# Innovative Marine Research

## Marine Resources and their Concealed Significance

Enhancing Ocean Governance in the Caribbean Region Symposium

**Enhancing Ocean Governance In the Caribbean Region**
**June 29 – 30, 2017**

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**Marine Sciences, UTT**

# Typical Marine Resource Focus - Macro

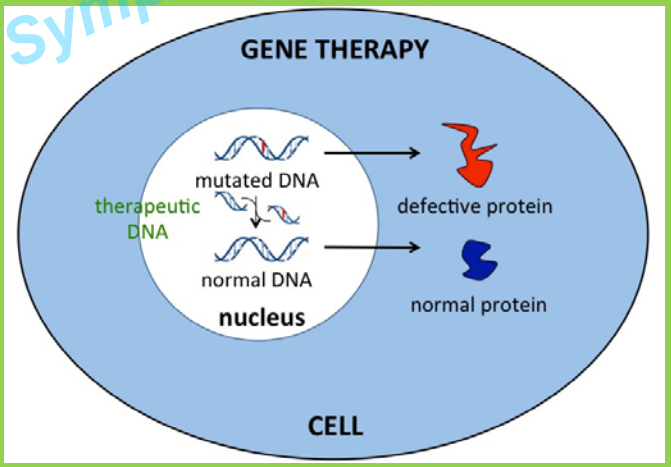
- **Fisheries**
  - e.g. shrimp, kingfish, conch
- **Habitat and Flagship spp.**
  - e.g. mangroves, sea grasses, coral reefs, Leatherback turtles, dolphins, whales
- **Boundaries / Management**
  - E.g. geopolitical, MPAs, IMSPs, ICZM
- **Energy**
  - oil and gas exploration and production
- **Environmental health**
  - climate change, pollution, invasive spp., ocean acidification
- **International Trade**
  - E.g. shipping, illegal drugs

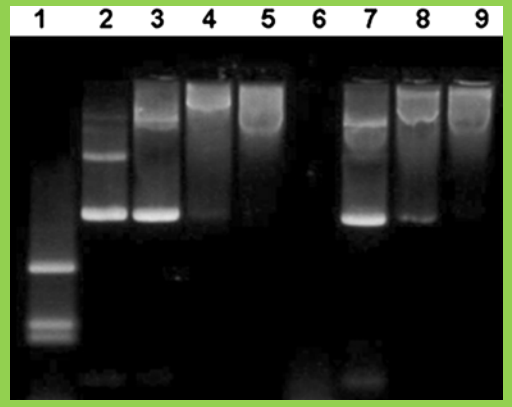
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# ‘Micro’ attention in Caribbeean Marine Resources

- **Environmental and aquatic**
  - Aquaculture, bioremediation
- **Agriculture biotechnology**
  - Transgenic crops/animals, DNA tracking
- **Detection**
  - Forensics, DNA fingerprinting, Disease
- **Pharmaceuticals and health care**
  - Gene therapy, fermentation technology, Biopharma
- **Drug development**
- **Regulatory approval/ Oversight**
  - FDA, EPA, USDA, OSHA








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# Marine bioprospecting



... is the collection of biological material and the analysis of its material properties, or its molecular, biochemical or genetic content, for the purpose of developing a commercial product.
(MED 1999)

- The discovery and commercialization of *new* products from biological sources



- Marine invertebrates the most important source




- Large number of new natural products (NP) displaying bioactivity

- Few NPs successfully reach the end of drug discovery

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# Bone grafting



- 2nd most common medical transplant after blood transfusions
- Coral structure similar to human bone (hard outer, spongy inner)
- *Porites, Avleopora, Acropora, Goniopora*

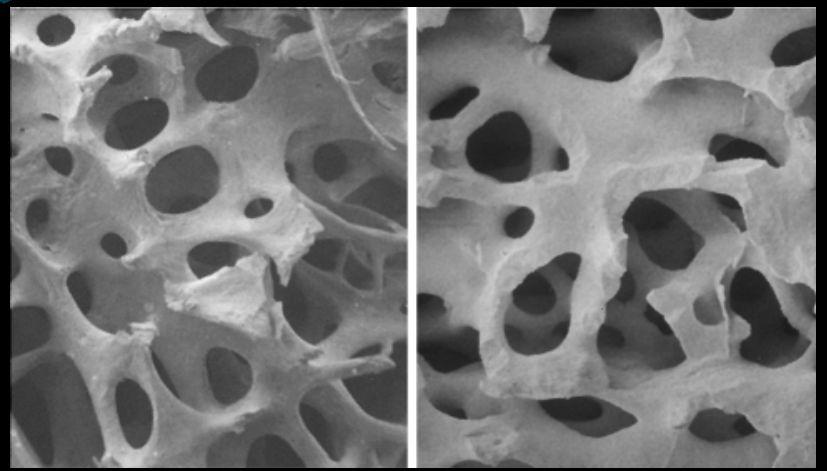
- Porosity
- Interconnectivity
- Pore size
- Mechanical strength

