Pharmaceutical Uses of Aquatic Organisms

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- Aquatic biotechnology is an emerging field encompassing marine biomedicine (new pharmaceuticals discovery), materials technology, bioremediation, marine biomedical model organisms, molecular genetics, genomics, bioinformatics and much more. The fundamental enthusiasm for this discipline is clearly derived from the enormous biodiversity and genetic uniqueness of life in the sea. Thirty-four of the 36 fundamental Phyla of eukaryotes are found in the world's oceans. Many of these life forms, such as those that reside in the deep oceans, are poorly known. Aquatic biotechnology still in its infancy, is likely to change how we look at global biodiversity.

Background to Aquatic Biotechnology Activities

Depends on aquatic biodiversity in different aquatic habitats.

(deep sea, coastal areas, lakes, ponds…etc….).

Aquatic Biotechnology is closely related to resource utilization.

(eg. aquaculture industry needs urgently new feed formulation, disease prevention methods).

This can be achieved through understanding the molecular biology of the disease, fish resistant mechanisms and understanding lipid and protein metabolism.

The most common Biotech activities are:

1. Biodiscovery or BioProspective Initiatives: i.e. programs or projects which support the search for useful compounds from extract of marine organism (e.g. Drugs, enzymes) (Australia, Japan and Germany).

2. Genomics of Aquaculture Species: research to understand the genetic metabolism of farmed stock so as to improve healthcare, reproduction, yield or other traits (France, Australia and Norway).

3. Genomics of Wild Species: research to understand the population dynamics, migration patterns, and distribution of wild species, and also to provide genetic markers to prevent poaching, validate product description of fish, etc…

4. Food Safety: research to detect shellfish and fish-borne human pathogens and other hazards (eg. Metal Bioaccumulation) and to develop methods to prevent their occurrence (USA and Australia).

5. Environmental Research: research to understand aquatic ecosystems and to develop diagnostics which can be used to monitor environmental quality , production capacity and their safety for fish and humans (USA and Australia).

The above themes are locally refined to suit national expertise, economic needs and aquatic habitat.

Chemicals in the oceans

- 60 % of potentially useful chemical compounds were discovered from marine animals

- 70 % of those were from sponges

- Almost all of the chemical compounds are SECONDARY METABOLITES,

What are Secondary Metabolites?

- Natural products of metabolism
- Chemical compounds
- Not essential for normal growth, development or reproduction

Functions of secondary metabolites

- Defense against predators
- Inter specific competition
- To facilitate the reproductive processes

So why are Marine Environments a Good Place to Find new Drugs ?

- There is a large diversity of organisms.
- There are many chemical reactions from metabolic processes.
- Marine organisms produce different compounds than terrestrial Organisms.

What is Stopping Them From Making These Miracle Drugs ?

- It is often hard to find the compound to initially identify.

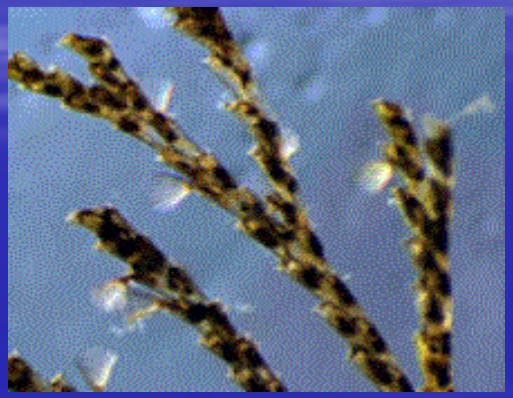
- We then have to produce the active substance, which is often a manipulated form of the original substance.

- We have to continue to harvest the animal, raise the animal or find a way to produce a synthetic copy

What Kind of Illnesses Do These Substances Treat?

- Malaria
- AIDS
- Allergies
- Herpes simplex I and II and Herpes Zoster
- Cancers- melanomas, lung, colon, breast, ovarian, renal, leukemia and non-Hodgkin's lymphoma.

Bugula neritina



- Bryozoans
- They produce macrolactones called bryostatins.
- They live in Temperate waters around the world.
- There are bryozoan farms off the coast of California

What Are Bryostatins?

