ВЛИЯНИЕ МАГНЕТИЗМА НА РЕГЕНЕРАЦИЮ
EFFECT OF MAGNETISM ON REGENERATION

Автор работы:
Гайдеров Антон Александрович
учащийся 10 класса
телефон: +7(916)743-59-56
E-mail: gaiderovanton@gmail.com

Научный руководитель:
Оськина Екатерина Викторовна
учитель английского языка

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Introduction

Since the ancient times people have believed that the Earth’s magnetic field influences living organisms and, therefore, the magnets also do. Magnets and magnetic powder have been widely applied in treating various diseases. About 20 years ago Japanese scientist even suggested the idea of a so-called “Magnetic field deficiency syndrome”: they suppose that under modern day living conditions, the effect of the Earth’s magnetic field has decreased and this causes some abnormalities which can be treated by the external application of a magnetic field to the human body to supplement this deficiency.

Recently on TV and on the Internet we may have seen dozens of adverts of magnetic bracelets which are called “universal medicine” or “revolutionary panacea”. The manufacturers and retailers claim that magnets have positive effect on bloodstream and oxygenation, on the production of the body’s endorphins and that these piece of jewelry have many more positive effects. For us the most interesting has been the statement that the bracelets help to heal wounds by accelerating tissues regeneration.

Regeneration is the process of renewal, restoration, and growth that makes genomes, cells, organisms, and ecosystems resilient to natural fluctuations or events that cause disturbance or damage. Therefore, it is an important process in any living body helping to sustain life.

As today living beings are more and more often affected not only by the natural Earth’s magnetic field but also by those manmade ones, it seemed interesting enough to conduct an experiment and see how magnetic fields may influence this process. Moreover, we found it more important to observe if magnets of different strength have various impact or not.

The experiment is to be conducted on Planaria, which are often used as models for studying the process of regeneration.
Chapter 1. Theoretical input

In the first chapter we will make an attempt to introduce the theoretical basis for our practical research. To implement and assess correctly the results of the experiment which is to be conducted in course of the current project work it is essential to observe the following points:

- what magnetism is and its possible influence of living beings;
- general description of the process of regeneration;
- the anatomy of planaria which are subject to the experiment.

Magnetism and living beings

The effects of magnets and magnetic fields have been known for a very long time. Galen, a Greek physician around 200 BC, in his book, De Simplicium Medicamentorum Facultatibus, mentions the use of magnets. In 1000 A.D., a famous Persian physician described his findings using magnetism to relieve various disorders. In the early 1500s, the great medical doctor, Paracelsus, wrote several treatises on the use of magnets and magnetism. The observations of the magnetic influence have been continued throughout the following centuries.

There is no definite view of how magnetic field can influence the processes in a living organism. Thus, some have believed that magnets aids in healing wounds and other injuries by enhancing regeneration. For example, in the writings of Dr. Ambrose Pare, regarded as one of the top five physicians of all time, he described how physicians took lodestone, a natural magnet, ground it into fine powder, and mixed it with 'pappe' to be taken internally. The magnetic powder mixed with honey was applied to external openings, wounds, ruptures, and 'other forms' of human ailments.

One the other hand two of the greatest researchers into magnetic effects, Albert Roy Davis and Walter C. Rawls, in their book The Magnetic Effect and Magnetism and Its Effects on the Living System describe that the two magnet poles act
in different ways. In the experiment with animals suffering from cancer “it has been proven that the N pole, the magnetic negative energy of the two poles and their separate energies, has slowed, controlled and arrested further development of the active cancer site... When the S pole of a magnet, this being the positive energy of a magnet, is applied to cancers they become more advanced and then develop, grow and spread at an accelerated rate.”

The energies that flow from the different poles of a magnet are not homogeneous and, therefore, may really cause various effects. When those two act simultaneously, the outcome is different.

In our project work we want to observe the influence of magnetism of different strength on the process of regeneration on the example of planaria.

**Planaria: basic anatomy facts**

In this section we would like to introduce some general facts about planaria. A planarian is one of many non-parasitic flatworms of the Turbellaria class. They can be of different colour from black to white and of various size ranging from about 3mm to 12mm and 30cm to 2.54cm in length mostly. Talking about the habitat it may be noted that planaria can be found all over the world mainly in water, both salty and fresh, and some species are terrestrial and can live in or on the soil surface in humid places.

As for the anatomy these flatworms have an extremely simple organ system. The planarian has the rounded head on the dorsal side. At the head of planarian, there is chemosense organs and two, or sometimes more, eye-pots, ocelli that are groups of cells sensitive to the light.
The planarian has bilateral symmetrical body that can be divided into equal halves. It has no coelom (body cavity), but consists of three cell layers: ectoderm, endoderm, and mesoderm\(^1\).

