Marine Sponges as a Model for Cellular Recognition

Author: Michaelle Exhume

Freeport High School

Mr. Ed Irwin

Harlem Children Society

Dr. Sat Bhattacharya

July 21, 2006

Introduction

Marine sponges are the oldest and simplest multi-cellular animals on earth, having originated over a billion year ago. Because of its simplicity, this creature has become a useful tool for medical researchers attempting to unravel the mechanisms of the human immune system. Sponges grow in clusters from rocks on the ocean floor; they do not form true tissues, and lack muscles, nerves and internal organs. They consist of cells, which organize themselves into a series of filters used to strain nutrients from their aquatic environment. The marine sponge is a useful model for the human immune system because it illustrates the functions of membrane receptors at the cellular level. It has been shown that when some species of sponges are dissociated in a seawater solution, they soon clump together in an attempt to reform the original sponge structure. However when cells of two different species are mixed, they aggregate in a species-specific manner. Sponges are able to distinguish between "self" and "non-self", a capability, which is the central feature of the immune system. The immune system is the system of specialized cells and organs that protect an organism from outside biological influences. (Though in a broad sense, almost every organ has a protective function - for example, the tight seal of the

skin or the acidic environment of the stomach.) When the immune system is functioning properly, it protects the body against bacteria and viral infections, destroying cancer cells and foreign substances. If the immune system weakens, its ability to defend the body also weakens, allowing pathogens, including viruses that cause common colds and flu, to grow and flourish in the body. The immune system also performs surveillance of tumor cells, and immune suppression has been reported to increase the risk of certain types of cancer.

One of the most important properties required to maintain life of a living organism is the ability to react to external stimuli. Sense organs are specialized for this task. The essential element of these organs is the receptor cell; each is specialized to respond primarily to one particular type of stimulus.

Abstract

This project has shown that when specific species of sponges are dissociated in a seawaost every organ has a protective function - for example, the tight seal of the skin or the acidic environment of the stomach.) When the immune system is functioning properly, it protects the body against bacteria and viral infections, destroying cancer cells and

foreign substances. If the immune system weakens, its ability to defend the body also weakens, allowing pathogens, including viruses that cause common colds and flu, to grow and flourish in the body. The immune system also performs surveillance of tumor cells, and immune suppression has been reported to increase the risk of certain types of cancer.

One of the most important properties required to maintain life of a living organism is the ability to react to external stimuli. Sense organs are specialized for this task. The essential element of these organs is the receptor cell; each is specialized to respond primarily to one particular type of stimulus.

Abstract

This project has shown that when specific species of sponges are dissociated in a seawater solution, they soon clumped together in an attempt to reform the original sponge structure. However when cells of two different species were mixed, they aggregated in a species specific manner. Sponges are able to distinguish between "self" and "non-self", a capability which is the central feature of the immune system.

Hypothesis

Initially it was assumed that the yellow sponge (Cleona celata) and the red sponge (Microciona porifera) would both aggregate, not recognizing their own species.

After analyzing the first series of experiments, it was then postulated that the red sponge uses a mechanism to recognize its own cells in an attempt to reform the original organism.

Materials

1. Petri dish
2. Sponges – Microciona Porifera and Cliona Celata
3. Centrifuge tube
4. Tissue sieve
5. Lumbriculus Worms
6. Salt water

Procedure

Experiment I

Step 1:

A piece of Microciona Porifera and Cliona Celata was placed in a Petri dish and crushed through a screen tissue sieve.

Step 2:

The resultants were than place in a Petri dish divided into 3.

Dish 1- Microciona Porifera alone

Dish 2- Cliona Celata alone

Dish 3-Cliona Celata and Microciona Porifera mixed

Experiment II

Both sponges were placed in a Petri dish and dissociated through a screen tissue sieve.

