



Bioprospecting from Marine Genetic Resources from Areas Beyond National Jurisdiction

Marcel Jaspars

Director, Marine Biodiscovery Centre; Leader PharmaSea Consortium

University of Aberdeen

Scotland, UK

m.jaspars@abdn.ac.uk

With thanks to Oonagh McMeel and Thomas Vanagt

Marcel Jaspars

Professor of Organic Chemistry, University of Aberdeen, UK

Director of Marine Biodiscovery Centre, University of Aberdeen, UK

Co-founder and Chief Scientific Officer of Ripptide Pharma

Co-Author of ESF Marine Board Position Paper “Marine Biotechnology – A New Vision and Strategy for Europe”

Scientific Leader, PharmaSea EU FP7 Consortium

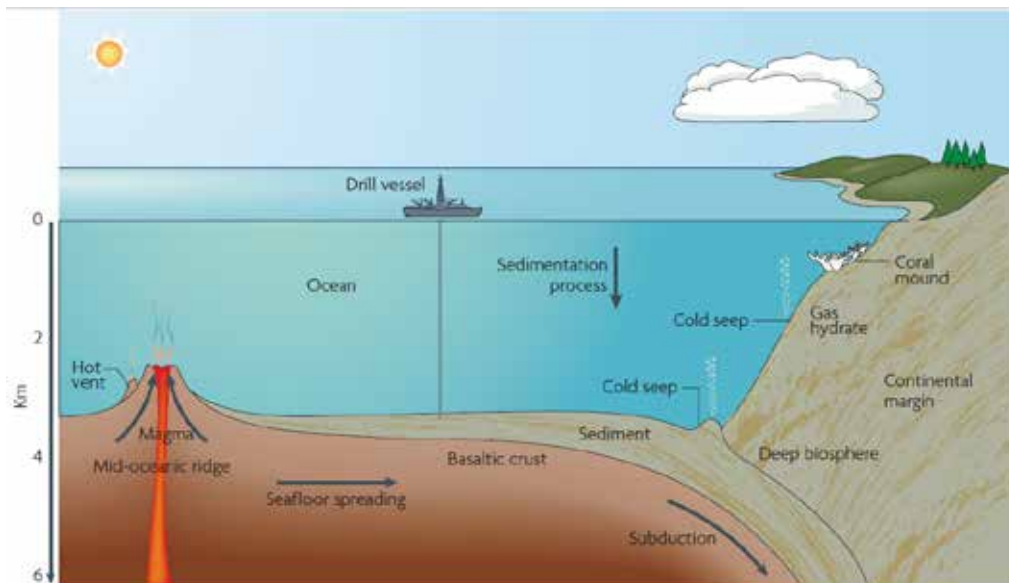
Chair of the Advisory Panel of Policy and Legal Experts – aiming to provide clear recommendations and ready-to-use solutions to address critical policy and legal barriers which impede the access and sustainable use of MGR for European biotechnological research, development and commercialisation

Marine Genetic Resources

Term has no meaning to biologists and is not defined in UNCLOS but is taken to mean the Nagoya Equivalent:

“Marine genetic material” means any material of plant, animal, microbial or other origin, **found in the marine environment**, containing functional units of heredity ;

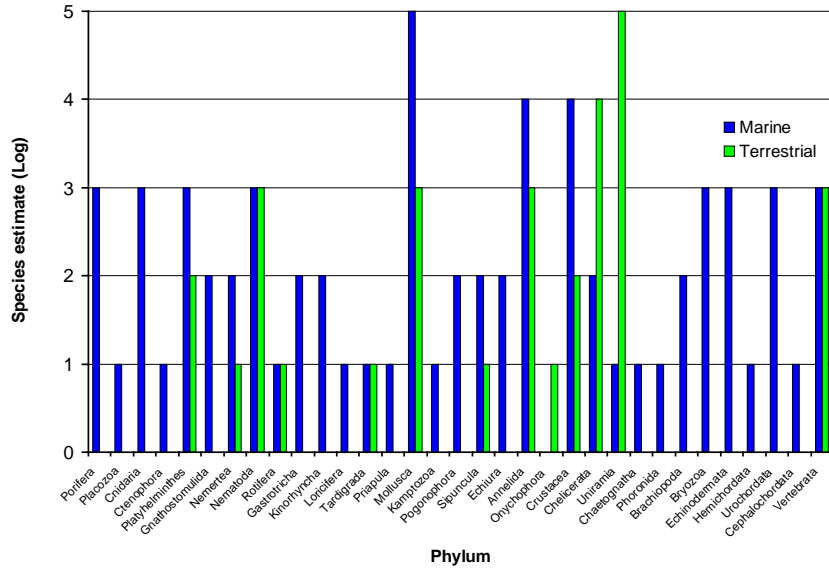
“Marine genetic resources” means **marine** genetic material of actual or potential value”