The planarian must move to find the food. There are two ways for locomotion for eating, gliding (beating by cilia\(^2\)) and creeping (muscular activity).

It has a single-opening digestive system with one anterior branch and two posterior branches. The digestive system is composed of a mouth, pharynx, and the intestine. It feeds on the decayed and small animals, as it is zoophagous.

Planaria have no specific respiratory and circulatory organs. Because of its thin body, the oxygen and carbon dioxide exchanges occur by diffusion, through the skin. It has many tubes and pores for excretion.

The flatworm, planarian has different nervous system from other invertebrates, ladder-type nervous organ. There is a small brain and two nerve cords. The brain of planarian under eye-spots consists of two ganglia, clusters of nerve tissues. Also, it is joined by commissure. The nerve cords extend from the brain by many transverse commissures connecting.

The planarian is a hermaphroditic animal (has testicles and ovaries), so it can reproduce both asexually and sexually.

Planaria are often used in various biological and biomedical researches having important implication for human health as these worms have a number of cell types, tissues and simple organs that are homologous to our own cells, tissues and organs. Planaria are also an emerging model organism for aging research. Still one of the most peculiar features of these creatures attracting scientific interest is the process of regeneration. Scientists found out the stem cells called neoblasts help the planarian to regenerate its entire body.

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\(^1\) The ectoderm is outermost layer that helps the animal to move, but it also protects. The endoderm is the innermost layer that lines the digestive tract. The mesoderm between other layers developes many organs and systems.

\(^2\) Cilia is on the lateral and dorsal surface, but not head side.
Regeneration

Regeneration is an important biological process which enables renewal, restoration, and growth that makes genomes, cells, organisms, and ecosystems resilient to natural fluctuations or events that cause disturbance or damage. Every living being, from bacteria to humans, is capable of regeneration, which either can be either be complete where the new tissue is the same as the lost tissue, or incomplete where after the necrotic tissue comes fibrosis.

As it has already been stated in the previous section planaria have been a model for regeneration for a long time as they exhibit an extraordinary ability to regenerate lost body parts. For example, a planarian split lengthwise or crosswise will regenerate into two separate individuals. In one experiment, T. H. Morgan found that a piece corresponding to 1/279th of a planarian could successfully regenerate into a new worm. This size (about 10,000 cells) is typically accepted as the smallest fragment that can regrow into a new planarian. Regeneration of planaria is epimorphic regeneration. After amputation, stump cells form blastema.

The process of regeneration differs in different living organisms. For example, simple animals like planarians have an enhanced capacity to regenerate because the adults retain clusters of stem cells (neoblast) within their bodies that migrate to the parts that need healing. They then divide and differentiate to grow the missing tissue and organs back. Meanwhile, in vertebrates the process is more complex.

Chapter 2. Practical Experiment

Objectives

As it has already been stated in the corresponding section of the paper, there is no common opinion on the magnetism influence on the process of regeneration: one the one hand it is believed to be positive, on the other – negative. Moreover it
is important to find out if the strength of magnetic fields is relevant in this case or not.

Therefore, we decide to conduct our own experiment on the subject. Two main objectives of the practical research may be singled out:

1) To find out if magnetism has a certain effect on regeneration and if it does, to see if the effect is positive or negative.
2) To check if magnets with different strength have different impact on the process of regeneration.

For the experiments we used planaria worms as they often serve as a very good model to study about the process of regeneration.

**Materials and methods**

For the experiment we needed the following materials:

- 30 flatworms (known as Planaria)
- 6 Petri dishes
- Baking sheet
- Spring water
- Scalpel
- Ice
- 84 Neodymium magnets of the same dimensions, though 21 should have a low field strength (we chose № 40), another 21 should be a bit higher (№ 42), and 42 should have a very high field strength (№ 45).

The procedure of the experiment was as follows:

1) We divided the planaria into 6 groups, according to the following scheme:

<table>
<thead>
<tr>
<th>Group #</th>
<th>Condition</th>
<th>Magnet</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>bisected</td>
<td>no magnets</td>
</tr>
<tr>
<td>2</td>
<td>bisected</td>
<td>+ magnets, strength 1</td>
</tr>
<tr>
<td>3</td>
<td>bisected</td>
<td>+ magnets, strength 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>4</td>
<td>bisected</td>
<td>+ magnets, strength 3</td>
</tr>
<tr>
<td>5</td>
<td>untreated</td>
<td>no magnets</td>
</tr>
<tr>
<td>6</td>
<td>untreated</td>
<td>+ magnets, strength 3</td>
</tr>
</tbody>
</table>

Groups 1–4 will be bisected and exposed to various magnetic field intensities. Groups 5 and 6 will be unoperated controls. Group 5 is not exposed to an increased magnetic field; group 6 is exposed to the strongest magnetic field (strength 3).