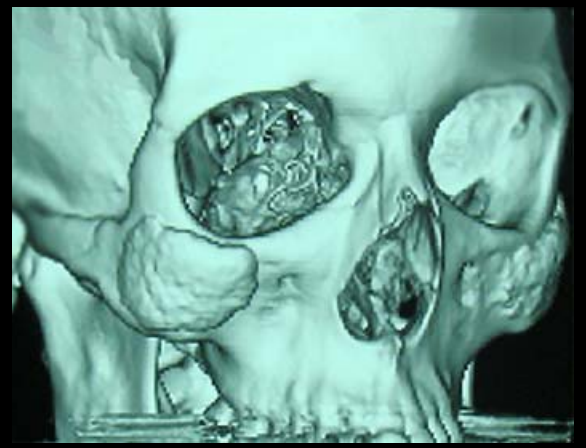
Nather 2005

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*Mendelson et al. 2010*

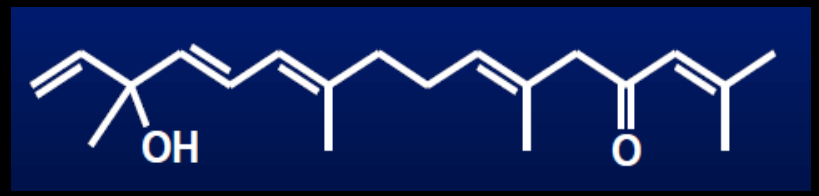
Coral





Human facial bone

# Sponges at Various Depths – Early research




< 33m = antitumor activity




33m <x< 66m = antitumor activity




> 66m = antiviral activity HSV-1



*Myrmekioderma rea*

Mangrove tunicate
*Ecteinascidia turbinata*

**Sarcosoma activity**



*Sennett et. al., 1992*
*Kashman et. al., 1987*

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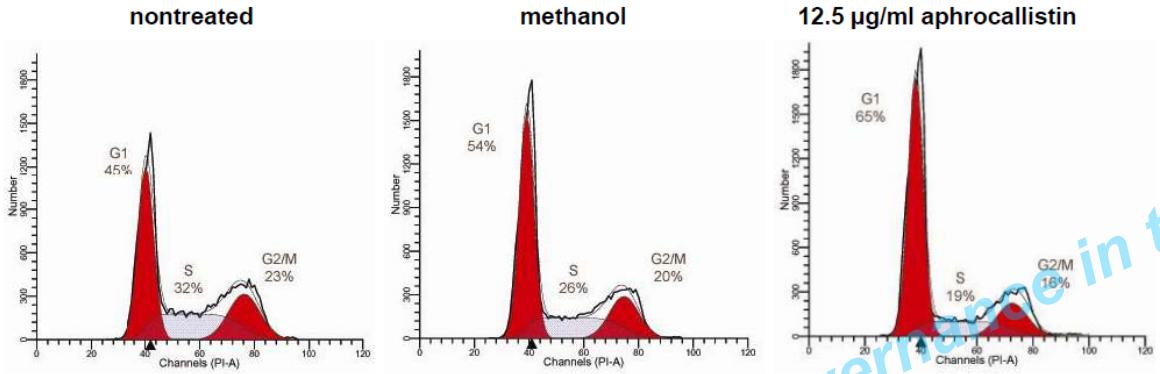
# *Aphrocallistin* Sponge

(Wright et al 2009)



