



Implications of access and benefit-sharing (ABS) frameworks for collection and utilisation of marine genetic resources (MGR)

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With thanks to Oonagh McMeel

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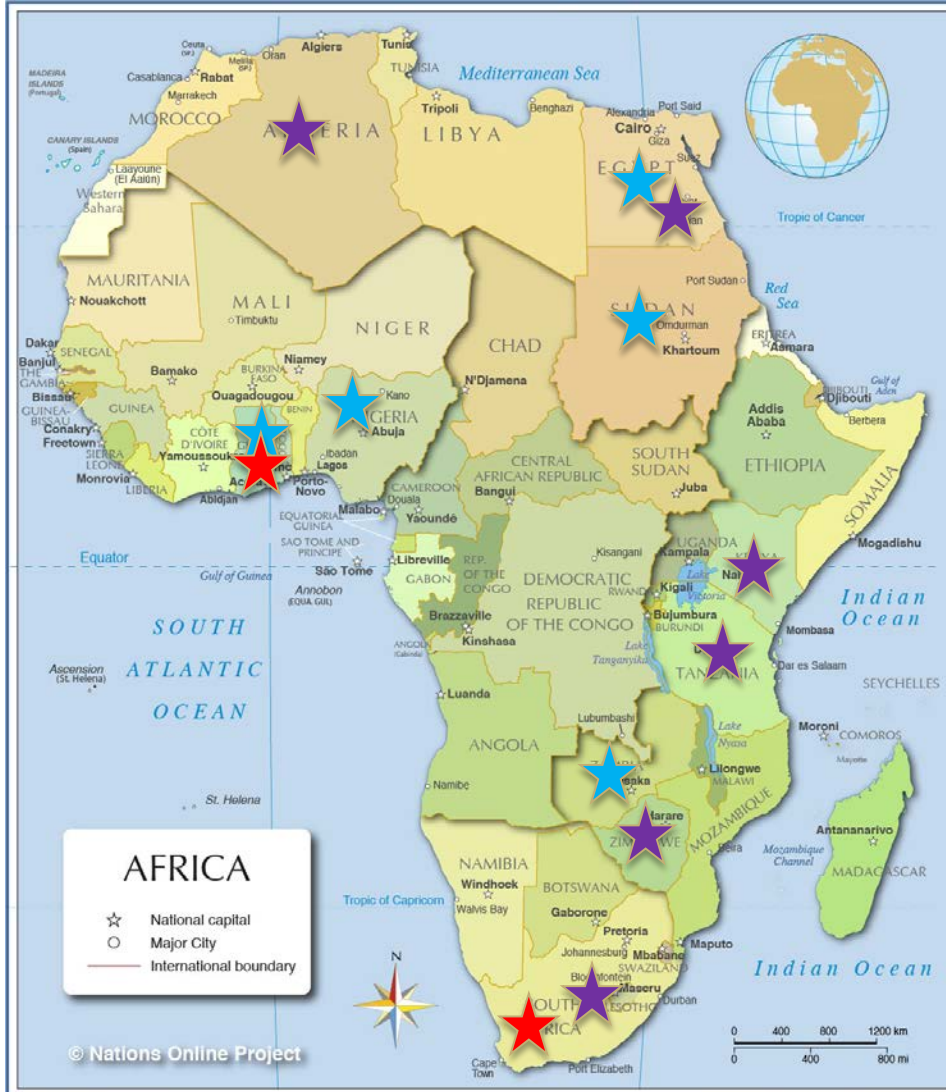
Co-founder and Chief Scientific Officer of Ripptide Pharma

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

Work With Africa To Date



- ★ Active collaboration
- ★ PhD students
- ★ Visitors

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, MGRs are not mined.

Why use marine genetic resources?

Offers advantage over comparable terrestrial resource:

- Superior performance

- Better economics

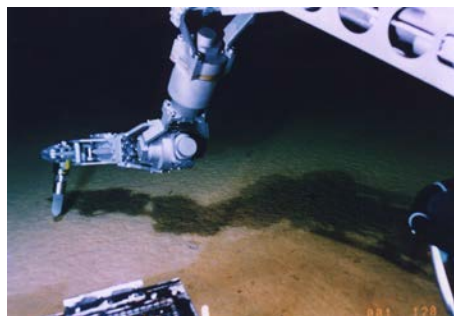
Unprecedented activity in particular application:

- Enzymes: new reactivity/new biotransformation

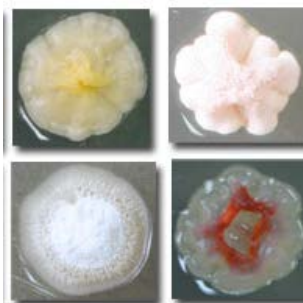
- Small molecules: novel chemical structures & new mechanism of action

- Materials: new properties

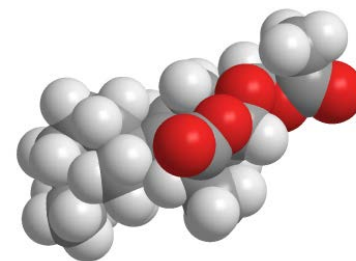
Bioprospecting in BBNJ



Sampling in ABNJ



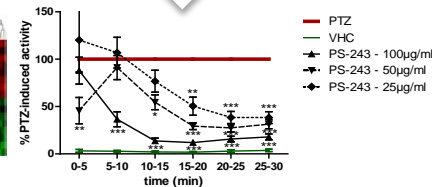
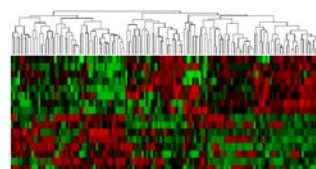
MGR



