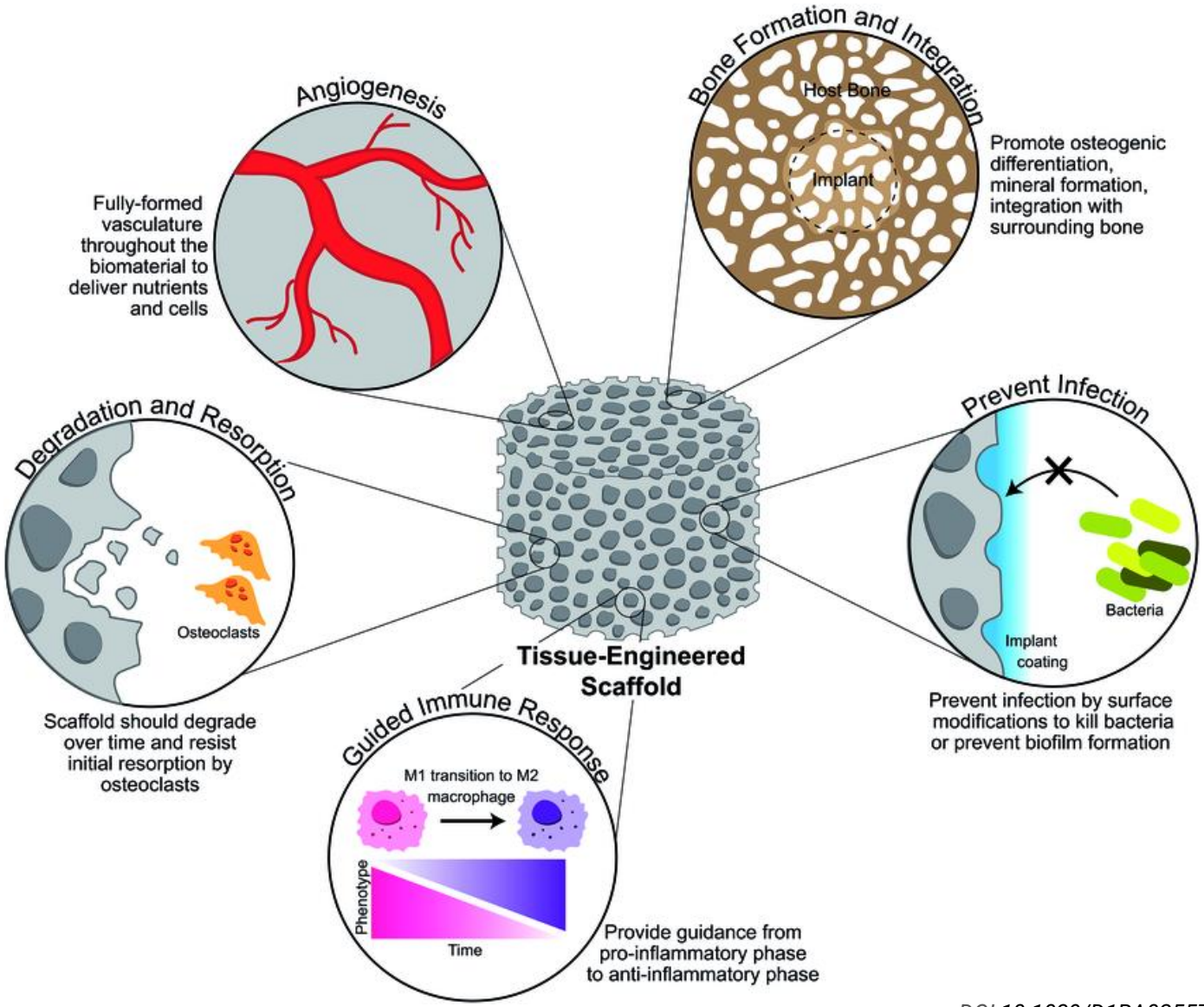
$Ca_{10}(PO_4)_6(OH)_2$





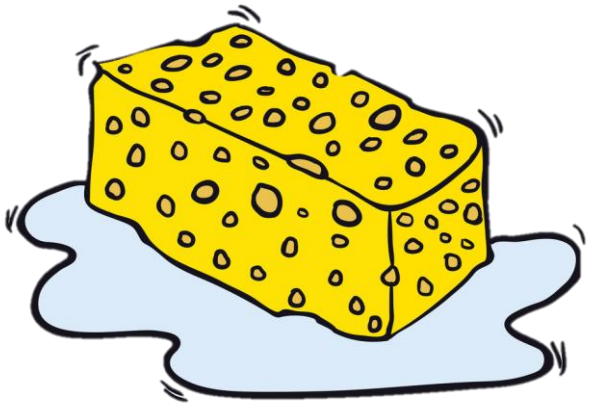
CO_3^{2-}
Mg^{2+}
SiO_4^{4-}
Sr^{2+}
.....

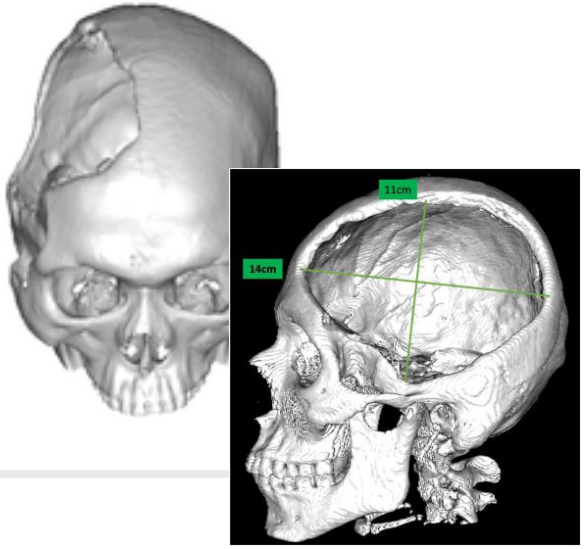
LO SCAFFOLD IDEALE: Biomimesi

