Hong Kong Student Science Project Competition 2022

Template of Extended Abstract (Investigation)
(Word Limit: 1,000 words, Pages: 2 pages only)

Team Number: SBBC248

Project Title: Disco Bioreactors

Project Type: Investigation

To our best knowledge and after thorough literature research, as at 12 / 6 / 2022, there are / are no* similar works. If there are, the reference links are as below:

The enhancement our project has made for the existing related products or research is summarized as below:

*Please delete if not applicable. HKSSPC values the originality of works. Students must conduct literature research thoroughly to ensure that their works are unique, and to list relevant reference materials to complement the research or invention.

I. Background

Nowadays, the medical industry is under immense stress due to lack of organs for transplantation. 3D printing organs / lab-grown organs are seen as a remedy, while all branches of regenerative technology depend on one thing -- stem cells.

Planarians are known for their unique properties of regenerating body parts, this is due to the presence of large amounts of stem cells in them. Recent years, planarians are studied as an in vivo model of stem cell biology. Through observing their regeneration speed under exposure to colored light, we hope to have an insight into the biological effects of electromagnetic radiation, and hopefully, explore the possible applications of our findings.

II. Objectives

We experimented with planarians by placing them under IR (infrared), UV (ultraviolet), R (red), G (green), B (blue) LED light, illuminating them for a constant duration per day. By observing 2 biological changes of their body, eye growth and tail splitting, we tracked their growth progress. We aim to find out the effects of light on their regeneration rate.

III. Hypothesis

(1) Ultraviolet light will reduce growth.
As is a type of ionizing radiation, we hypothesize that its high energy will bring harm to the specimens.
(2) Infrared light will aid in growth.
There are infrared lamps on the market used for skin treatment, and some papers suggest that it can help with wound healing and tissue regeneration

Our hypothesis can be tested by comparing experimental groups to the growth rate of control groups, finding whether the light induces the same effects as what we proposed.

IV. Methodology

Materials)
For amputation: Iced trays, Small petri dish
During experiment: 5mm LEDs, Black box, Macro lens
Experiment Setup)
We place each specimen in its own container, which is covered by a black box to prevent external light from affecting the planarian. For the experimental groups, LED lights are attached to the top of the black box, illuminating the compartment. While for the control group, no LED lights are placed, since planarians are negatively phototactic, and live under the dark in their natural habitat.
Analysis)
Since the experimental stages last over a fairly long period, stage 1 to 4 are not conducted in the same seasons. To compensate for the effects of temperature / other environmental factors, we compare the effects of light with respect to the regeneration rate of the control group. And derive our conclusion from the quickening / meandering effects from analyzing each stage.

V. Results

Stage 1:

(3-hour illumination period)

	Infared			Ultraviolet			Red			Green			Blue			Control		
Day	IR1	IR2	IR3	UV1	UV2	UV3	R1	R2	R3	G1	G2	G3	B1	B2	B3	C1	C2	C3
4																		
5																		
6																		
...																		
31																		
33																		
56																		
65	End of stage																	

Slight eye growth | Full eye growth | 1st tail split

Stage 2:

(8-hour illumination period)

	Infared			Ultraviolet			Red			Green			Blue			Control		
Day	IR1	IR2	IR3	UV1	UV2	UV3	R1	R2	R3	G1	G2	G3	B1	B2	B3	C1	C2	C3
1																		
2																		
3																		
4																		
5																		
6																		
7																		
...																		
23																		
27																		
28																		
29																		
30																		
32																		
38																		
44																		
65	End of stage																	

Slight eye growth | Full eye growth | 1st tail split | 2nd tail split

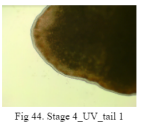
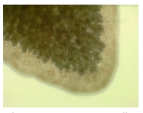
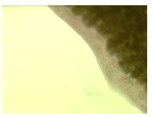
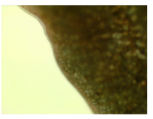
Stage 3:

(22-hour illumination period)

	Infared			Ultraviolet			Red			Green			Blue			Control		
Day	IR1	IR2	IR3	UV1	UV2	UV3	R1	R2	R3	G1	G2	G3	B1	B2	B3	C1	C2	C3
2																		
3																		
4																		
...																		
8																		
9																		
14																		
15																		
16																		
17																		
19																		
21																		
22																		
30																		
31																		
32																		
	End of stage																	

Slight eye growth | Full eye growth | 1st tail split | 2nd tail split

Stage 4:

Normal Specimen	UV Illuminated
 Fig 43. Stage 4_Non-UV_tail 1	 Fig 44. Stage 4_UV_tail 1
 Fig 45. Stage 4_Non-UV_tail 2	 Fig 46. Stage 4_UV_tail 2
 Fig 47. Stage 4_Non-UV_side	 Fig 48. Stage 4_UV_side

Limitations)

- Variations exist within organisms → Use a larger specimen size.
- Different colored LED light may give off different brightness → Perform light intensity compensation
- Manually amputated planarians are in different lengths → Use similar lengthed planarians and accurately bisect when cutting.

Importance)

Our findings can have implications on experiments/technology that involves regeneration.
For example:

- shortening the time for stem cell growth, to help people with low stem cell count to quicken their stem cell reproduction rates
- increase the efficiency of regenerative technology
- hasten the process of lab-grown organoids

VI. Conclusion

We found out that infrared light speeds up planarian regeneration rate, and ultraviolet light causes darkening in planarians. As this experiment aims to use planarian as an in vivo model, we expect similar results to be applicable to stem cells as well.

□ **Our project is developed based on our school's previous project and the enhancement is as below:**

This report is a continuum of our project from last year. Enhancements made include conducting Stage 3 and Stage 4 experiments, reorganizing data from all stages, then driving to an updated conclusion. As well as making improvements to our literature review by adding on information regarding pigmentation in planarians, to complement our finding in Stage 4.