The resulting liquid was than placed in a 4 part Petri dish as follows:

Dish 1 – Microciona Porifera

Dish 2 – Cliona Celata

Dish 3 – Microciona Porifera and Cliona Celata

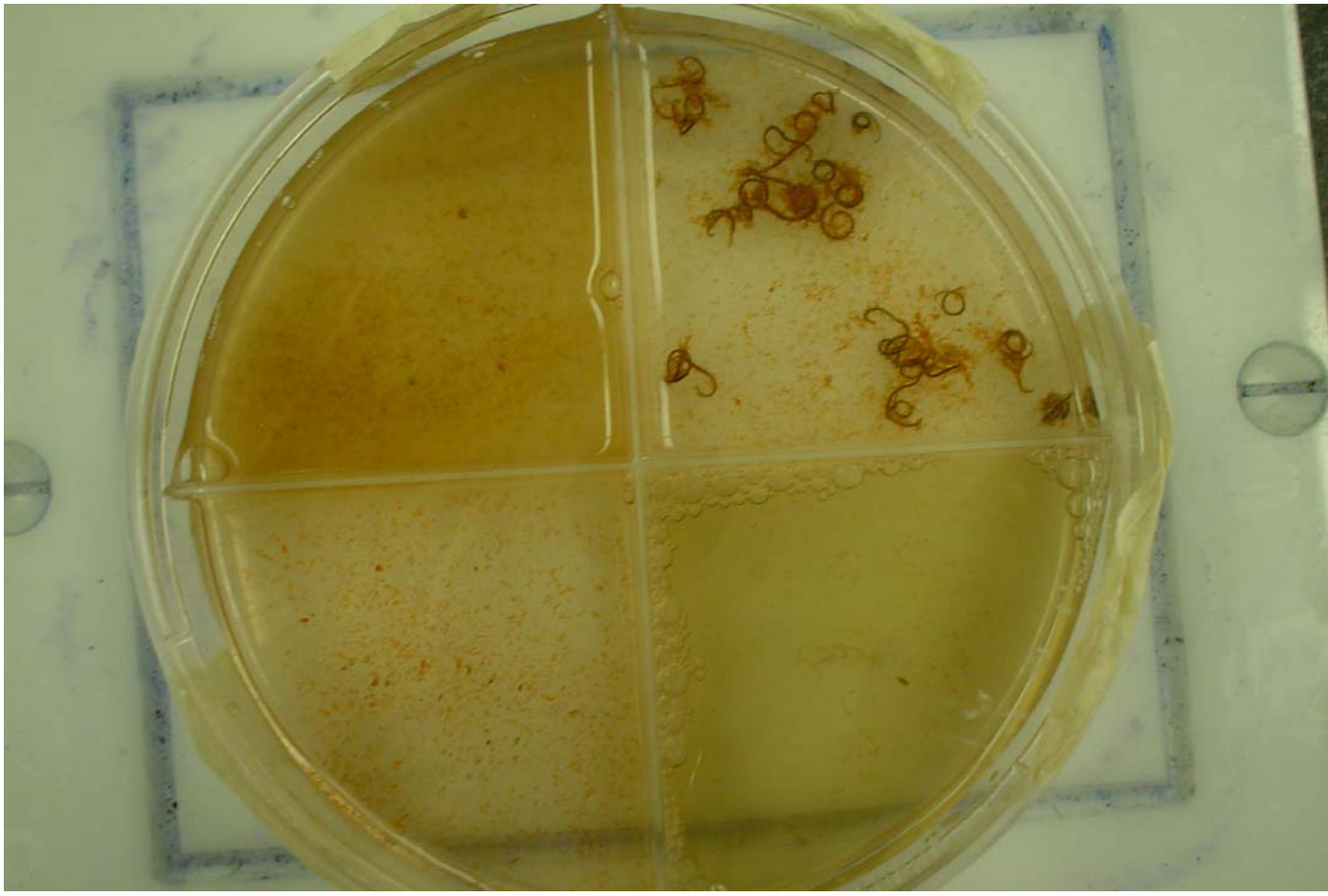
Dish 4 – Microciona Porifera and an extract of Cliona Celata