2) 20 of the planaria were measured (we tried to put the species of the same size in one group to get more objective results) and cut in two halves, 10 being untreated as they are in two control groups (1 and 6).

3) When both the bisected and the control untreated planaria were put in the correspondingly numbered Petri dishes with fresh spring water, the dishes were placed on square metal plates and the magnets were put around the same pole up according to the scheme.

4) All the dishes were kept at the same temperature in a place not exposed to bright light. The bisected Planaria were not feed during the regeneration period as in the natural environment they are unlikely to feed during this time. The water in the dishes was changed practically every day to keep it clean.

5) Every day during the next 10 days of the experiment we observed the worms and measured them three times: on the first, the fifth and the tenth days.

6) Then we calculated the average results of growth for both segments, tails and heads, and compared the results.

**Results**

During the experiment we made three measurements: on the first day, on the fifth and on the tenth days.

Comparing the results of the three measurements conducted in course of the experiment (see Appendix, Table 1), we may observe the following:

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3 The sheet metal allows you to place the magnets closer together than you would on a non-magnetic surface, and also increases the magnetic field strength.
1) In control group 1 (bisected Planaria with no outside influence) the worms regenerated successfully and grew more than twice.

2) The results of group 2 (bisected Planaria with the magnets of strength 1) are inferior to those of group 1 in 1-2% in each case.

3) Group 3 (bisected Planaria under the influence of the magnets with strength 2) demonstrated the growth 7% worse than the control group.

4) In group 4 (bisected Planaria and the magnets of strength 3) the first growth measure on the fifth day is 15% smaller than the same of the control group and the second growth is 18% less.

5) In control group 5 (untreated Planaria with no outside influence) the rate of growth was quite high with the Planaria having grown more than twice (103% of the initial length).

6) As for the 6th group (untreated Planaria but surrounded by the magnets of strength 3) here we may observe much slower growth as compared with group 5. The length of the Planaria in group 6 has not doubled.

Conclusions

One basis of the obtained results described in the previous section and of the comparative analysis of the data, the following conclusions may be drawn:

1) Magnetism do influence the process of regeneration in Planaria, moreover, it also has impact on the process of growth.

2) The influence depends on the strength of a magnet.

3) In case of the weakest magnets, the results were a little bit worse if compared with the control group. However, we do not reject the fact that it can even have a positive impact on certain types of tissues as some scientific studies have proved.

4) The stronger the magnetic field is the more suppressive impact in has on the process of regeneration, thus, in our experiment the magnets with
strength 3 affected the regenerating Planaria more than the magnets with strength 2. Moreover, even the untreated Planaria (group 6) demonstrated the slower pace of growth as compared with the control group 5 as they had been under the influence of the strongest magnets.

The general conclusion is that increasing magnetism negatively impacts Planaria’s ability to regenerate and grow.

We suppose that the impact magnets have depends not only on their strength but also the type of the target cells of the living organism. Still, the strength also matters. Therefore, magnets of various strength having different effect on the process of regeneration may have different practical use. Coming back to the concept of magnetic bracelets, which actually inspired us to make the project, we may say with a certain degree of certainty, that they are 90% a commercial trick rather than a real help in wound healing.

Anyway, magnets might have a wider use in medicine if their influence is studied better.
References

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   http://www.exploratorium.edu/imagingstation/research/planaria/story_planaria.pdf
Table 1. The measurements of the planaria’s growth in mm (average numbers)

<table>
<thead>
<tr>
<th>Group #</th>
<th>Day 1</th>
<th>Day 5</th>
<th>Day 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (bisected control)</td>
<td>3.18</td>
<td>4.48 + 41%</td>
<td>6.52 + 105%</td>
</tr>
<tr>
<td>2 (bisected + strength 1)</td>
<td>3.20</td>
<td>4.49 + 40%</td>
<td>6.50 + 103%</td>
</tr>
<tr>
<td>3 (bisected + strength 2)</td>
<td>3.20</td>
<td>4.30 + 34%</td>
<td>6.35 + 98%</td>
</tr>
<tr>
<td>4 (bisected + strength 3)</td>
<td>2.21</td>
<td>4.05 + 26%</td>
<td>6.02 + 87%</td>
</tr>
<tr>
<td>5 (untreated control)</td>
<td>7.04</td>
<td>9.83.0 + 39%</td>
<td>14.33 + 103%</td>
</tr>
<tr>
<td>6 (untreated + strength 3)</td>
<td>7.00</td>
<td>8.85 + 26%</td>
<td>13.05 + 90%</td>
</tr>
</tbody>
</table>