Chemistry



Product



Bioassay

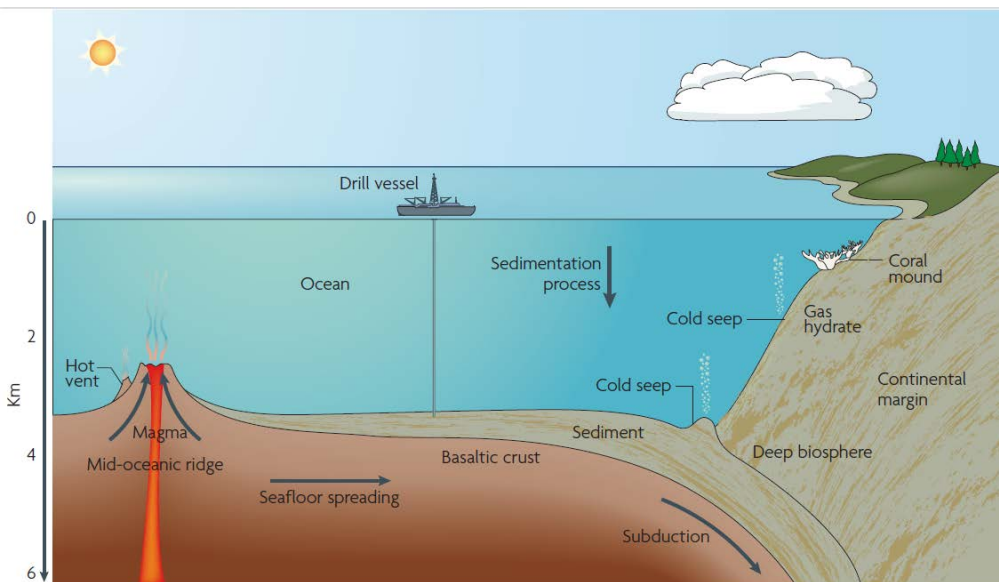
Elements of good practice already exist at all stages of the marine biodiscovery pipeline

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 ;

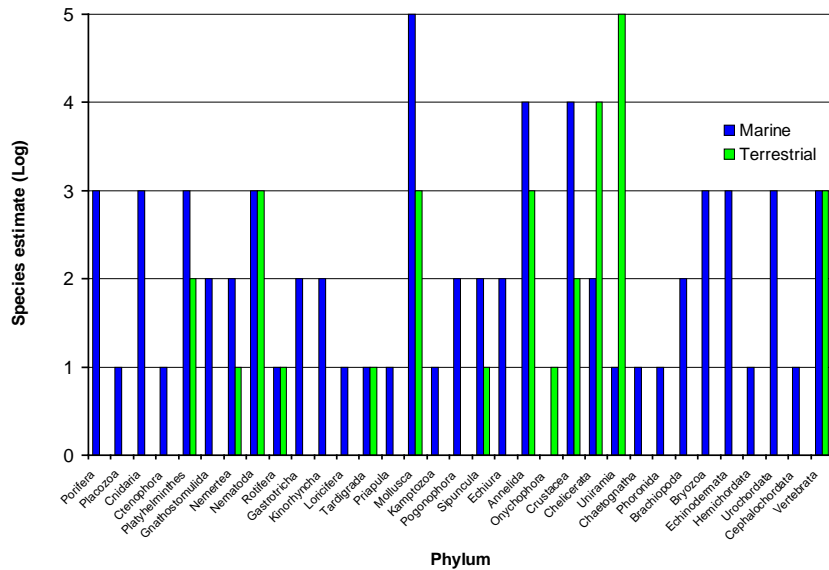
“Marine genetic resources” means **marine** genetic material of actual or potential value”