The sizes of the aggregates were then followed on a day-to-day basis. (each experiment were repeated about six times)

***As a second source of evidence for cellular recognition, we used lumbriculus regenerating worms to see if it would have an effect on cell reaggretion. The same procedure used to dissociate the sponges was followed in this fraction of the experiment. *

Results

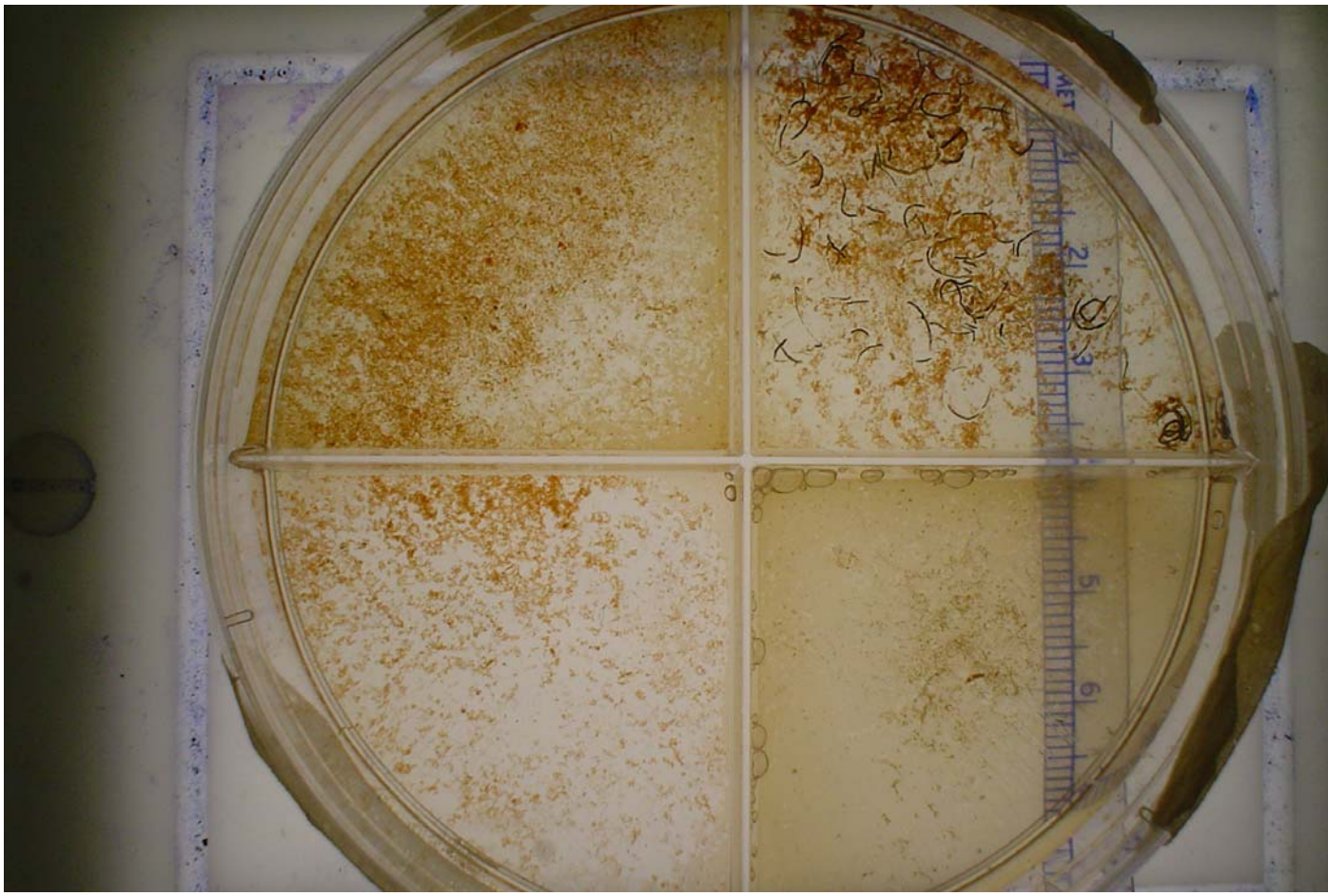
Day 0 - red sponge red and Lumbriculus worms