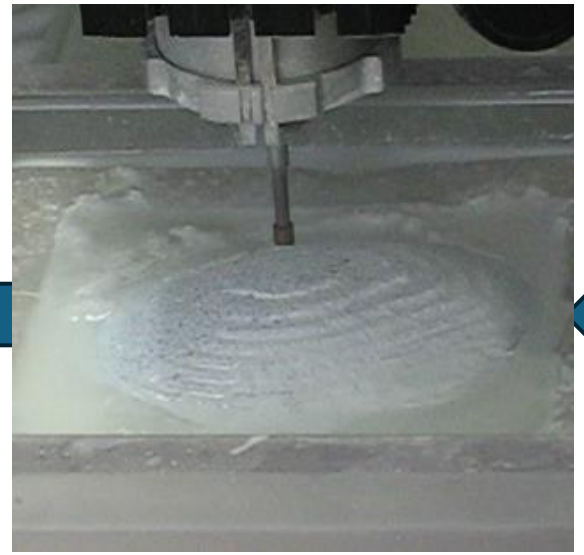


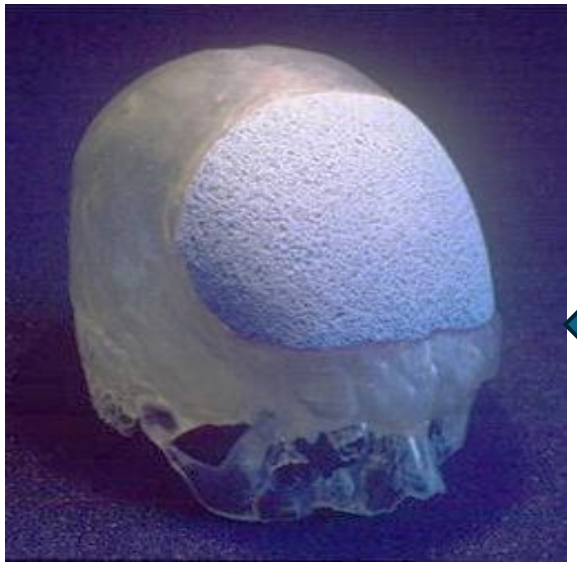
DOI:10.1039/D1RA02557K

DALLA SPUGNA ALL'OSSO
Il metodo «Replica»









http://www.cranioplastica.it/demolition/pdf/vol_16_14_2010/TopMed_2010_%20Nataloni.pdf