Diversity of habitat is assumed to translate to biological diversity

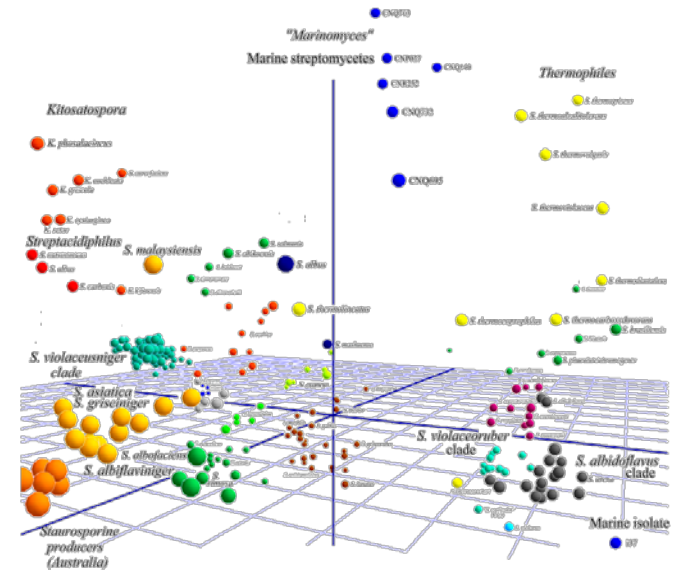
Marine Species Diversity

Animal Diversity



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

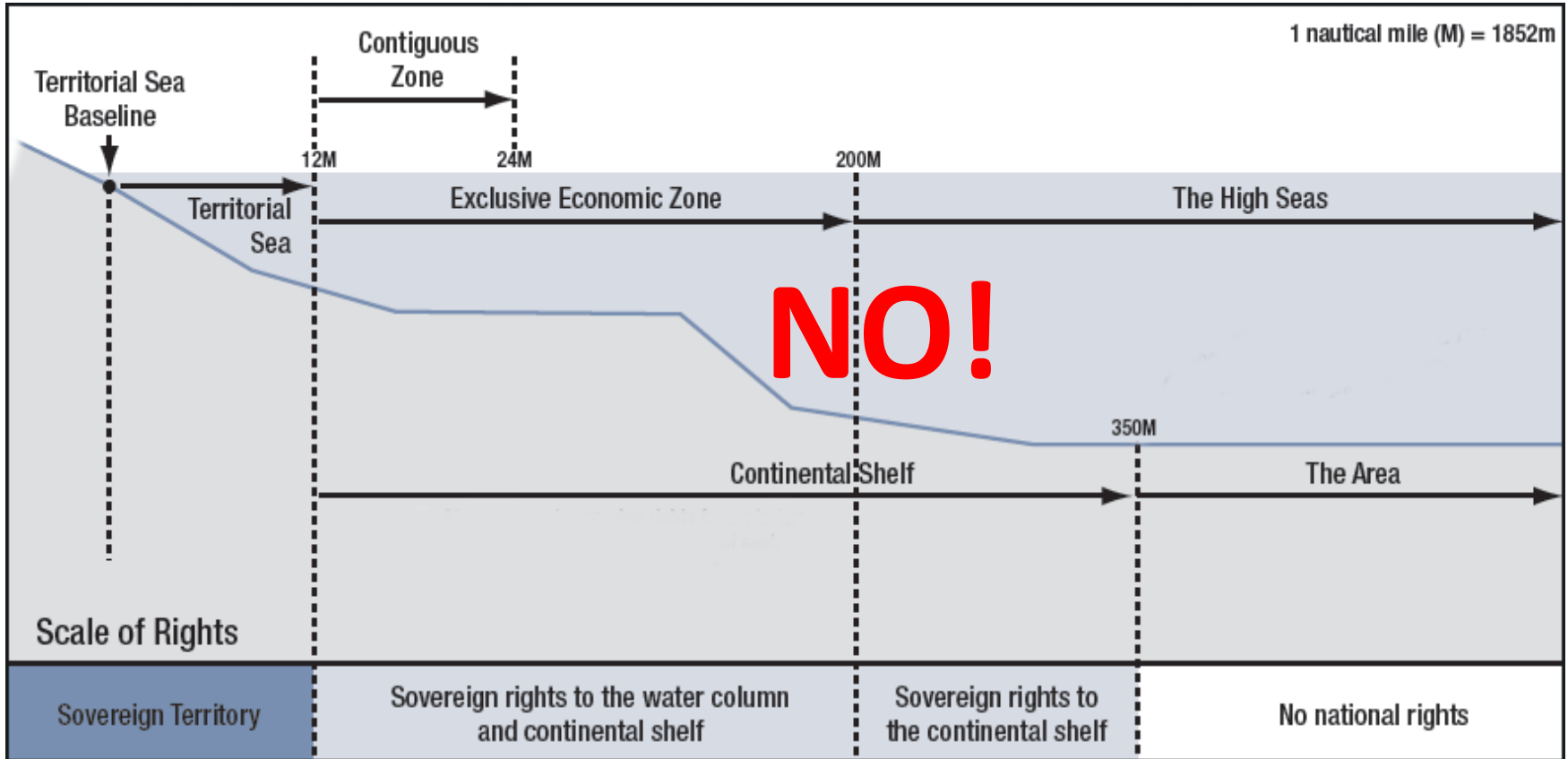
Microbial Diversity



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

MGR from EEZ or ABNJ

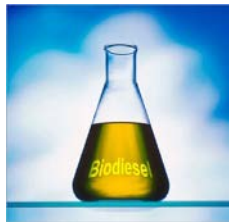
Can we determine which legal regime an organism came from?



Non-Pharma MGR Derived Products on the Market



Vent Polymerase – for DNA amplification
Origin: Vent bacterium (location unknown)
Production: Recombinant
Owner: New England Biolabs



Fuelzyme – Enzyme used in biodiesel production
Origin: Deep sea bacterium (location unknown)
Production: Recombinant
Owner: Verenium (BASF)



Cosmetic screening infra-red rays
Origin: Vent bacterium (location unknown)
Production: Bacterial culture
Owner: Sederma (Croda)



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



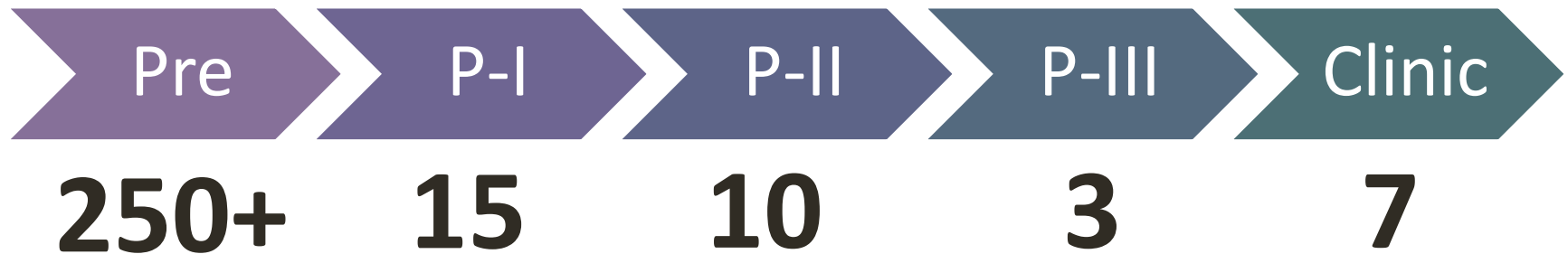
lowering very high
triglyceride levels



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

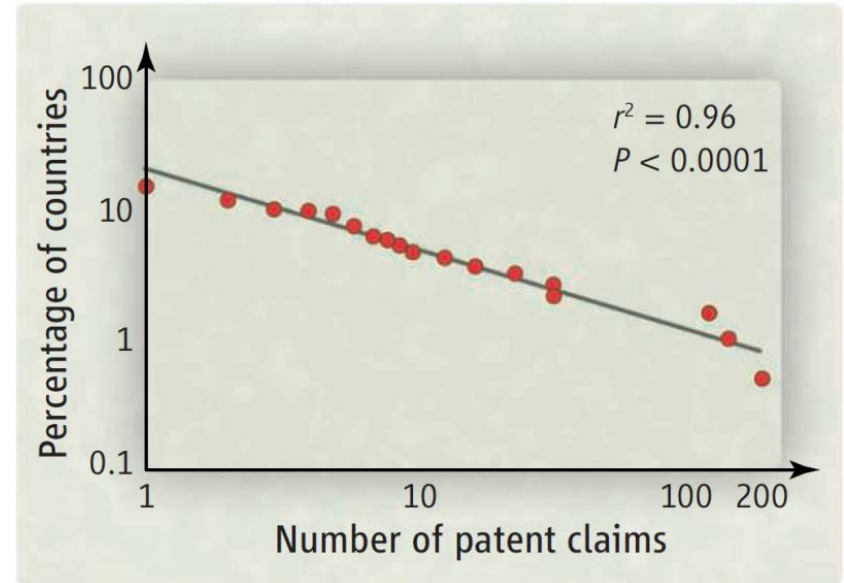
Mainly anti-cancer with a few analgesics and antivirals