Diversity of habitat is assumed to translate to biological diversity

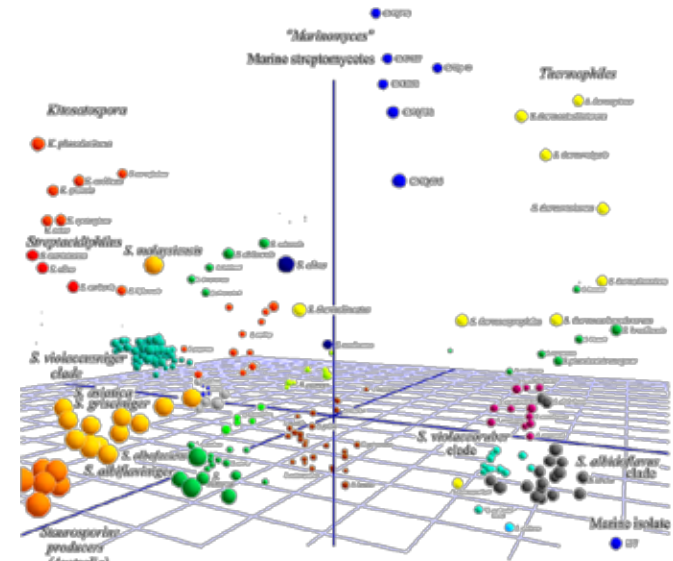
Marine Species Diversity

Animal Diversity



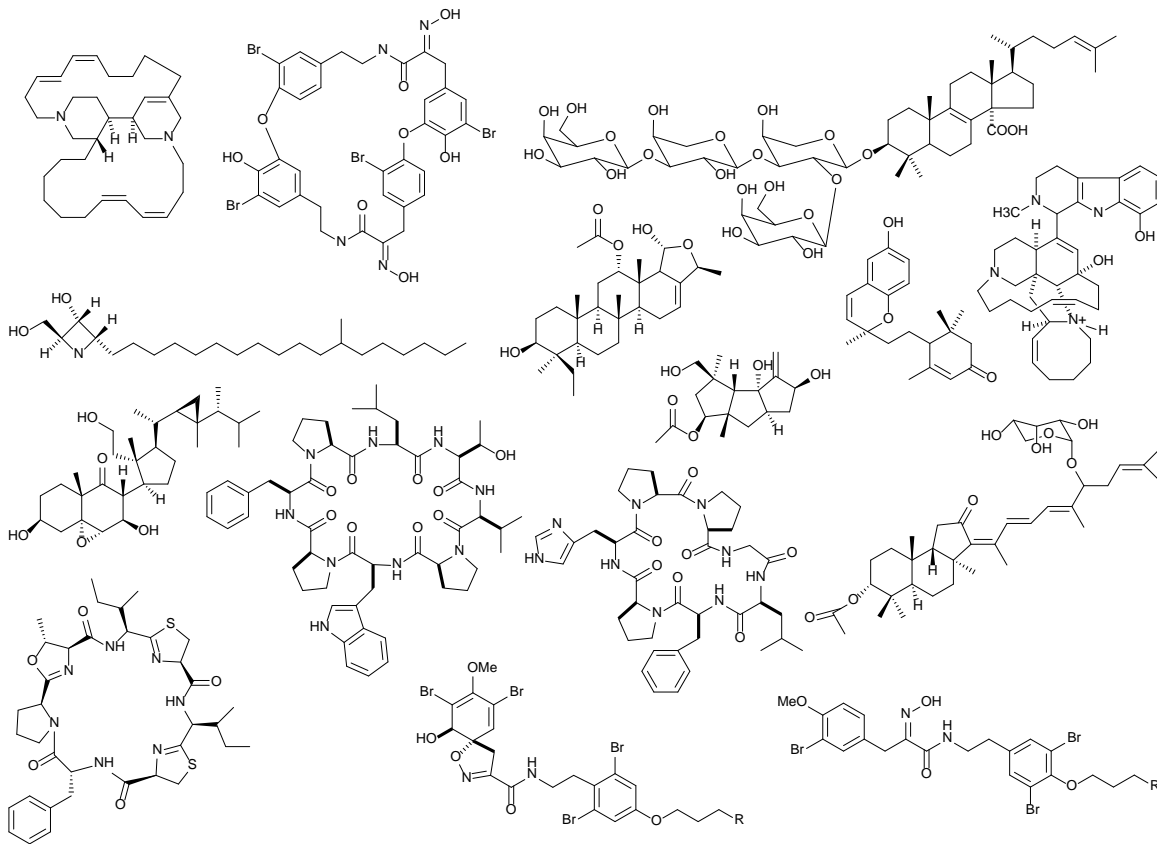
Of the major divisions of animal life ~20 have no representatives on land