DAL LEGNO ALL'OSSO – Trasformazione Biomorfica

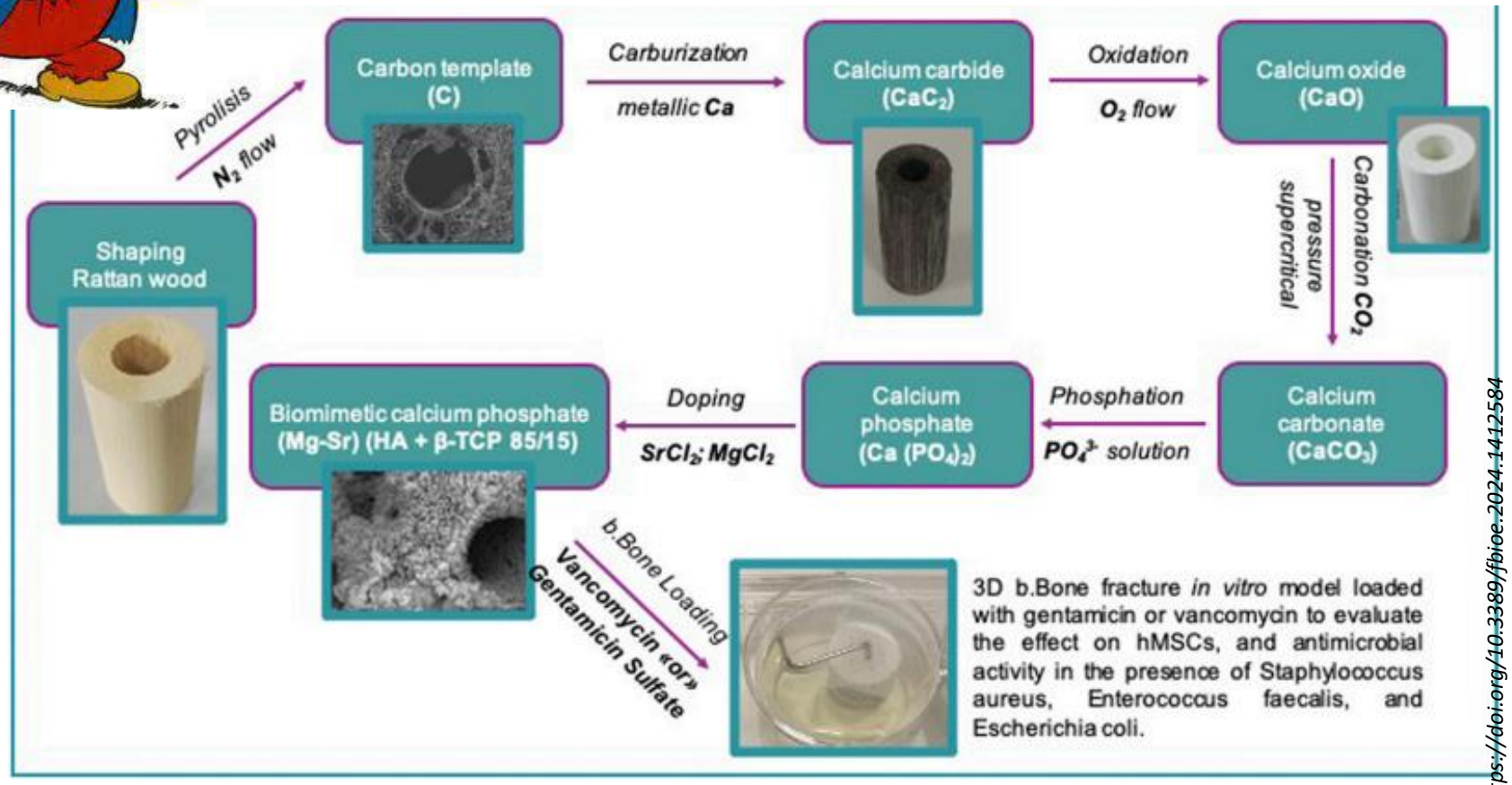
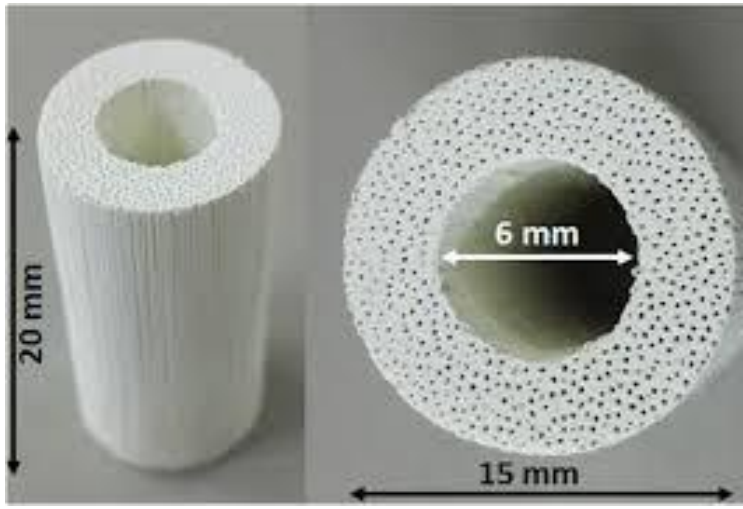