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

MGR and Gene Patents

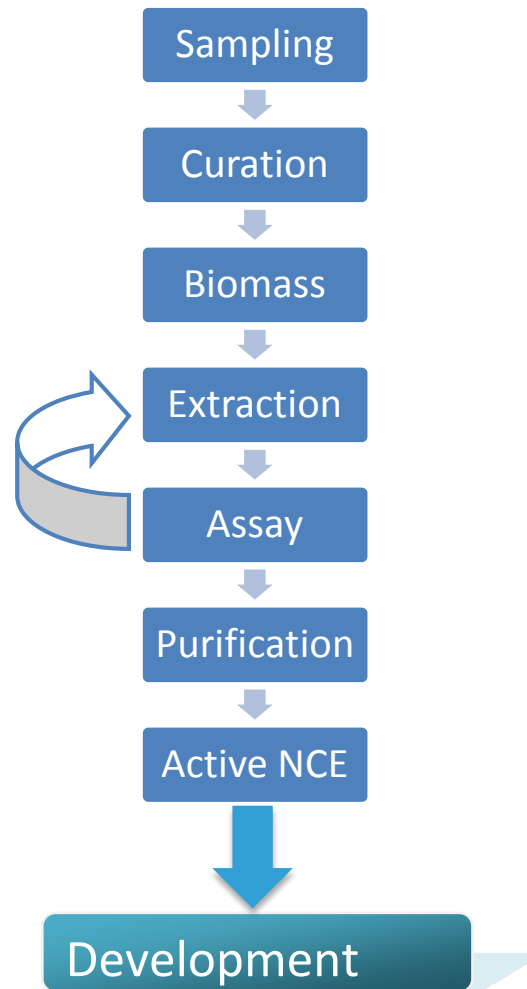
PATENT CLAIMS FOR A GENE OF MARINE ORIGIN WITH SOURCE

Country	Marine organism patent claims
USA	199
Germany	149
Japan	128
France	34
United Kingdom	33
Denmark	24
Belgium	17
Netherland	13
Switzerland	11
Norway	9



Patent claims associated with genes of marine origin

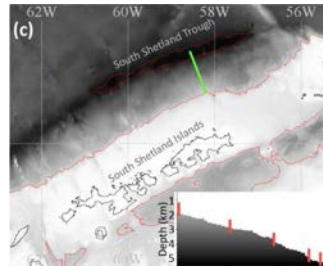
Bioprospecting Pipeline



Notification & Reporting Requirements

Application

- Cruise plan



Award

- Feasibility
- Checks



After Cruise

- Cruise report

VESSEL	CRUISE	DATE	SAMPLING GEAR	DIVE #	SAMPLE NUMBER	LATITUDE	LONGITUDE	DEPTH	SAMPLE TYPE	DESTINATION
Scotia	09122	18/01/2015	Van Veen Grab	3	20915_VV_3A	52.07662N	15.24400W	1218.4	SED Sub&	JAIPHARS
Scotia	09155	18/01/2015	Van Veen Grab	3	20915_VV_3B	52.04824N	15.54809W	1316.6	SED Sub&	JAIPHARS
Scotia	09129	18/01/2015	Van Veen Grab	3	20915_VV_3A	52.07662N	15.24400W	1218.4	SED Sub&	JAIPHARS
Scotia	09129	18/01/2015	Van Veen Grab	3	20915_VV_3B	52.04824N	15.54809W	1218.4	SED Sub&	JAIPHARS
Scotia	09155	19/01/2015	Water/Larvae	1	20915_WL_1_1	52.01311N	15.15079W		Amphipods	P108147
Scotia	09155	19/01/2015	Water/Larvae	1	20915_WL_1_2	52.01311N	15.15079W		Amphipods	P108147
Scotia	09155	19/01/2015	Water/Larvae	1	20915_WL_2_1A	52.00877N	15.55205W		SED Sub&	JAIPHARS
Scotia	09155	19/01/2015	Water/Larvae	1	20915_WL_2_1B	52.01007N	15.55205W		SED Sub&	JAIPHARS
Scotia	09155	19/01/2015	Water/Larvae	2	20915_WL_2_2A	52.00577N	15.55205W		Bacterial Mat	JAIPHARS
Scotia	09155	19/01/2015	Water/Larvae	2	20915_WL_2_2B	52.00577N	15.55205W		Bacterial Mat	JAIPHARS
Scotia	09129	19/01/2015	Water/Larvae	2	20915_WL_2_2C	52.00577N	15.55205W		Bacterial Mat	JAIPHARS
Scotia	09155	19/01/2015	Water/Larvae	2	20915_WL_2_2D	52.00577N	15.55205W		Bacterial Mat	JAIPHARS
Scotia	09155	19/01/2015	Water/Larvae	2	20915_WL_2_2E	52.00577N	15.55205W		Bacterial Mat	JAIPHARS

- Starts with marine scientific research

Where to report data?

- Nagoya Protocol clearing-house
- New clearing house linked to NP
- A new international organisation

NP already requires evidence that collection did not come from area under national jurisdiction

Cruises are expensive!
\$40,000+ per day

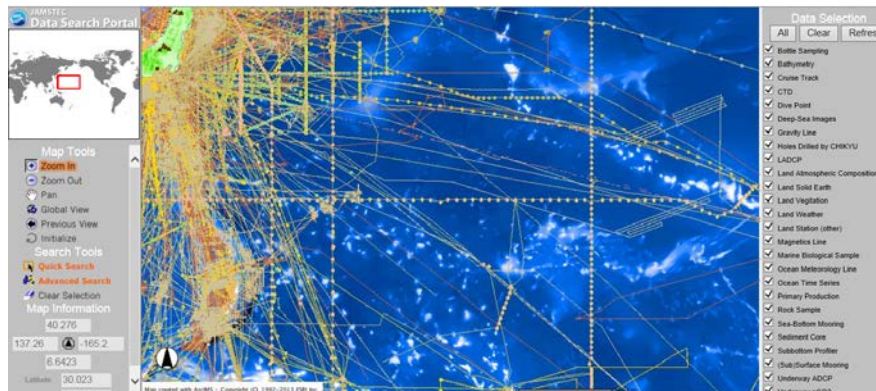
Good Practice for Cruise Data and Samples

Metadata may include

- | Location
- | Depth
- | Temperature
- | Salinity
- | pH
- | Oxygen content
- | Seafloor conditions