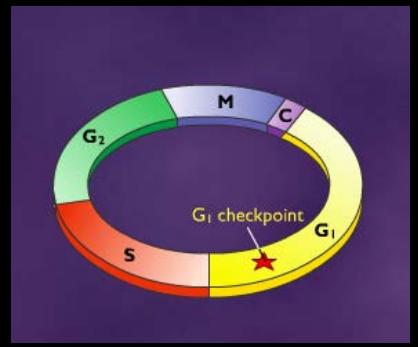
***Cell Cycle Analysis—Aphrocallistin***

*Panc-1 cells; 24 hour treatment*




Aphrocallistin induces a G1 block in the cell cycle

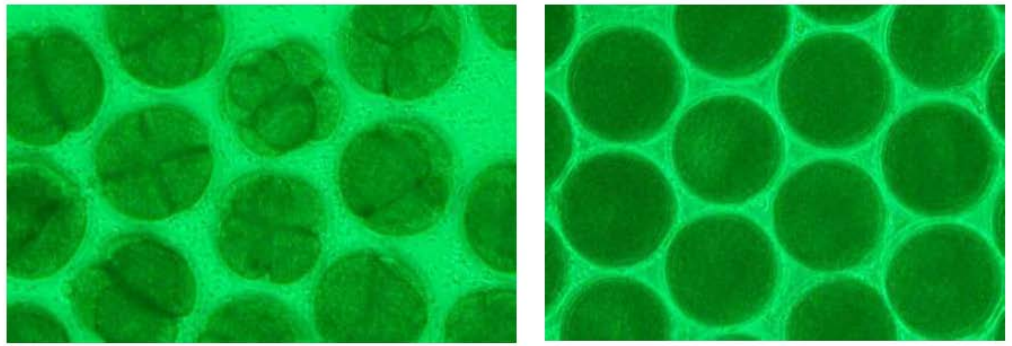
**Suppresses cell growth**




**CELL CYCLE**

## The Sea Urchin Embryo Assay

1.5 hours post fertilization



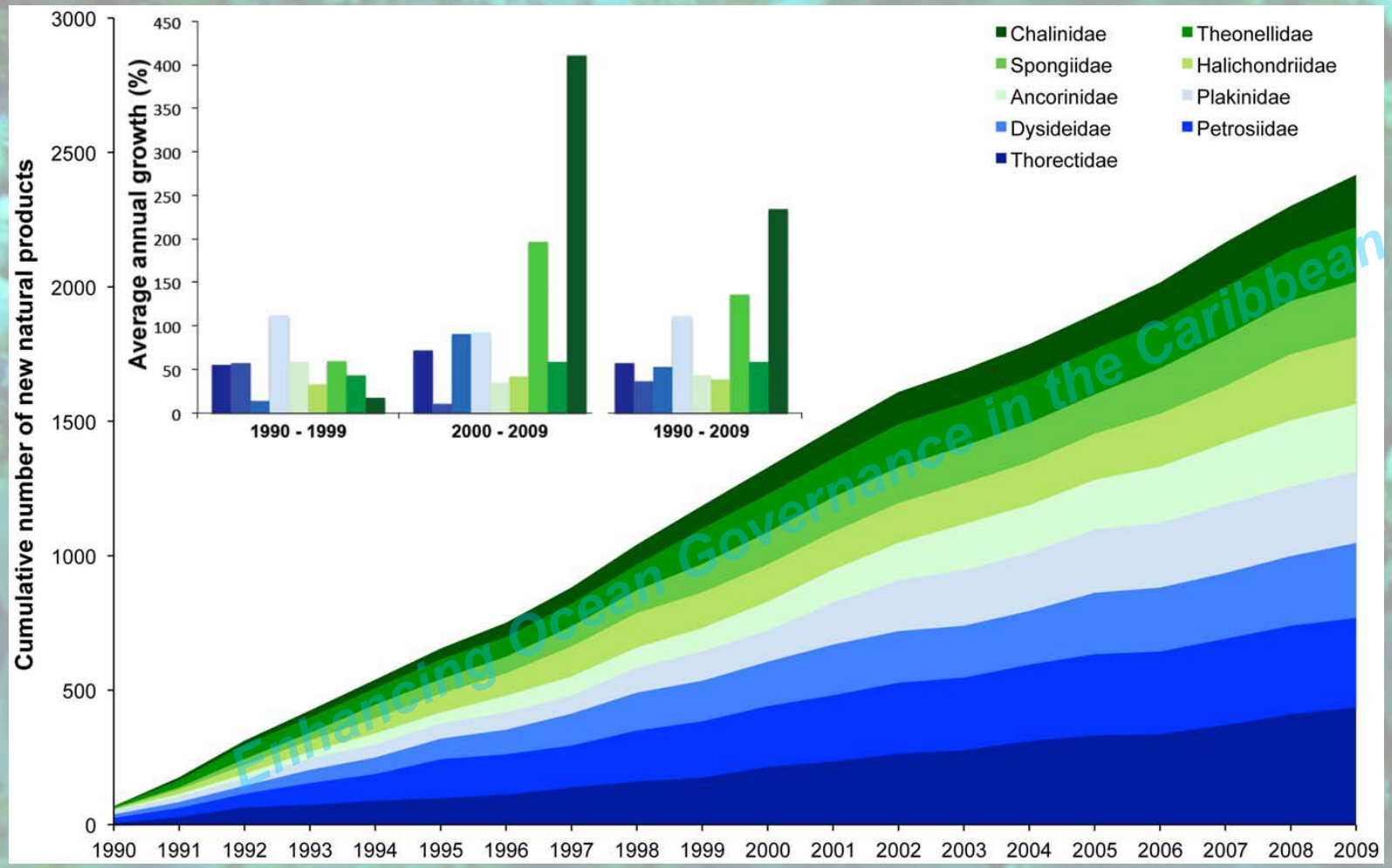
Vehicle control
Embryos at 4-8 cell stage

