

MARINE AND OCEAN CHEMISTRY

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Read the details of the information provided below from the sources recommended as a reference.

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PLAN – CONTENT – REFERENCES

1. Introduction
2. The water in seawater
3. Salinity, chlorinity, conductivity, and density
4. Major constituents of seawater
5. Simple gases
6. Salts in solution
7. Carbon dioxide
8. Nutrients
9. Trace metals and other minor elements
10. Chemical extraction of useful substances from the sea

References:

1. An Introduction to the Chemistry of the Sea, Michael E. Q. Pilson
2. Marine Chemistry & Geochemistry, John H. Steele et al.
3. Chemistry in the Marine Environment, R. E. Hester and R. M. Harrison
4. Marine Chemistry, P. J. Wangersky

CHEMICAL EXTRACTION OF USEFUL SUBSTANCES FROM THE SEA

(Pharmaceuticals from the sea)

1. Introduction
2. Opportunities in the oceans
3. Challenges involved in developing a 'drug from the sea'
4. Success stories

- There are a large number of life-threatening or chronically debilitating human diseases such as solid tumor cancers, AIDS, antibiotic-resistant microbial infections, asthma, and diabetes that urgently require improved medical treatments. Drug therapy represents one well-established and still attractive approach to treating these serious diseases.
- In order for the chemotherapeutic approach to be more effective, there is a pressing need to discover and develop new drugs that act against cancer cells, viruses, microbial pathogens, and other molecular disease targets by novel biochemical mechanisms and have diminished side effects.
- Secondary metabolites produced by the plants, animals, and microorganisms living in the world's oceans represent a vast and relatively unexplored resource of structurally diverse low molecular weight organic molecules that are ideal raw materials for the development of new drugs.

OPPORTUNITIES IN THE OCEANS

- Secondary metabolites (natural products) are so named because they are apparently not essential for the primary metabolic activities involved in the growth of the producing organism.

- Greater than 70% of the Earth's surface is covered by oceans. The oceans are much bigger volumetrically than inhabitable land surfaces so they provide much more space in which organisms can live and diversify.
- The thermal buffering capacity of seawater means that ocean temperatures are very stable in comparison to those of freshwater and terrestrial environments.
- Furthermore, the ions that contribute to the total salinity of seawater are in nearly the same proportions throughout the oceans and their total concentrations in seawater are very similar to their concentrations in physiological fluids, minimizing problems of osmoregulation and ionic regulation.
- The very stable physical and chemical environment in the oceans, the wide range of habitats and the ready availability of nutrients have been major factors in the development of the high biodiversity found in the marine environment.

- **Red algae**
- **Dinoflagellates**
- **Marine sponges**

CHALLENGES INVOLVED IN DEVELOPING A 'DRUG FROM THE SEA'

- The process of developing any new drug is a lengthy and very costly business. The failure rate is also enormous. In the initial stages, thousands of chemical entities are evaluated to find one or more 'lead' compounds that merit extra evaluation and only a very small percentage of these 'lead' compounds ever make it into the clinic.

1. The first step in discovering a marine natural product 'lead' compound involves accumulating collections of the source organisms.

2. Once extracts have been obtained, they have to be screened for bioactivity and the chemical structures of the active constituents have to be elucidated. Contemporary drug scanning programs have been designed to speed up the process of identifying 'lead' structures in an attempt to shorten the timeline for drug development.

3. After a bioactive marine natural product 'lead' structure has been identified, the issues of short-term small-scale and long-term manufacturing-scale supply become the determining factors in its further progress towards development.

4. Moving a promising marine natural product from the demonstration of *in vivo* activity in secondary assays to a genuine drug development project is a major step because of the required commitment of both financial and human resources.

SUCCESS STORIES

- The number of marine natural product derived drugs currently in clinical use is still very small; however, there are many promising marine natural products or synthetic analogs in clinical or pre-clinical trials, so the expectation that new drugs based on marine natural products will appear in the clinic in the next few years is genuine.

- Nearly four decades of marine natural products chemistry investigations have demonstrated that organisms living in the world's oceans are an incredibly rich storehouse of novel low molecular weight chemical entities.
- A large number of very promising compounds from the marine natural products chemical pool are currently in the pre-clinical and clinical stages of development, leading to the clear expectation that new pharmaceuticals from the sea will emerge for clinical use in the next decade.

There is certainly much more to learn and we wonder if there are more real surprises yet waiting.