FIGURE 1
The b.Bone manufacturing process and loading flow chart.

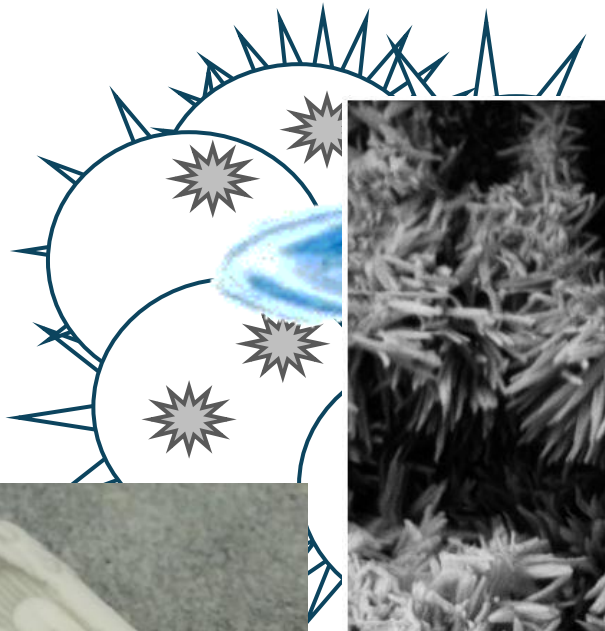


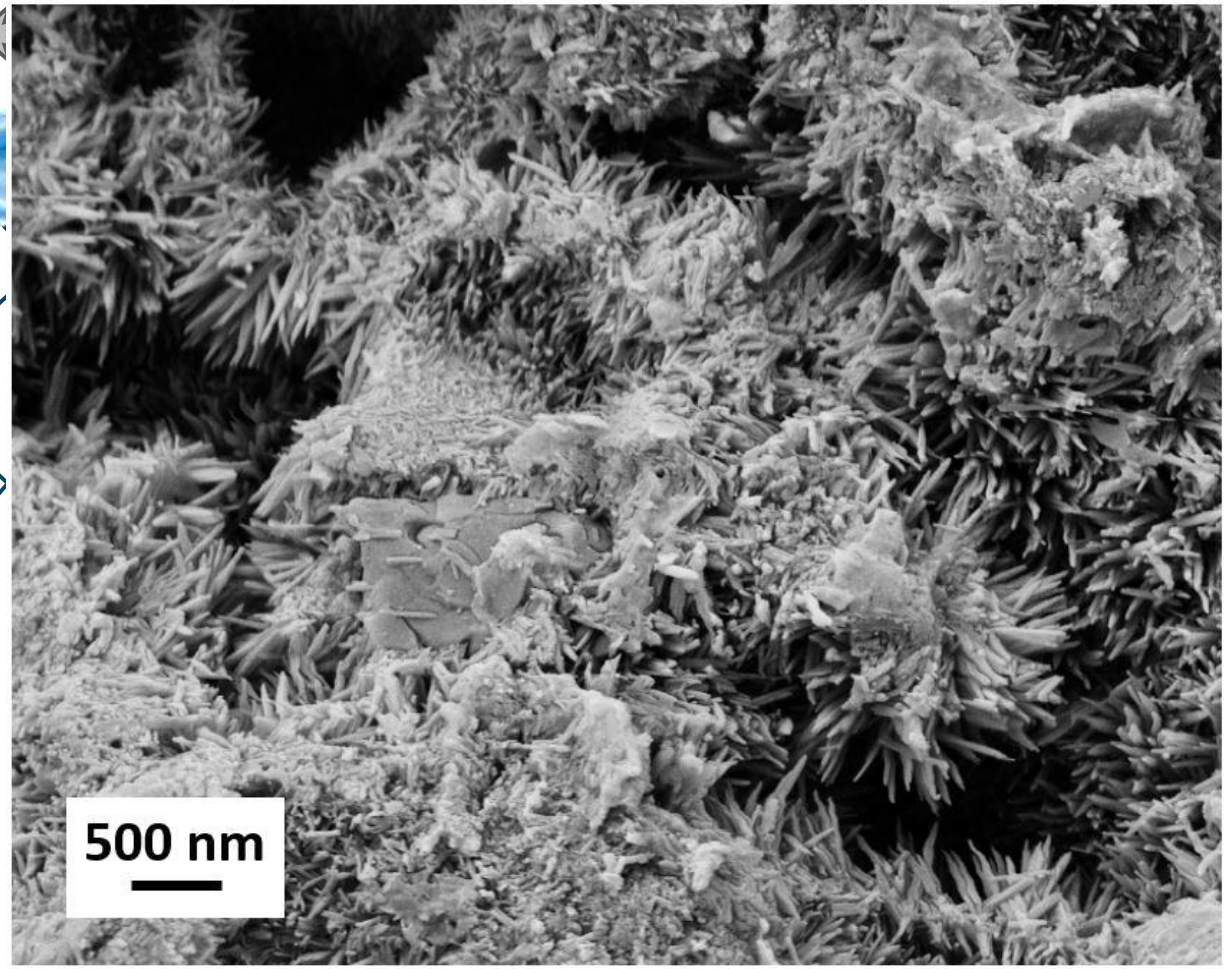
https://doi.org/10.3389/fbioe.2024.1412584

