Medical Aspects of Bones and Movement in Chemistry Education

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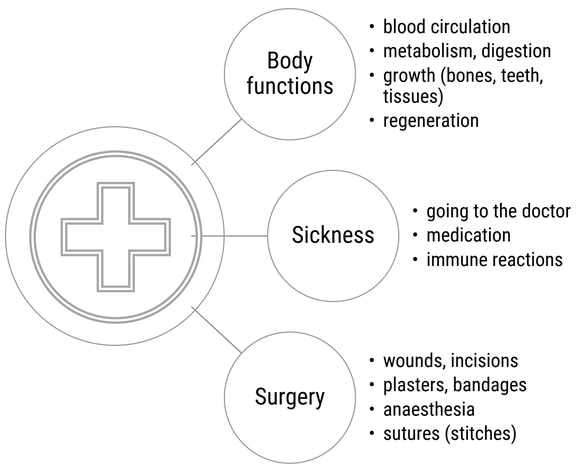
Medicine and Chemistry

Chemistry might not be the first association to come in mind when thinking of **medicine**, but there are many **overlaps** between those disciplines (Fig. 1). Chemistry can help us understand our body functions as well as the mode of action of medical treatments.



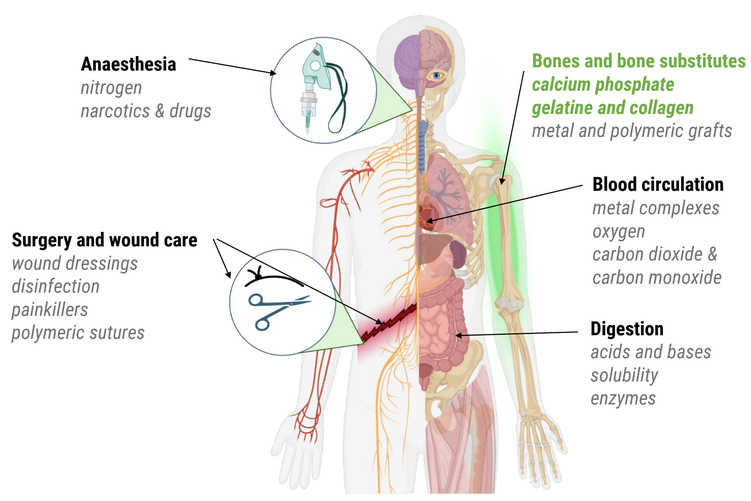


Fig. 1: Selection of overlaps between medicine and chemistry.

Human Bones

Bones consist of 30-40% **organic bone matrix** and 60-70% **inorganic minerals**, making calcium phosphates and proteins dominating chemical structures in bones (Fig. 2) [1].

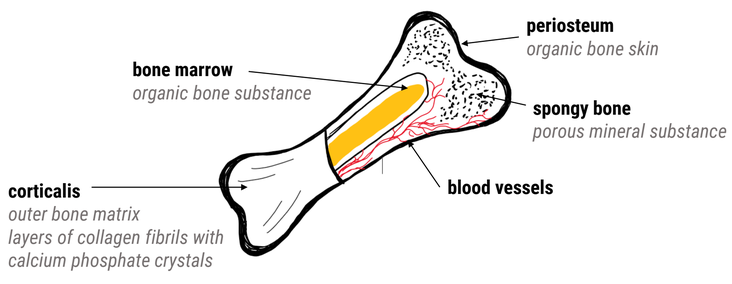
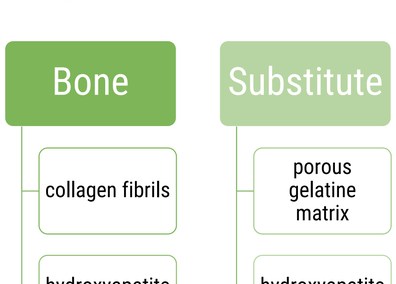
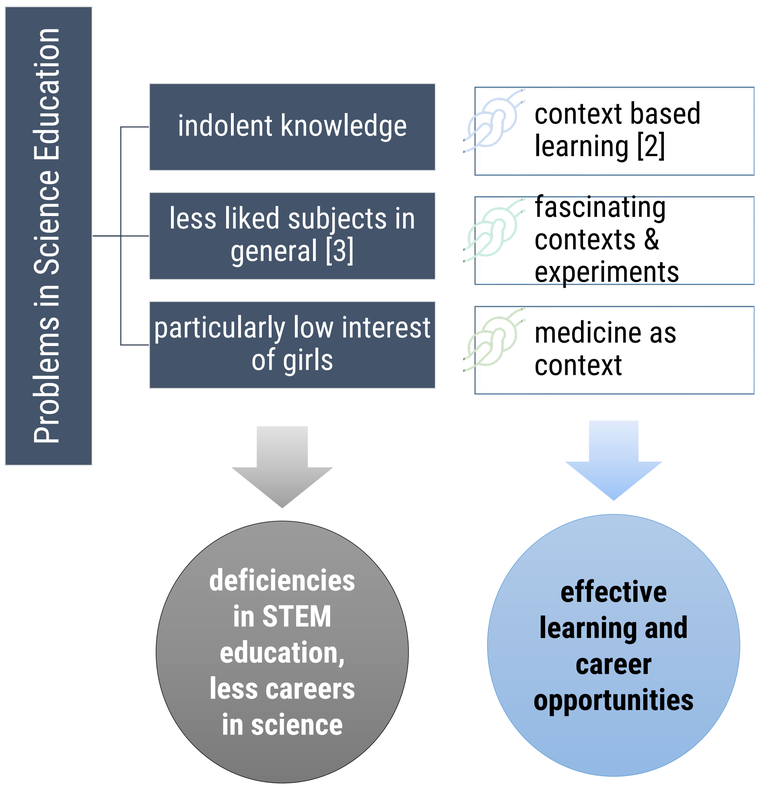


Fig. 2: Bone structure and composition.