Microbial Diversity

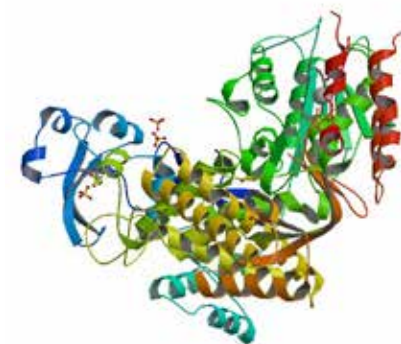
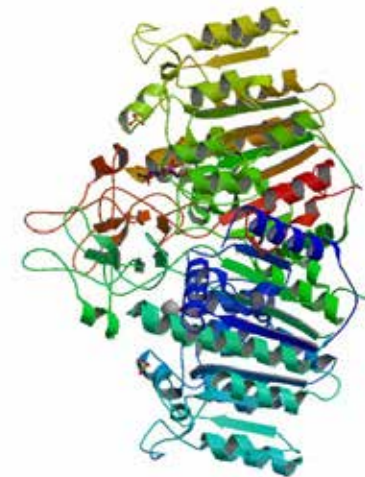


There is no clear estimate of marine microbial diversity or its economic value

Biological Diversity = Chemical Diversity



Small Molecules



Biomolecules

The Marine Bioprospecting Process

Bioprospecting is the discovery of compounds and associated ideas from genetic resources to develop novel biomedicines, biomedical research tools, antifoulants, catalysts, nutraceuticals, cosmeceuticals, etc. **Unlike seabed mining, marine genetic resources are not mined.**

Why use marine genetic resources?

Offers advantage over comparable terrestrial resource:

- Superior performance

- Better economics

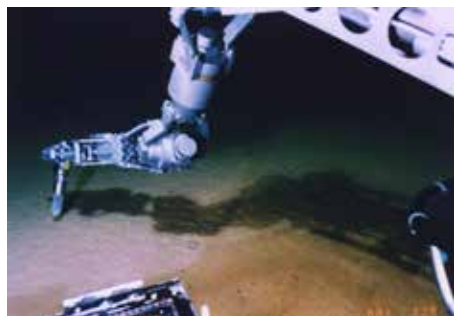
Unprecedented activity in particular application:

- Enzymes: new reactivity/new biotransformation

- Small molecules: novel chemical structures & new mechanism of action

- Materials: new properties

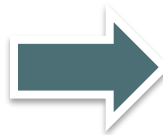
Bioprospecting Biodiversity Beyond National Jurisdiction