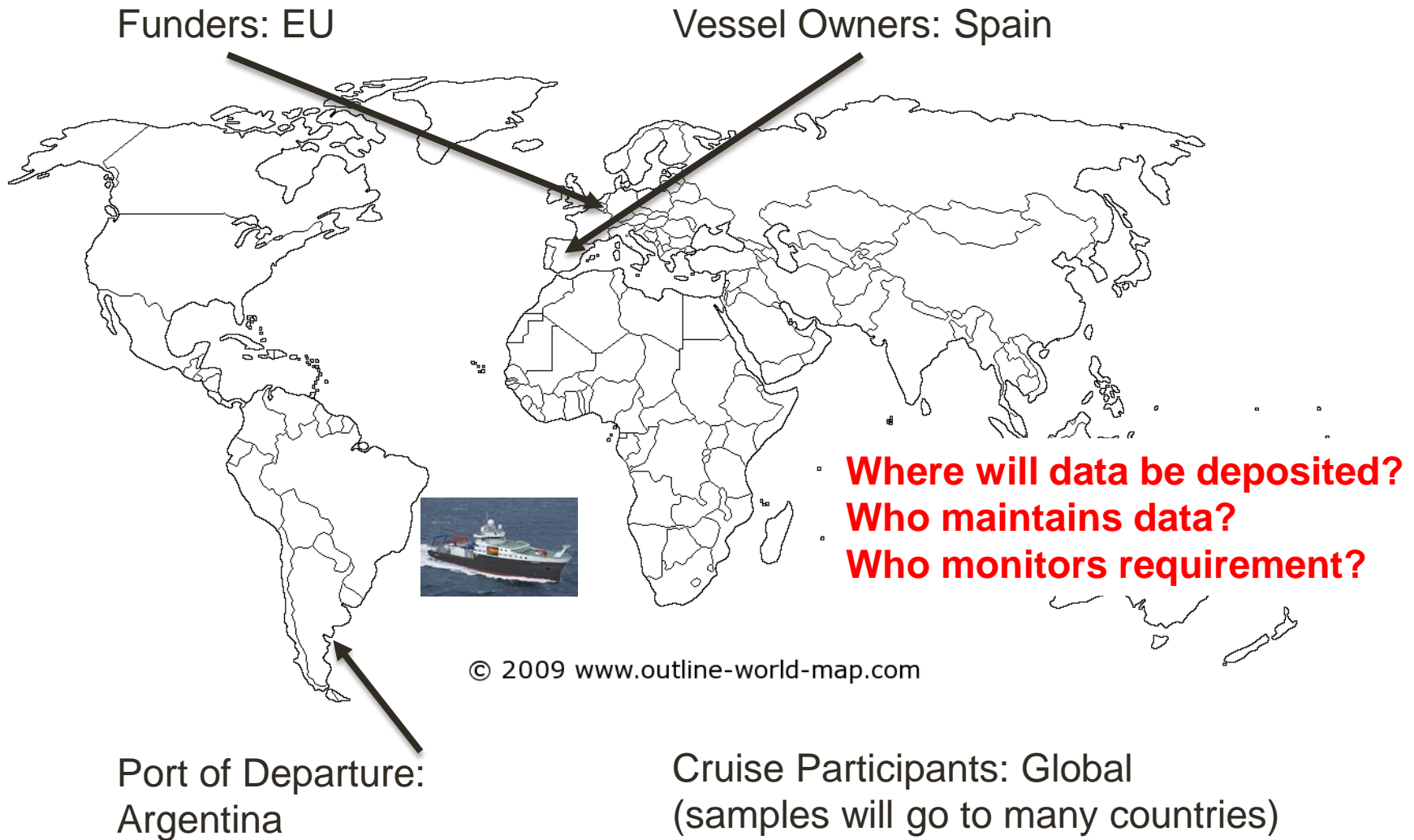
Sample storage

- | Ambient temperature
- | Cooler (4°C)
- | Freezer (-20°C)
- | -80°C Freezer
- | Liquid nitrogen (-196°C)
- | Formaldehyde
- | Ethanol
- | DNA/RNA preservation liquids



Needs standardisation

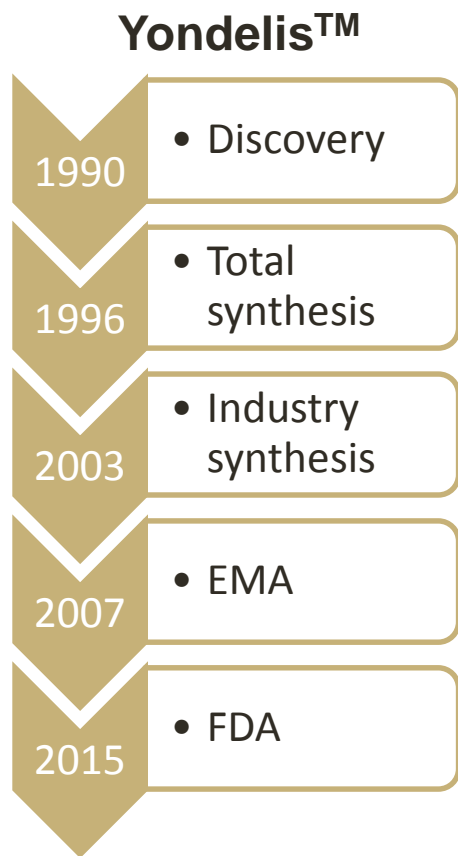
Flag State Problem



Benefit Sharing

- Must be multilateral compared to bilateral for Nagoya Protocol
- In many cases most important benefits from use of MGR are non-monetary.
- Non-monetary benefits may include:
 - Scientific exchanges/training
 - Technology transfer
 - Capacity building (infrastructure)
 - Enhanced reputation
 - Increased number/quality of scientific publications
 - Biodiversity conservation
 - Valuable regional resources developed (knowledge, samples, data)
- Non-monetary benefits still cost money – however they are upfront compared to royalties

Real Benefit Scenario



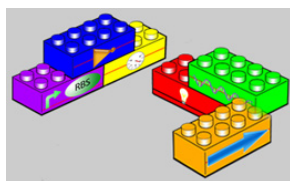
- Cost in 2014 to bring drug to market US\$2,558 M* - >70% Clinical trials
- Typical industry royalties on natural products developed into drugs is 1-3%
- Halaven (Eisai), derived from a Japanese sponge makes US\$200 M per year – in principle yielding US\$ 2-6 M pa.
- Currently 7 approved marine drugs – 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

Benefit Sharing

- Multilateral NOT Bilateral
- Most important benefits are non-monetary.