Yellow mix Yellow alone

(Day 0 – day cells were dissociated and placed in Petri dish)

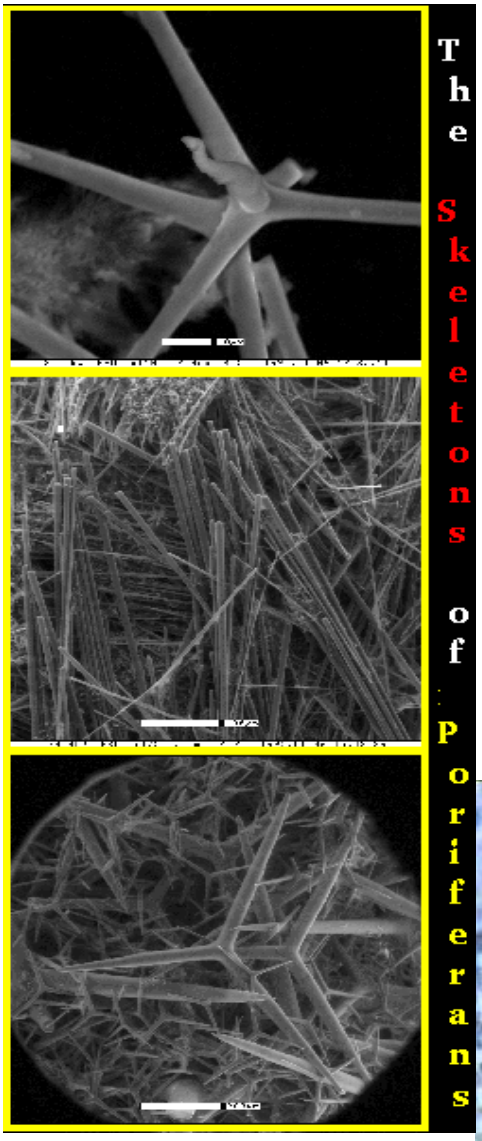
Day 5 – Red sponge Red sponge and lumbriculus worms



Red and yellow mixture yellow sponge

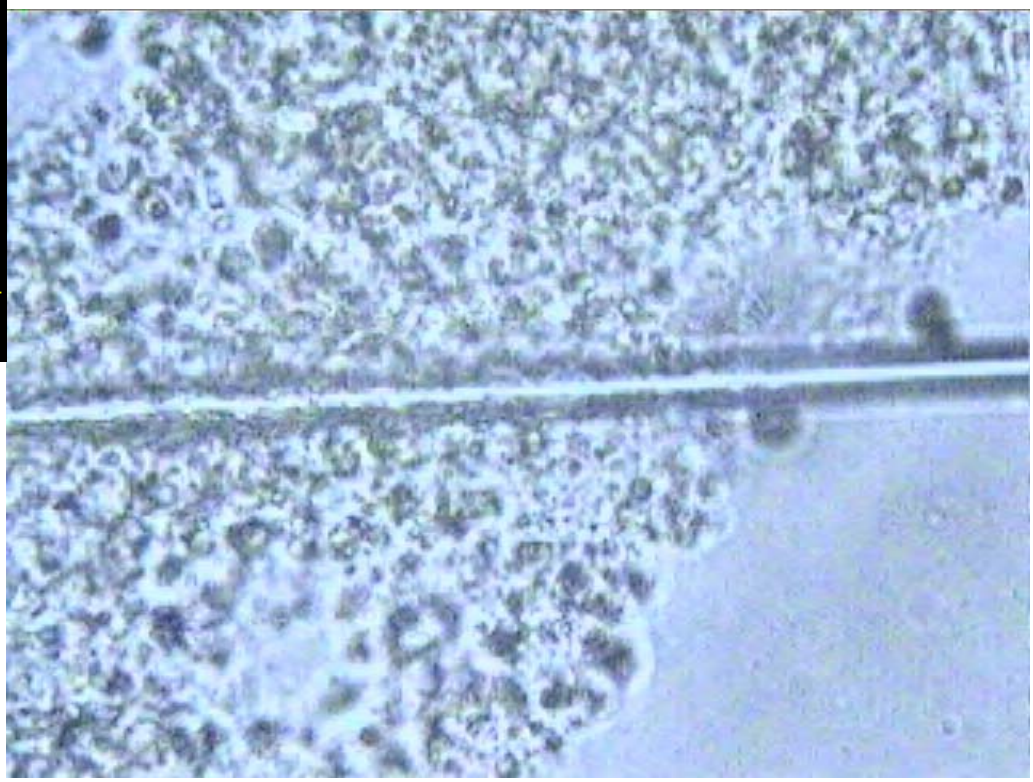
(Day 5 – 5 days after cells were dissociated)