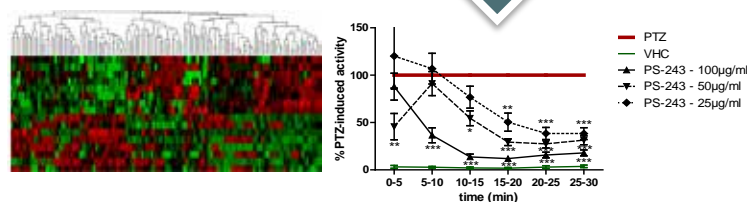
Sampling in ABNJ



MGR



Chemistry



Bioassay

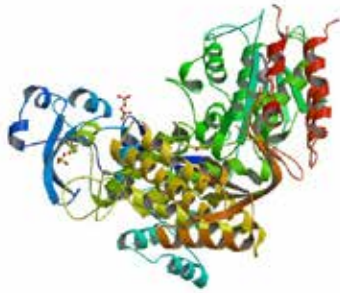


Product



Elements of good practice already exist at all stages of the marine biodiscovery pipeline

Non-Pharma MGR Derived Products on the Market



Vent Polymerase – for DNA amplification
Origin: Vent bacterium (Naples, Italy)

Production: Recombinant

Owner: New England Biolabs



Cosmetic screening infra-red rays

Origin: Vent bacterium (location unknown)

Production: Bacterial culture

Owner: Sederma (Croda)



THE NEXT-GENERATION, HIGH-PERFORMANCE
ALPHA-AMYLASE FOR MASH LIQUEFACTION

Fuelzyme – Enzyme used in biodiesel production

Origin: Deep sea bacterium (location unknown)

Production: Recombinant

Owner: Verenium (BASF)



Anti biofilm agents

Origin: Red seaweed

Production: Chemical Synthesis

Owner: XXXXX

MGR Derived Pharmaceutical Products on the Market



Soft tissue carcinoma



Ecteinascidia turbinata



Chronic pain (analgesic)



Conus magus



Breast cancer



Halichondria okadai



Ara-C
(cytarabine)
treatment of leukemia



Ara-A (vidarabine)
antiviral



Tethya crypta



Hodgkin's Lymphoma



Dolabella auricularia



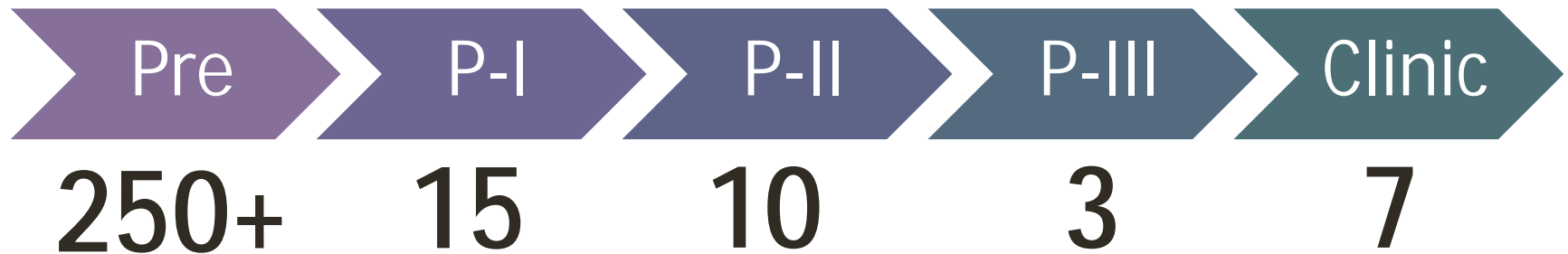
lowering very high
triglyceride levels



Purified
fish oil

All from EEZ apart from 1 (high seas) – All prior to CBD coming into force
None rely on harvesting natural source except fish oils