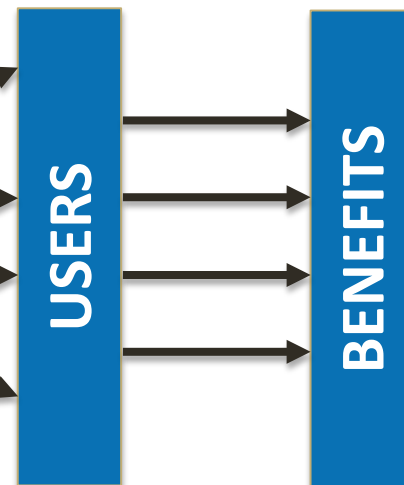
Public domain approach



Biobricks

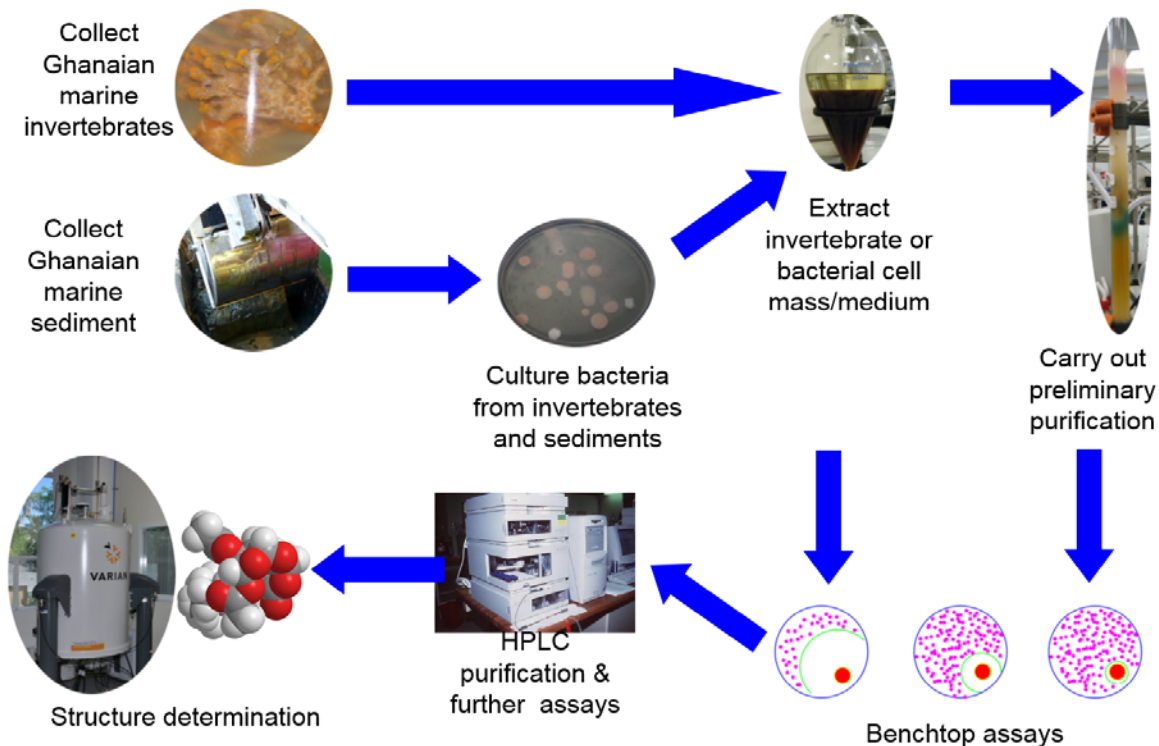


open source™



- Low cost
- Benefits will accrue locally
- All should be able to benefit from discoveries
- **Requires capacity building to ensure fairness**
- This approach will lead to greater innovation, transparency and openness

