Do you need to know chemistry in order to be a good bone surgeon?

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Country: Israel

Subject: Chemistry.

Grade level: 10-12.

Curriculum content: Oxidation-Reduction, electrochemical series.

Kind of activity: Critical reading and group activity

Anticipated time: 4 lessons of 45 minutes each.

Competencies: Group activity and critical reading of an article; group laboratory work: perform virtual experiment, data collecting, explanation of the results; group discussion.

The activity is dealing with metal properties: Mechanical strength, toxicity, density, chemical stability and the electrochemical series. It introduces the goals and rationale of the unit of oxidation-reduction, enables constructive building of the electrochemical series, and gives an example to the use of chemistry outside school.

Teaching guide

A In the first lesson we suggest group working. Each student read the short text and the small group discuss it. The group should pose as much questions as they can (a list of students questions is given in the teacher notes).

The group work is followed with a class discussion (scientific background is available in the teacher notes). The goals for the discussion are:

- To rise the connections between chemistry and medicine.
- To create the students "need to know" – which metal is less reactive.

B. The students enter to the site:

http://stwww.weizmann.ac.il/G-CHEM/animationsindex/Redox/home.html

This site offers to perform virtual experiments, to inquir the relative reactivity of metals.

It is possible to conduct these experiments in the lab, instead of using the web site, as the teacher prefers, but this will take more then one lesson.

After the virtual experiment, the students have the ability to construct the electrochemistry series.

We recommend having a class discussion regarding the next questions:

1. How can you explain the results?
2. What are possible conclusions?
3. In all the experiments we used metals and solutions of metal ions, can you rank the metal by their reactivity order?
4. What is the chemical process in the molecular level?

This discussion can be at the beginning of the second lesson.

Usually, after this discussion we focus in the scientific concept of oxidation-reduction.

- We define: Oxidation and Reduction.
- Each teacher teaches this concept in his way.

In the link
http://stwww.weizmann.ac.il/G-CHEM/center/animationsindex/Redox/home.html
there are more activities. Activities 2 and 3 can be used in order to verified the electrochemistry series that was build by the students.

The concepts of redox:

After the previouse introduction the students should have an aouthentic "need to know" the concept of Redox. We suggest each teacher to teach Redox as he/she are used to teach.

We suggest closing the last lesson by the same questions that opened the first lesson – Do you need chemistry in order to be a good bones surgeon?

It is possible to give the students information regarding the "real solution" of the starting question (information is given in the teacher notes).

Teacher notes

Students questions after the critical reading exercise:

Exemplary students' questions

1. What kinds of materials are suitable for bone affixing?
2. Why do the surgeons use metals?
3. Will the metals rust?

4. How will the metals fixed in the bones, influence the patient's life?
5. What are the criteria for choosing the metals?
6. Why don't the surgeons use plaster?
7. Will the patient who has undergone such a surgery, be able to go through a metals detector checkup?
8. When the bone will knit, will it be able to remove the metal?
9. Will the body reject the metal?

Scientific answer to the question

A breakthrough regarding bone affixing occurred during the 1960. Suitable synthesized materials started to be used for bone stitching and even for join replacement. Those alloys of metals such as: Steel; Cobalt and Chrome and Titanium alloys. The production of those materials has enormously developed – the alloys were modified and improved according to the specifications and in addition, the physicians started to use ceramic materials. It was found, that the human body does not reject these alloys and ceramic materials, and there's no danger in using them, as long as they remain in one piece and do not break.

The latest innovation is the use of unbreakable ceramic materials in combination with Titanium alloys. This combination enables on one side the matching of the ceramic materials to the bone segment of the patient (the join, for example), and its binding to the implanted part (composed of Titanium alloys). The Titanium alloys are fixed in the bone, and in this way, the bone grows into the surface of the Titanium alloys.

Why Titanium alloys?

Titanium (Ti) is an element which atomic number is 22. It is a light and strong metal, and has a few properties which contribute to the technological needs:

* A high ratio between strength and weight.
* A good resistance in high temperatures.
* Malleable.
* Its alloys resist corrosion due to the protective layer of Titanium Oxide which covers its surface.