Pharmaceutical Pipeline



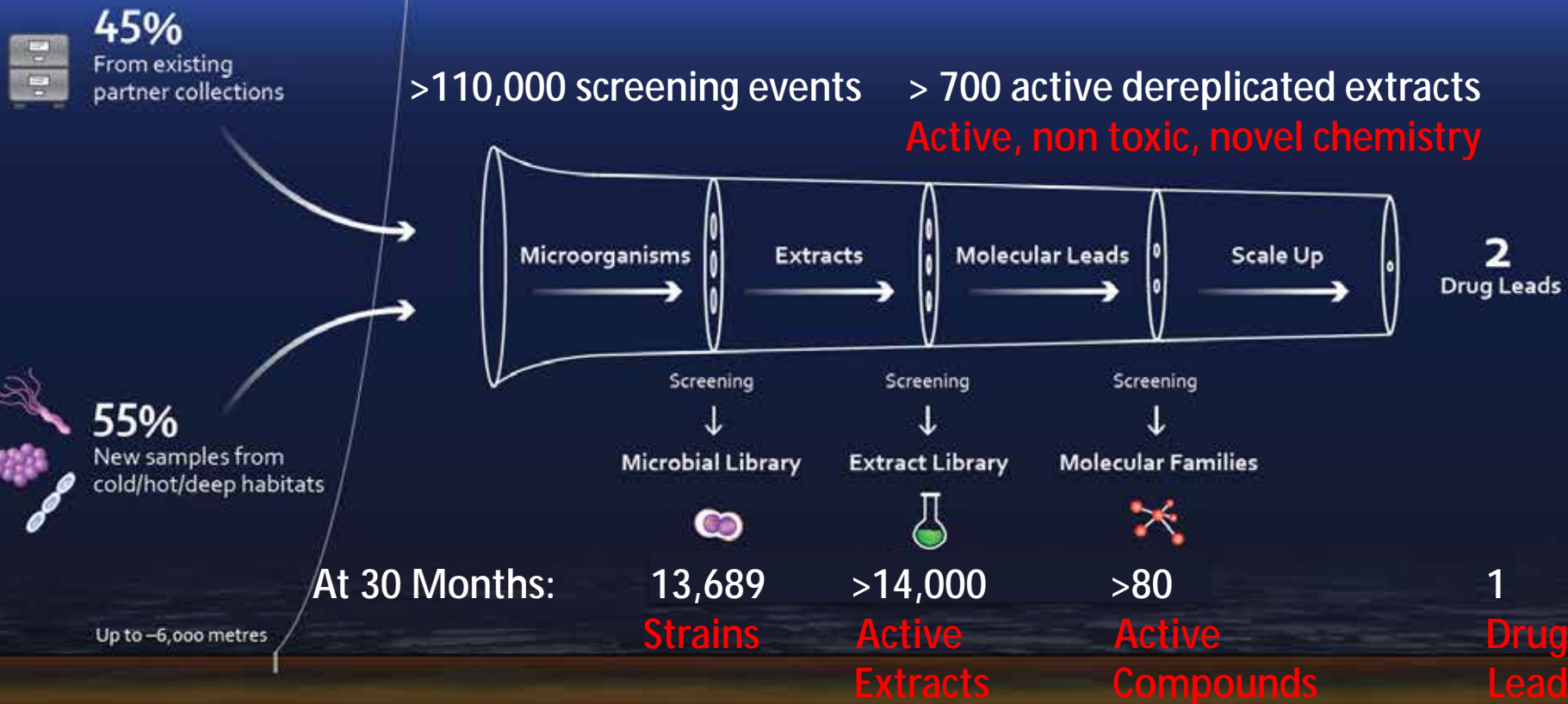
None from ABNJ – mainly reef derived

7 successful compounds came from 28,000 known marine compounds

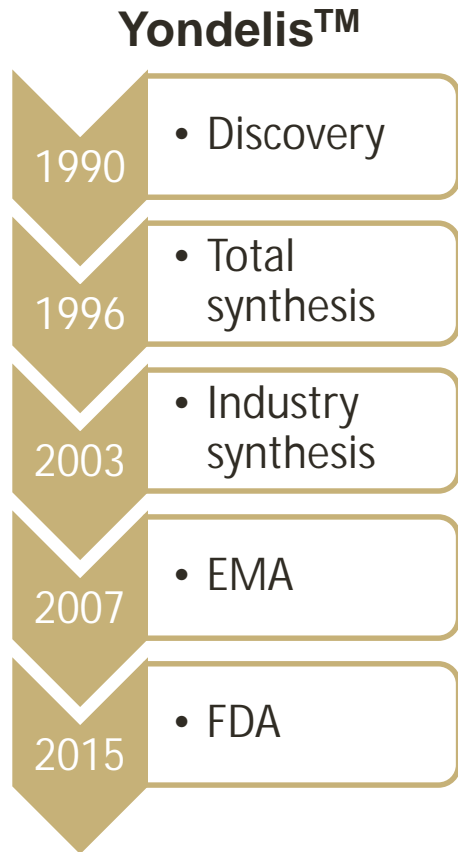
Mainly anti-cancer with a few analgesics and antivirals