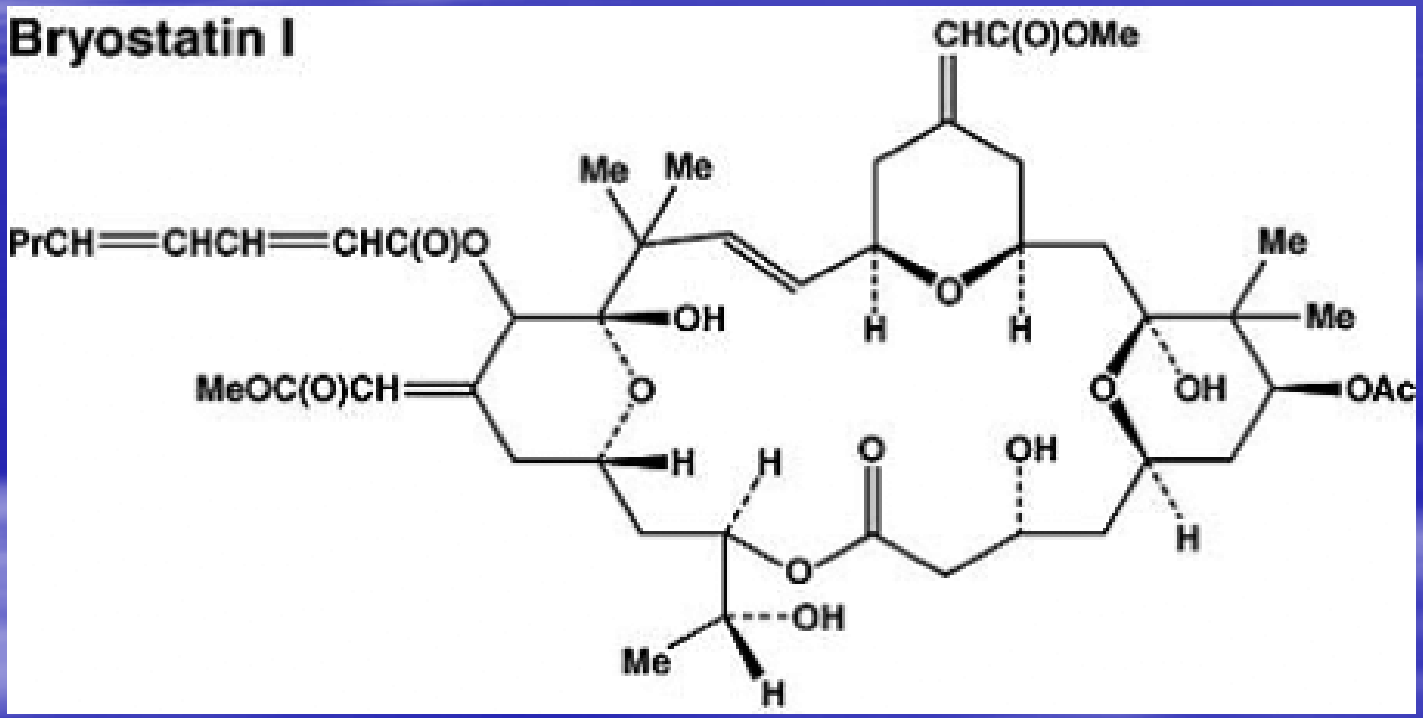
- They prevent the growth of tumors.

- They are competitive inhibitors acting on the same active sites as phorbol esters.

- Phorbol esters promote the first stage of tumors.

- If the bryostatins binds instead of the phorbol esters then the first stage of tumor formation is not promoted in the proteins.

This is what bryostatin Looks Like



What are phorbol esters?

- Esters are an acid and an alcohol combined by dehydration synthesis.

- Phorbol alcohol is a cancer causing agent (carcinogen)

Testing.

- More than 40 clinical studies have been done in the USA.
- 75% of patients showed improvement.
- They have relatively low side effects.
- The frequency and quantity of dosage are currently being tested.

Problems

- It takes 14 tones of *Bugula neritina to produce 1 ounce of* Bryostatin.

- If it is approved, the small supply would translate into a high price for the consumer.

Possible Solutions.

- Produce synthetic bryostatins.

- Remove segments of the molecule that do not inhibit Tumors to decrease production time,

- Use gene splicing to incorporate into bacteria genomes.

- Cultivate large masses of these bacteria to produce mass quantities of bryostatins.

What Are Arabinosides?

- They are nucleosides
(nucleotides without the phosphate group).

- They are composed of the sugar arabinose and a nitrogenous Base.

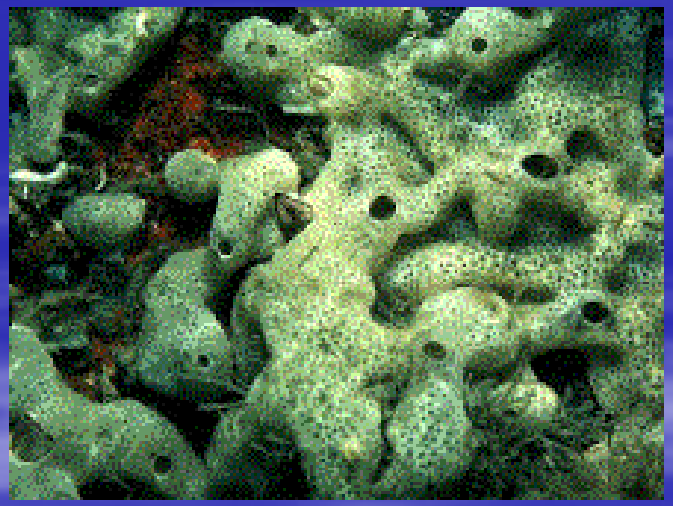
- They inhibit viral replication.

Cryptotethya crypta

- Sponge.
- Produces Arabinosides.
- Adenosine Arabinoside (Ara A) is used as antiviral medication.
- These medications are used mostly to treat Herpes.
- 50 million US $ are the annual sales of medications that include Ara A.

Tridemnin cyanophorum

- Tunicates or sea squirts.
- Filter feeder
- Poisonous for human consumption
- Produce Didemnin B.



Tridemnin cereum

What Is Didemnin B?

- It is a peptide.
- They are inhibitors of RNA, DNA and protein synthesis.
- They stop the formation of cancerous cells.

Pseudoperogorgia elisabehae

- Sponge
- Lives in the Caribbean sea.
- Resilience R is a drug that contains extracts from the sponge
- It is a skin cream for rashes.