Treated with antimitotic agent
Cell Division arrested

Rapid assay that detects compounds which block cell division

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# New natural products from Phylum Porifera




*(Leal et al., 2012)*

- >280 sponges in Caribbean
  (Reed and Pomponi 1997)
- NW Trinidad thermoclines …. potentially lucrative area?

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**Table 1.** Percentage (%) of new marine natural products from invertebrate sources considering the different chemical groups and corresponding phyla.

| Phyla | Terpenoids (%) | Alkaloids (%) | Aliphatic (%) | Steroids (%) | Carbohydrates (%) | Amino acids and peptides (%) |
|---|---|---|---|---|---|---|
| Porifera | 30.0 | 30.9 | 12.0 | 6.5 | 4.9 | 8.1 |
| Cnidaria | 65.9 | 10.1 | 7.7 | 8.9 | 6.1 | 0.4 |
| Echinodermata | 10.5 | 10.7 | 35.8 | 14.3 | 20.7 | 0.8 |
| Chordata | 23.0 | 39.4 | 16.1 | 2.8 | 4.4 | 7.9 |
| Mollusca | 42.6 | 12.5 | 19.0 | 1.1 | 3.0 | 17.1 |

Note: Only 99% of the phyla providing new natural products discovered between 2000 and 2009 and chemical groups representing 95% of new natural products are displayed.

NB Chordata = vertebrate (tunicates)

- **1° source**
  - Porifera (47.1%)
  - Cnidaria (33.5%)

Sponges
- *Plakortis*
- *Dysidea*
- *Haliclona*
- *Petrosia*
- *Xestospongia*
- *Theonella*
- *Pseudoceratina*

Soft corals
- *Sinularia*
- *Briareum*
- *Pseudopterogorgia*
- *Sarcophyton*
- *Nephthea*
- *Clavularia*

Sea slugs and sea snails possess very potent venoms which are commonly peptide-based

*Leal et al. 2012*

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| Role | Function |
|---|---|
| Antimicrobial | e.g. cephalosporins used as antibiotic |
| Antiviral | Ara-A (herpes)<br>HIV |
| Anticancer | e.g. Bryostatins<br>Leukaemia patients<br>Tumours<br>Melanoma<br>Colon, breast, lung cancer |
| Anti-inflammatory | e.g. topsentin<br>Arthritis<br>Skin irritations<br>(NB treatment for Alzheimer's, colon cancer) |
| Antiparasitic | Vermifuge (round worm, whip worm, tape worm) |
| Antimalarial | e.g. kalihinane diterpenoids |
| Analgesic | e.g. Prialt, treat pain |
| Bone grafting | 2nd most common medical transplant after blood transfusions<br>Coral structure similar to human bone (hard outer, spongy inner)<br>*Porites, Avleopora, Acropora, Goniopora* |