Mainly start-ups at early stage with large pharma at late stage

Before Getting to Preclinical Trials:



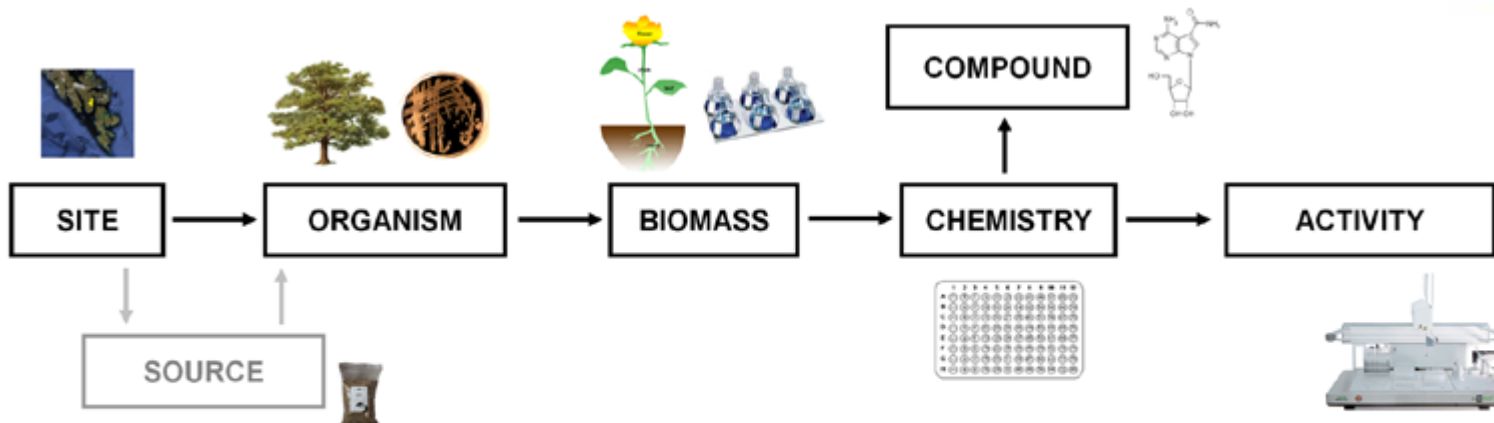
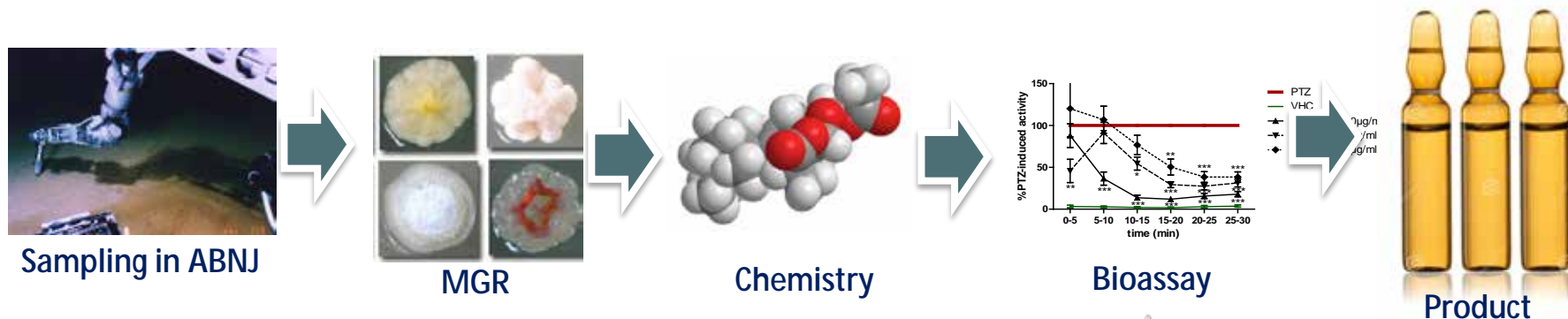
Real Benefit Scenario



