MarineBiotech

Introduction to Marine Biotechnology
The market driven approach

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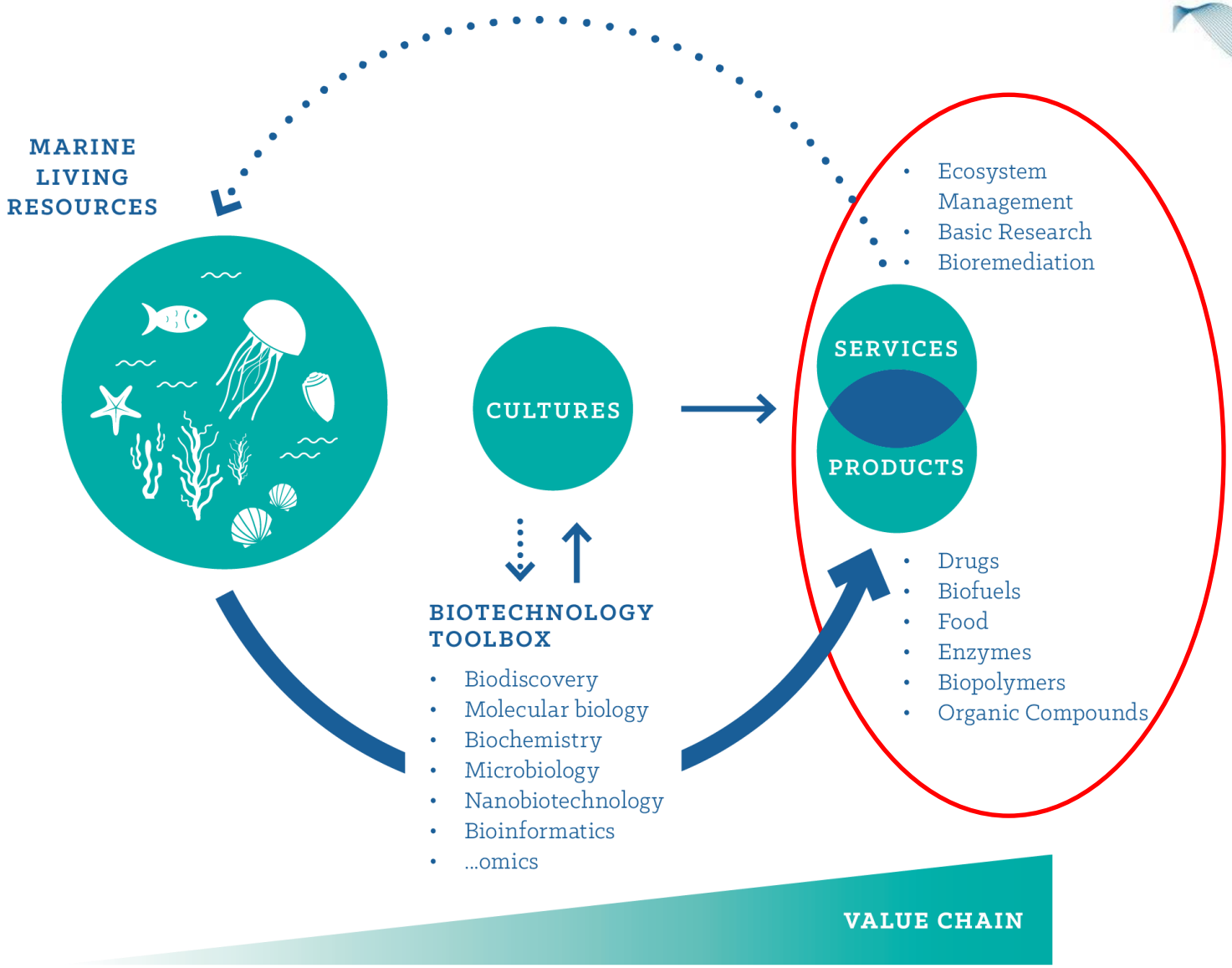
MarineBiotech