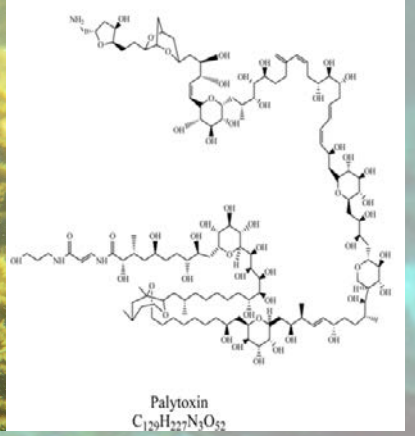
*Murti & Agrawal, 2010*



- **Merck** Pharmaceutical R&D (Costa Rica)
- **MSK** Pharmaceutical Research base (Guatemala)
- Estimated avg. cost for one drug… **US$ 800 million**

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| LC 50 (µg/mL) | Toxicity level |
|---|---|
| < 80 | highly toxic |
| 80 - 250 | moderately toxic |
| > 250 | Mildly toxic or non-toxic. |

# Palytoxins

- *Playthoa caribaeorum* considered as a bio-indicator of nutrient pollution

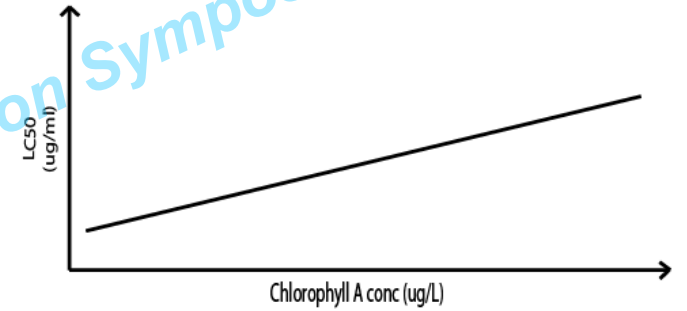
- Extract of palytoxin is one of the most potent non-proteinaceous marine toxin known to man thus far (Moore et al., 1982; Haywick and Mueller, 1997)
  - Inhalation, dermal contact
  - Ruptures blood cells, affects $Na^+/K^+$ pumps
  - abdominal cramps, nausea, vomiting, diarrhea, paresthesia, bradycardia, renal failure, cyanosis and respiratory distress
  - Anaphylactic shock, death

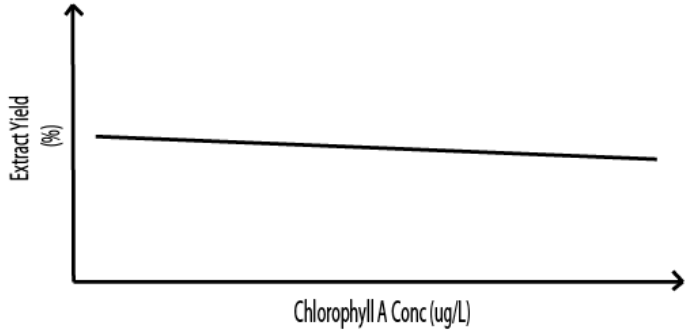
- *Palythoa caribaeorum* in Brazil which resulted in an $LC_{50}$ range between 80-250 µg/mL (Dolabela (1997)

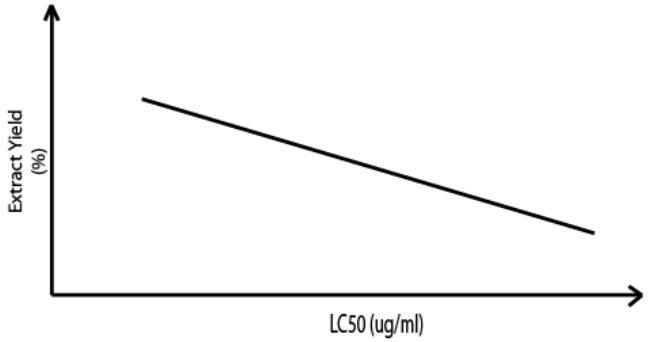
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# Toxicity of Palytoxins from *Palythoa caribaeorum* found in Trinidad and Tobago Ackbarali & Guppy (in preparation)

- 4 sites, chl a, palytoxin extracts
  - Macqueripe Bay, Salybia Reef, Arnos Vale Bay, Flying Reef
- Strong (+tve) correlation: Chl a, $LC_{50}$
- Weak correlation: Chl a, extract yield
- Strong (–tve) correlation: $LC_{50}$, extract yield
- LC50 range of 3.42 µg/ml - > 20.8 µg/ml (highly toxic)