- Cost in 2014 to bring drug to market US\$2,558 M* - >70% Clinical trials
- Typical industry royalties on natural products developed into drugs is 1-3%
- Halaven (Eisai), derived from a Japanese sponge makes US\$200 M per year – in principle yielding US\$ 2-6 M pa.
- Currently 7 approved marine drugs – total royalties would be US\$ 10-50 M.
- Blockbuster drug (> US\$ 1 Bn pa income) would yield US\$10-30 M pa
- Currently 7 approved marine drugs come from ~28,000 discovered marine compounds (1 in 4000 chance) – none are 'blockbusters'
- All examples were discovered pre-CBD – not clear if actual royalties are being paid
- Other markets – nutraceuticals/cosmeceuticals, lower risk, quicker to market, lower investment and lower returns.

*Tufts Study http://csdd.tufts.edu/news/complete_story/cost_study_press_event_webcast

Monitoring Sample and Data Flows



OpenNAPIS™

Functional Design

Possible to track sample from origin to exploitation (needs better databases)

Modifications to DNA or compound may make it hard to trace MGR origin

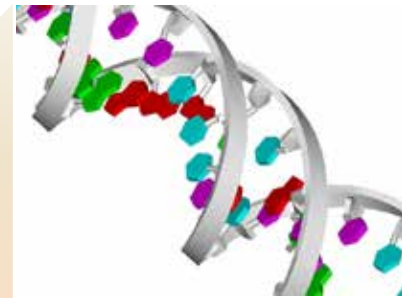
White Point Systems, Inc.
20100626

Synthetic Biology – From Genes to Products

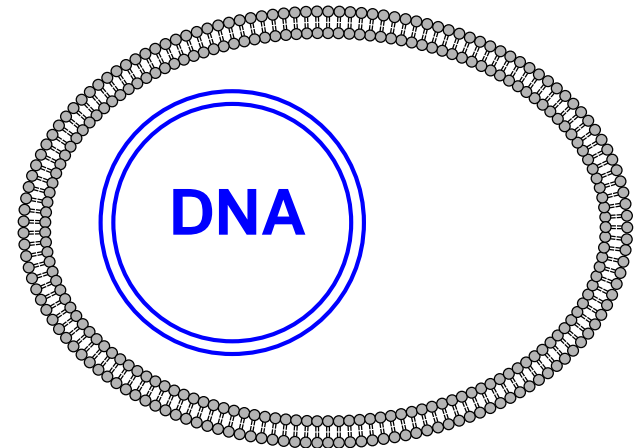
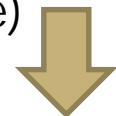
An UNCLOS implementing agreement developed over the next few years would need to be flexible enough to deal with rapid scientific progress



MGR



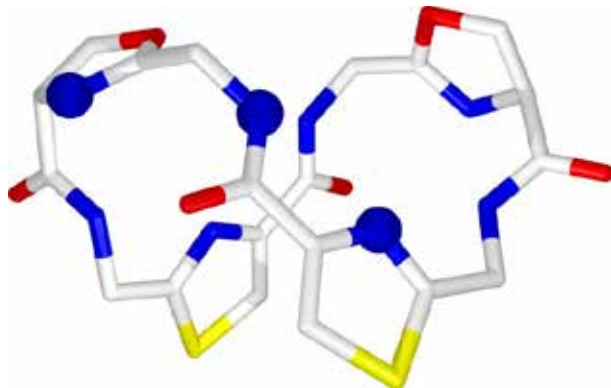
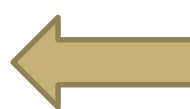
DNA (Synthetic genes
From sequence)



Cell with engineered DNA



Grow cells



Product

PHARMASEA



“The research leading to these results has received funding from the European Union's Seventh Framework Programme (FP7/2007-2013 under grant agreement n ° 312184)”