Capacity Building with Ghana



Dr Kwaku Kyeremeh



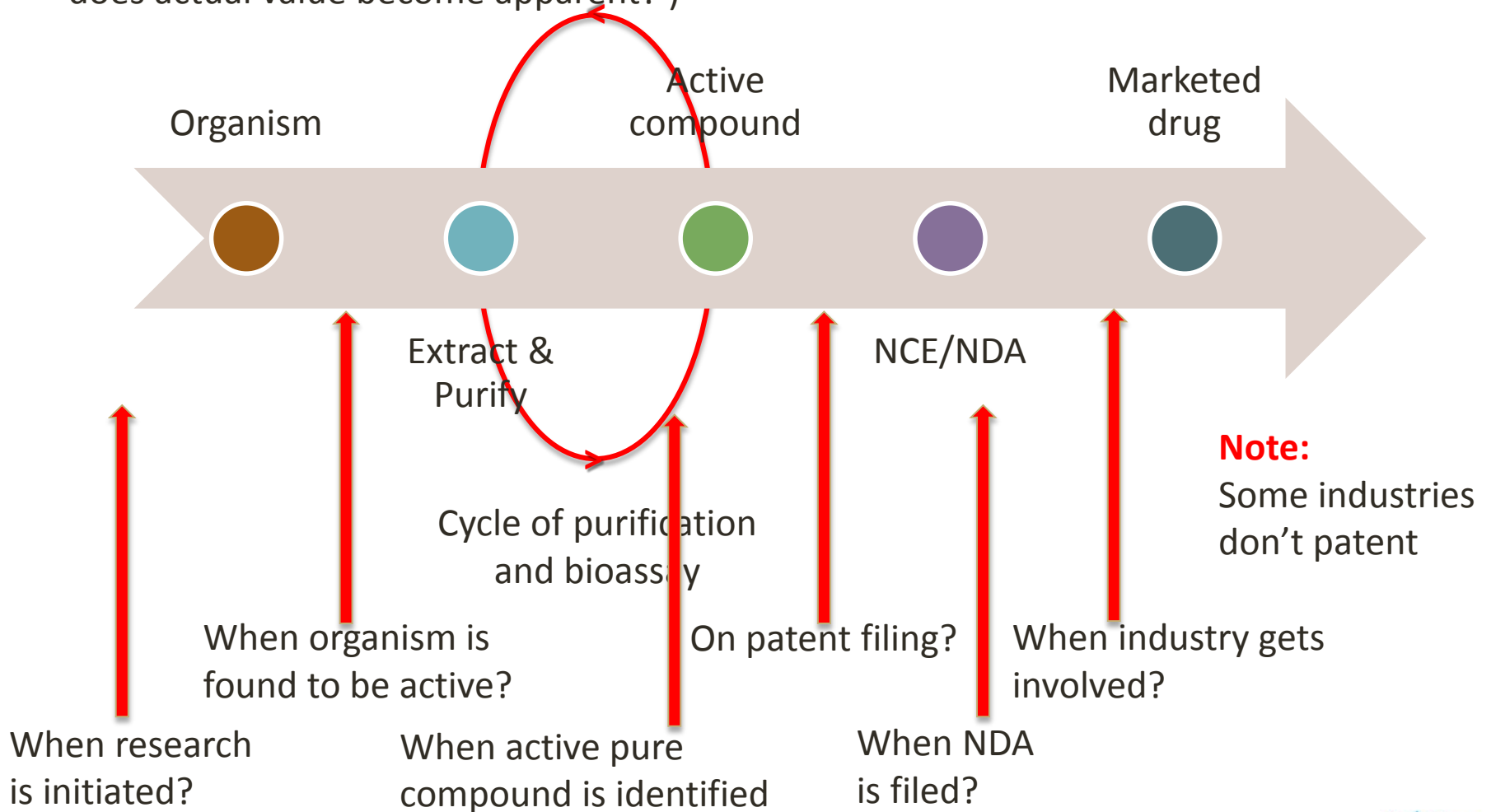
The Leverhulme Trust

Results

- Built biology and chemistry labs
- University support for big equipment
- Trained 3 PG students
- 7 publications

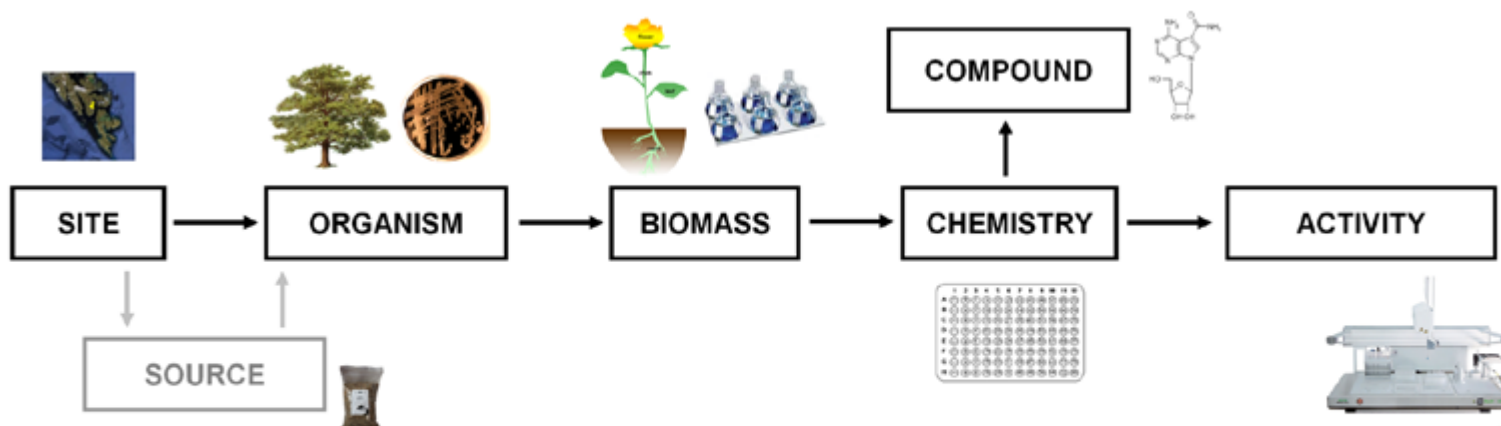
Commercial Research

Where is the transition from basic research to research with commercial intent? (when does actual value become apparent?)



Monitoring Sample and Data Flows

Possible to track sample from origin to exploitation
(but better databases are needed)



OpenNAPIS™
Functional Design

White Point Systems, Inc.
20100626

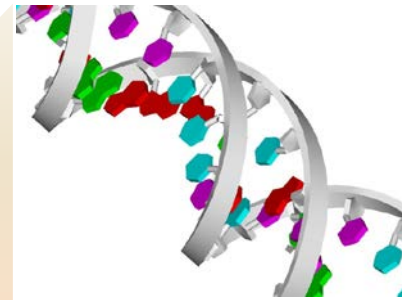
Modifications to DNA or compound may make it hard to trace MGR origin

Synthetic Biology – From Genes to Products

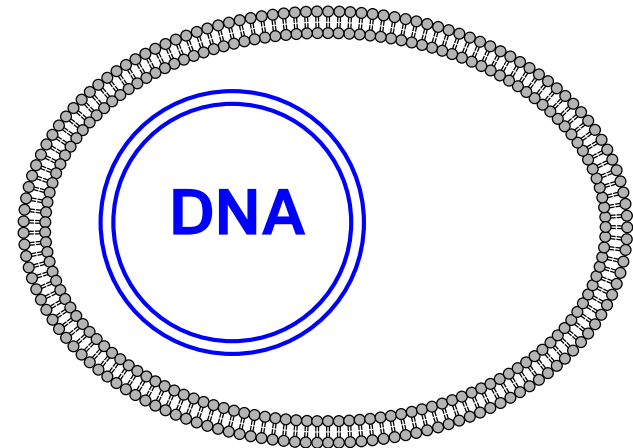
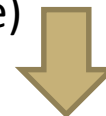
An UNCLOS implementing agreement developed over the next few years would need to be flexible enough to deal with rapid scientific progress