CEMENTI OSSEI

αTCP

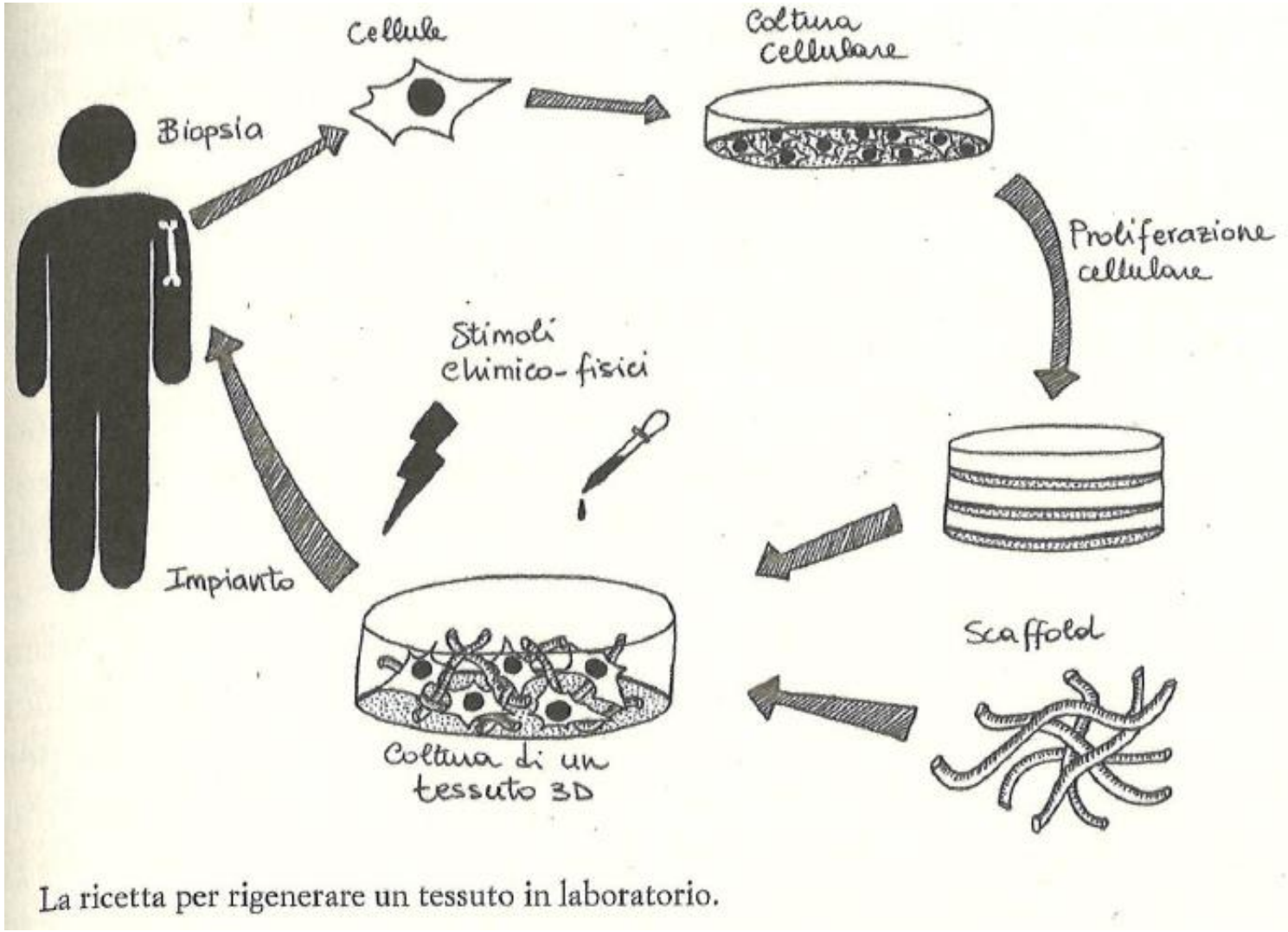
Idrossiapatite





INGEGNERIA TISSUTALE E MEDICINA RIGENERATIVA

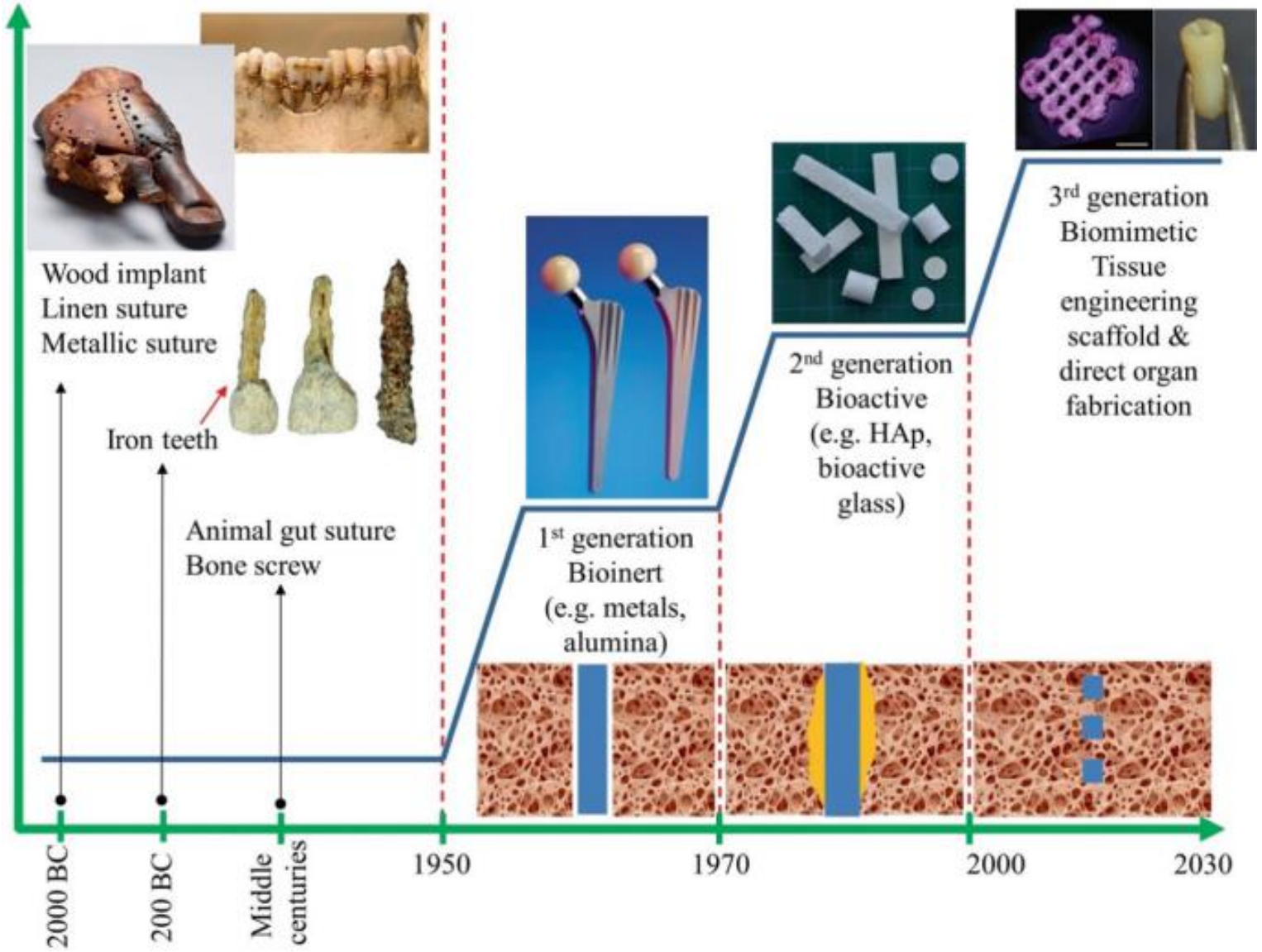
La Medicina Rigenerativa si avvale di strumenti come terapia genica, cellulare e biomateriali per stimolare la ricrescita di un tessuto



La ricetta per rigenerare un tessuto in laboratorio.

Bellucci D., Materiali per la Vita, Bollati Boringhieri, 2022

RIASSUMENDO…



https://doi.org/10.1007/978-3-031-75754-9_1

IL FUTURO PER GLI ORGANI ARTIFICIALI

Il sogno dell'Ingegneria Tissutale è quello di sviluppare sostituti biologici di interi organi.

- *3D Bioprinting*
- *Sferoidi e Organoidi*
- *Drug Delivery*
- *Organs-on-chips*
- *Stem cell reprogramming*
- *Cellularizzazione di espianti decellularizzati*
- *Genome editing*
- *Intelligenza Artificiale (IA)*
- *Robotica*
- *Biomateriale*

GRAZIE PER L’ATTENZIONE

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