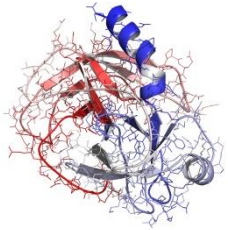


MarineBiotech

Marine biomass

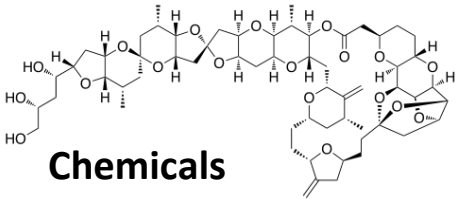
Pharmaceuticals

Bioenergy



Enzymes

Food - Nutraceuticals



Chemicals

Cosmeceuticals

Biopolymers

Aquaculture

Bioremediation

Pharmaceuticals

Selected marine natural products in development as anticancer drugs

MarineBiotech

clinical trial	name	source	target	developed by
In Clinical Use	ectenaiscidin 743 (Yondelis)	tunicate	tubulin	PharmaMar, Rinehart
phase III	E7389 (halichondrin B inspired)*	synthetic	tubulin	Eisai
phase II	dehydrodidemnin B (Aplidine)	tunicate	ornithine decarboxylase	PharmaMar, Rinehart
phase II	soblidotin (aka TZT1027, dola-10 insp.)	synthetic	tubulin	Teikoku, Pettit
phase II	synthadotin (aka ILX651, dola-15 insp.)	synthetic	tubulin	ILEX
phase II	bryostatin 1	bryozoan	PKC	GPC Biotech, Pettit
phase II	squalamine	shark	angiogenesis	Zasloff
phase II	kahalalide F	mollusk	multiple	PharmaMar, Scheuer
phase I	PM02734 (kahalalide insp.)	synthetic	solid tumor	PharmaMar
phase I	Zalypsis (jorumycin insp.)*	synthetic	DNA	PharmaMar
phase I	E7974 (hemiasterlin insp.)*	synthetic	tubulin	Eisai
phase I	taltobulin (aka HTI286, hemiasterlin insp.)*	synthetic	tubulin	Wyeth, Andersen
phase I	salinosporamide A (aka NPI0052)	bacteria	proteasome	Nereus, Fenical
phase I	spisulosine (aka ES285)	clam	Rho	PharmaMar
phase I	KRN-7000 (agelasphin insp.)*	synthetic	NKT	Koezuka-Kirin
phase I	NPI 2358 (halimide insp.)	synthetic	tubulin	Nereus, Fenical
phase I	LBH 589 (psammaplin insp.)*	synthetic	HDAC	Novartis
Discontinued				
phase II (<2004)	dolastatin 10	sea hare	tubulin	Pettit
phase II (<1999	didemnin B	tunicate	antineoplastic	Rinehart
phase II (<2004)	cemadotin (dola-15 insp.)	synthetic	tubulin	BASF, Pettit
phase II (<2002)	cryptophycin 52 (≈ arenastatin)*	synthetic	tubulin	Lilly, Valeriote
phase I (2004)	discodermolide*	sponge	tubulin	Novartis, HBOI
phase I (2002)	LAF 389 (bengamide insp.)*	synthetic	MetAP	Novartis, Crews
phase I (<2006)	LAQ 824 (psammaplin insp.)*	synthetic	HDAC	Novartis, Crews
phase I (<2000)	girolline (aka girodazole)*	sponge	protein synthesis	Potier