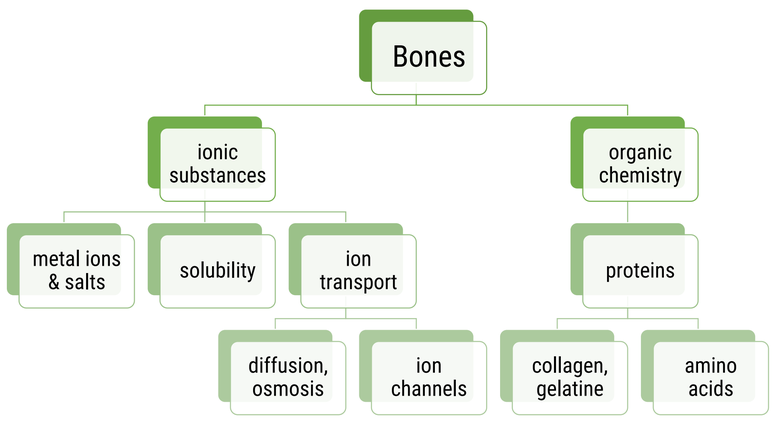
Despite resemblance in chemical composition, bone substitute materials often do not show the same characteristics as real bone due to **differing macro- and microstructure**.



Didactic Opportunities



Using bones and bone substitute materials as a topic offers **linkage to classical elements of the curriculum** such as ionic substances, solubility or metals in grade 8 (age 15) as well as proteins and organic chemistry at secondary level.



Teaching ionic substances and protein chemistry
Experimental series with bones

The experiments will be embedded in a learning arrangement using the approach of **context-based learning** [2]. Therefore, it will be expanded by related medical topics to build a **holistic learning environment**. Finally, various contextualised learning arrangements will be merged to form one unit. Orientating to the pathways of the **Model of Educational Transfer Research** (Fig. 3) [4], the series will be piloted, evaluated, and optimised.

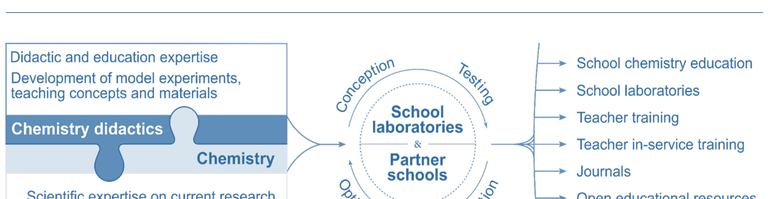


Fig. 3: Model of Educational Transfer Research [4].

Experimental Series

We present a **series of experiments suitable for various levels of chemistry education** based on two simple ways to identify organic and inorganic material as components of bones [5].

Basic bone components I:
Burning out bones
Identifying inorganic mineral salts

Usability for chemistry education:
Common school equipment, non-toxic and inexpensive chemicals, easily conductible by students

Analysing Bone Structure

Basic bone components II:
Incubating bones in acid
Identifying organic matrix
Biuret test and ion detection on the acidic solution

Bone substitute composite:
Combining hydroxyapatite (HAp) and gelatine [6]
Testing in experiments I & II

Fig. 4: Summary of experiments I & II with chicken bones and HAp-Gelatine-Composite.

Although creating a composite with **resembling chemical composition**, living structures cannot be easily mimicked. Notable **differences** between real bones and the composite (Fig. 4) contribute to the understanding of proteins, ionic substances and profound knowledge of **structure-property-relationships**.

References

[1] Jerosch, J. (**2002**). Knochen. Curasan Taschenatlas spezial. Thieme, Stuttgart. [2] Demuth, R., Gräsel, C., Parchmann, I., Ralle, B. (**2008**). Chemie im Kontext. Von der Innovation zur nachhaltigen Verbreitung eines Unterrichtskonzepts. Waxmann, Münster. [3] Sjoberg, S., Schreiner, C. (**2005**). How do learners in different cultures relate to science and technology? Results and perspectives from the project ROSE (the Relevance of Science Education). *Asia-Pacific Forum on Science Learning and Teaching* **6**/2. [4] Chemisch-Geowissenschaftliche Fakultät (**2021**). Fachdidaktische Transferforschung. www.chemgeo.uni-jena.de/fakultaet/institute-und-forschungszentren/institut-fuer-anorganische-und-analytische-chemie/arbeitsgruppe-chemiedidaktik/forschung-ag-wilke/fachdidaktische-transferforschung [5] Natura - Biologie für Gymnasien (**2006**), 1. Aufl. Klett, Stuttgart, Leipzig. [6] TenHuisen, K. S., Martin, R. I., Klimkiewicz, M., Brown, P. W. (*1995*). Formation and properties of a synthetic bone composite: hydroxyapatite-collagen. *Journal of biomedical materials research* **29**/7, 803–810.

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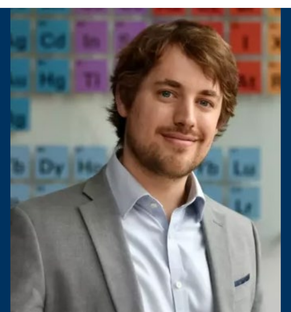

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