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# More than just a seaweed –
## MNP in the making? (UTT Marine Sciences)



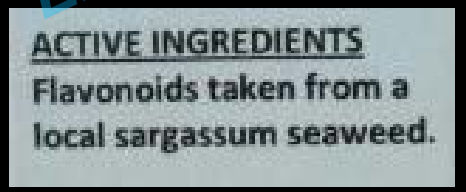








**Raw Product**




- Isolation of active compound(s)
- Stabilization
- Shelf life
- Patent

**Refined Product**

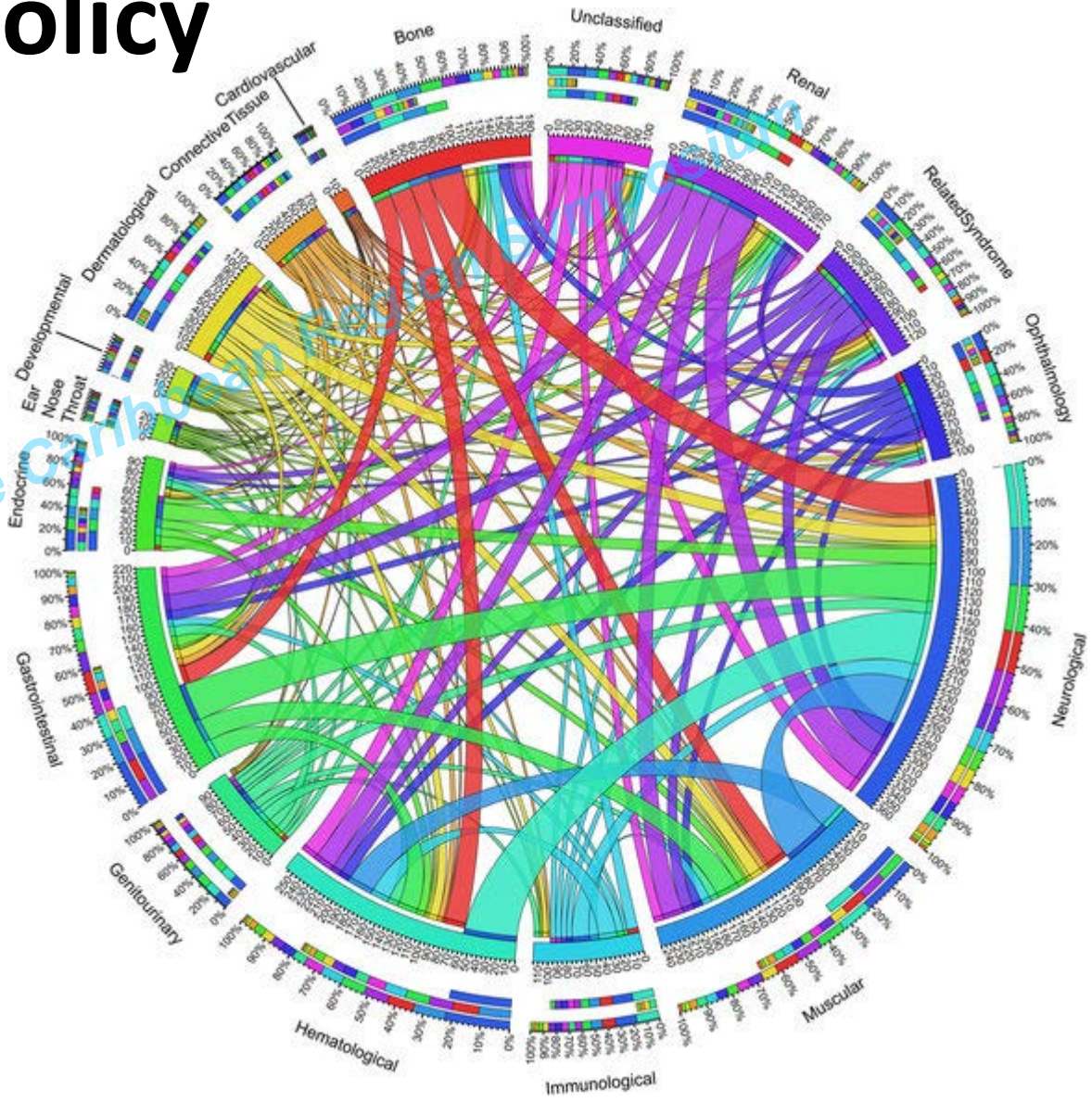
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# Need for Governance / Policy