***These pictures indicate that the cells of microciona porifera clump in an attempt to reform the original structure. Thus, indicating its ability to recognize self. ***



Sponge Skeleton

http://www.geocities.com/sciencejanetc/7th_8th_grade/animal_kingdom/sponges.html



(View of cell clump under digital microscope, after several weeks)

This picture shows evidence of the sponge skeleton reforming.

Discussion

According to the results of the experiment, marine sponges can be used to study the functions of the immune system. Preliminary results suggest that the "cell-to-cell" recognition system of the marine sponge, Microciona porifera, is similar to antigen antibody recognition, in that cell-surface proteins are involved. When whole sponge cells are mixed, aggregation occurred only between the Microciona cells, indicating its ability to recognize self.

Conclusion

Preliminary results suggest that a factor isolated from the yellow sponge, Cliona Celata enables the cells of the red sponge, Mircrociona Porifera to reaggregate further.

Future Work

In the future, more experiments will be conducted using the red and yellow sponge with a purpose of trying to figure out the factor in the yellow sponge that allows the red sponge to reaggregate.

Then, PAS stain will be used to identify proteins.

Bibliography

1. Jamie Talan (Staff Writer) Receptors" Cellular signposts tell tissue its job", Newsday August 4, 2006

2. Journal of Morphology, The fine structure of muocytes in the sponges Microciona prolifera (Ellis and Solander) and Tedania ignis (Duchassaing and Michelotti), Volume 118, Issue 2, Pages 167-181, Published online: 6 Feb 2005

3. J.Biol. "Two cell surface proteins bind the sponge Microciona prolifera aggregation factor" Chem., Vol. 263, Issue 17, 8498-8508, June 1988

4. S, Yum N. kojima, S.-i. Hakomori, S. Kudo, S.Inoue, and Y. Inoue, Binding of rainbow trout is mediated by strong carohydrate-to-carbohydrate interaction between (KDN) GM3 (deaminated neuraminyl ganglioside) and Gg3-like epitope PNAS, March 5, 2002; 99(5): 2854 – 2859.

5. Introduction to Porifera

6. HYPERLINK "http://webmit.edu/esgbio/www/cb/membranes/gf.html" \t "_parent"
7. http://webmit.edu/esgbio/www/cb/membranes/gf.html
8. http://www.ucmp.berkeley.edu/porifera/porifera.html
9. Genevieve Thiers “What is chitin?” - © 2002 Pagewise
10. HYPERLINK "http://wywy.essortment.com/whatischitin_rkkh.htm" \t "_parent"
11. http://wywy.essortment.com/whatischitin_rkkh.htm
12. HYPERLINK "http://webmit.edu/esgbio/www/cb/membranes/gf.html" \t "_parent"

Acknowledgements

Mr. Edward Irwin

Patty Els

ETL

Carlos Strauss

Freeport High School

Juan Cuba

Ricardo Cuba

Dr. Sat Bhattacharya

The Harlem Children Society