MGR



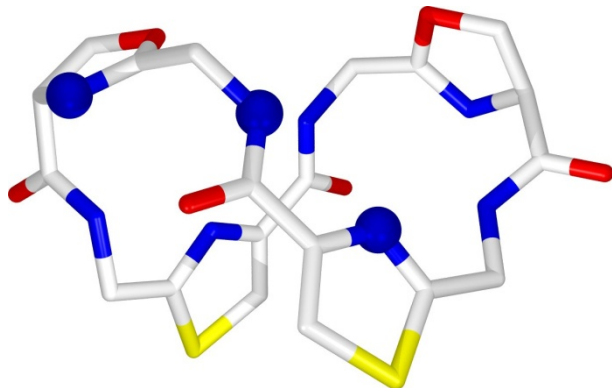
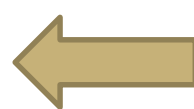
DNA (Synthetic genes
From sequence)



Cell with engineered DNA

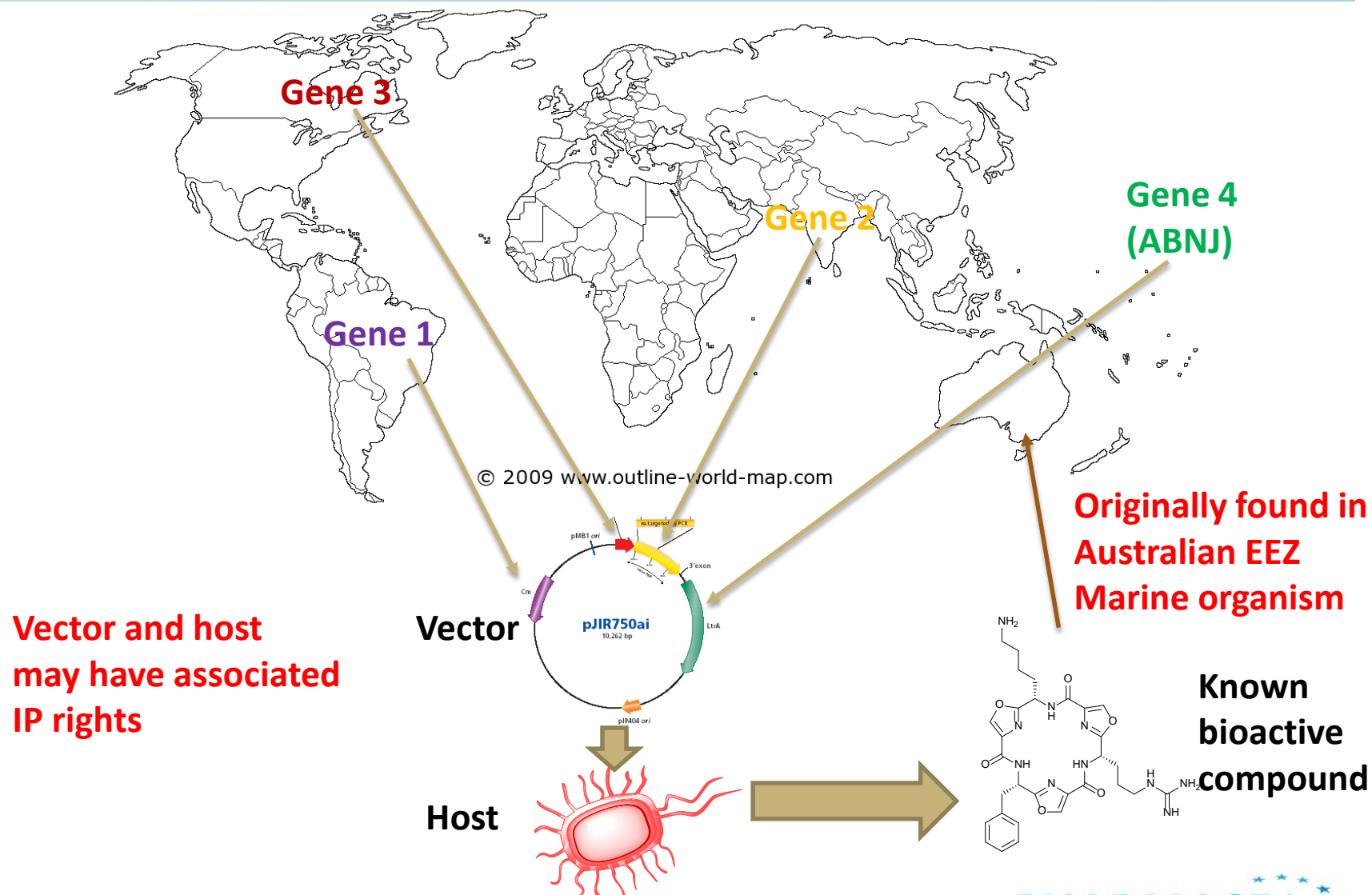


Grow cells



Product

Nightmare (But Realistic) Scenario



Nagoya-O-Meter

Nagoya-like regime

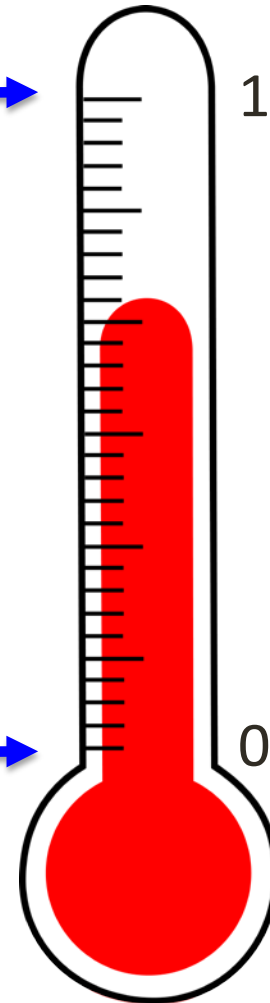


100% Nagoya

Public Domain Model



0% Nagoya



Overly restrictive regime can damage progress of products (Australian example)

Questions for Discussion

- How can we make sure MSR on MGR is not impeded?
- How will the process be monitored/policed and by whom?
- Who will collect monetary benefits and who will distribute funds and how?
- Traceability becomes an issue as benefits may take a long time to be realised. Who will trace this?
- How can we manage expectations for financial returns?
- Can we make an IA flexible enough to cope with scientific progress?
- Is a public domain model acceptable to the parties?
 - At what scale does the collection of BBNJ occur?
 - Will adapting current good practice be sufficient as monitoring tool?
 - Is it possible/desirable to control the flow of data, much of which is open access?
 - How can we be sure that all can utilise and benefit from MGR from ABNJ?
 - How can we ensure capacity building so all can truly benefit?

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^o 312184)”