1. Important to safeguard genetic diversity

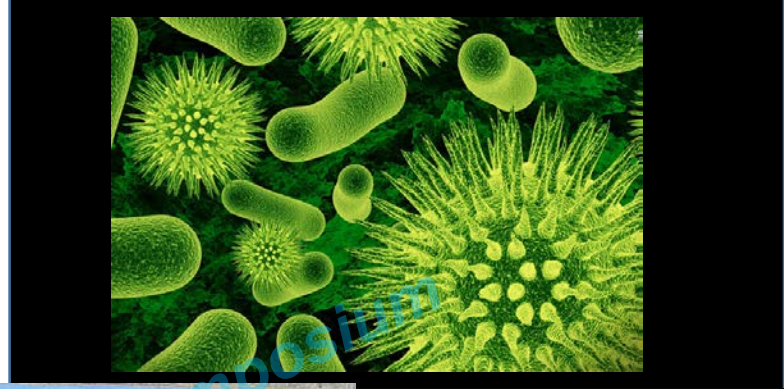
   i. Evolution
      - ✓ Natural selection and environment
      - ✓ Adaptation to climate change

   ii. MNPs
      - ✓ Homologous structures
      - ✓ Medical advances to diseases and deficiencies




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# Need for Governance / Policy

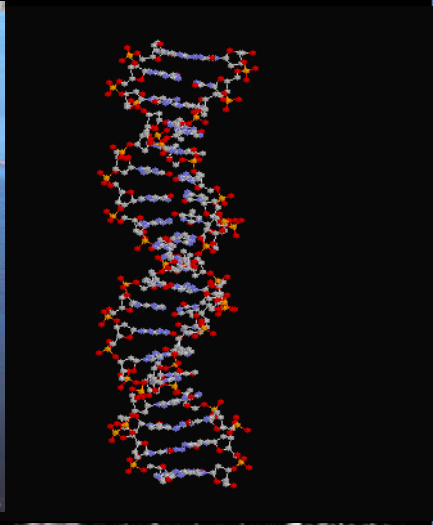


2. Research and development opportunities
   i. Food security

   ii. Pollution abatement

   iii. Gene therapy
      - ✓ Multiple myeloma
      - ✓ AIDS
      - ✓ Immune system disorder
      - ✓ Huntington's chorea
      - ✓ Cystic fibrosis
      - ✓ Haemophilia








   iv. Drug development and regulation

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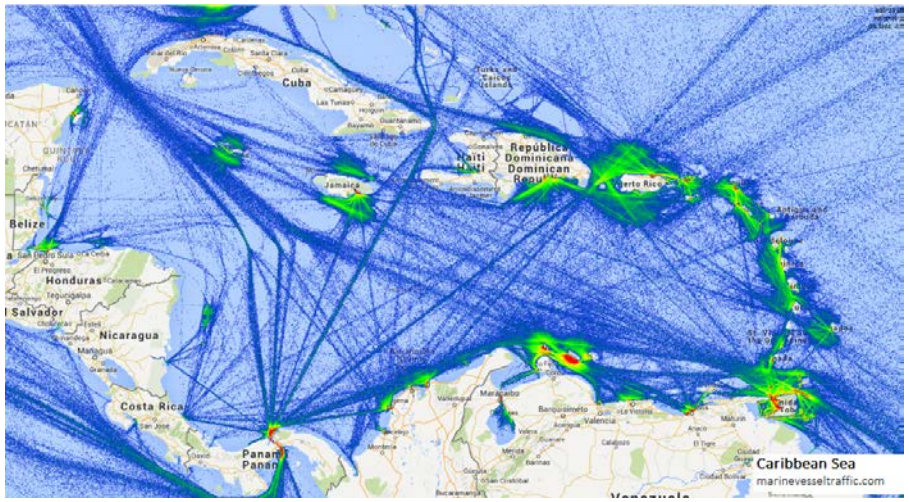
# Need for Governance / Policy

## 3. Implementation and compliance

i. Regional / international connectivity

ii. Convention on Biological Diversity

iii. Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits




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# Thank You!  Questions?




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