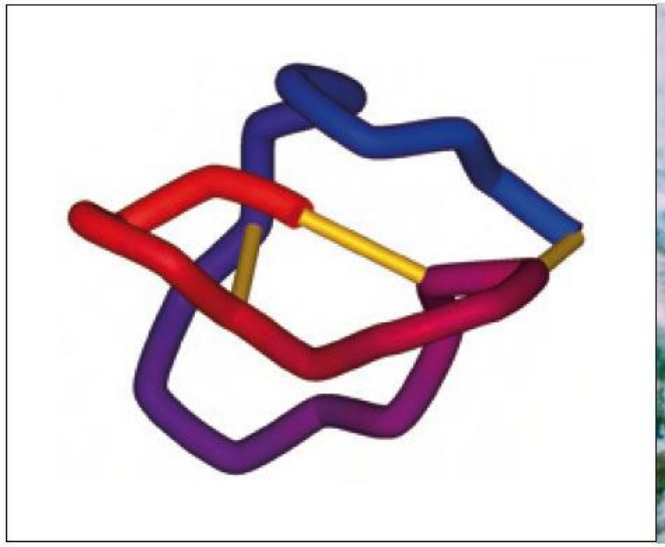
* Substances from marine sponges

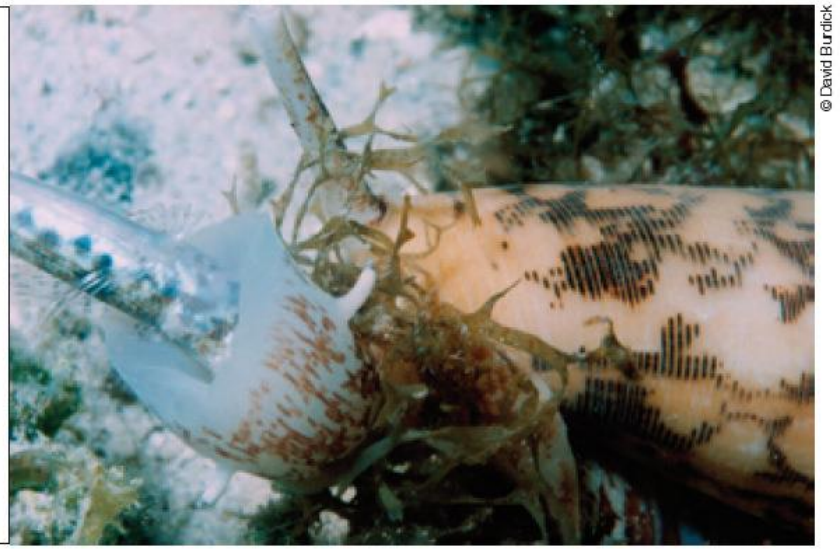
Neurotoxins

H-**Cys**-Lys-Gly-Lys-Gly-Ala-Lys-**Cys**-Ser-Arg-Leu-Met-Tyr-Asp-**Cys**-**Cys**-Thr-Gly-Ser-**Cys**-Arg-Ser-Gly-Lys-**Cys**-NH_2

- **Ziconotide** developed into a synthetic drug for the treatment of patients suffering from neuropathic pain
- Approved for sale under the name Prialt® by the FDA in December 2004 and by the EU in February 2005
- Mechanism: Ca-channel blocker

Cone snail *Conus magnus,* Jan Tytgat, Univ. Leuwen





Bioenergy

Scaling up production from the flask to commercial quantities of biofuels from algae is the real challenge.

D.J. PHILLIP/AP/PA

Gold rush for algae

The second of four weekly articles on biofuels describes how oil giants and others are placing their bets on algae.

THE BUSINESS OF BIOFUELS

No longer lowly pond scum, algae have rocketed in status to what some say is the most promising 'green' fuel source of the future. With the likes of Bill Gates, the US military and ExxonMobil trumpeting their potential, such as maize (corn), soybean and palm. In addition, algae capture carbon dioxide and can thrive in domestic waste water or salt water. But experts warn that there are still high hurdles to overcome before algal biofuels can compete economically with conventional California, co-founded by genomics pioneer J. Craig Venter. ExxonMobil has said that its investment is contingent on Synthetic Genomics achieving certain milestones, and that if their efforts are successful, it expects to spend billions more on final development and early commer-

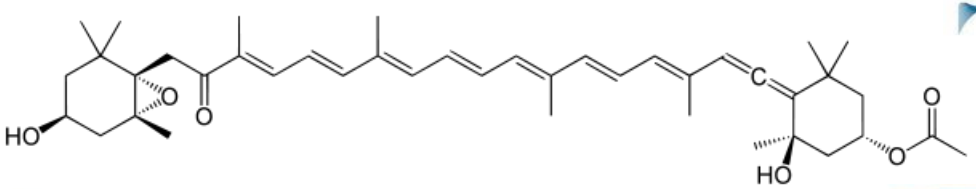
Nature Sept. 2009

Food

Feed

Nutraceuticals

Fucoxanthin



Wakame
Undaria pinnatifida

Claimed effects:

- Antioxidant
- Weight reduction
- Anti-cancer effect

Fucus serratus

- **Constitutes brown colour in algae**
- **Up to 70% of carotenoid in algae**
- **Amounts 170 – 720 mg/kg ww**
- **Highest amounts in *F. serratus***
- **Extracted from waste fractions**

Cosmeceuticals

Cosmeceuticals

- **European market > € 27.6 billion per year (COLIPA – The European Cosmetics Association, 2006)**

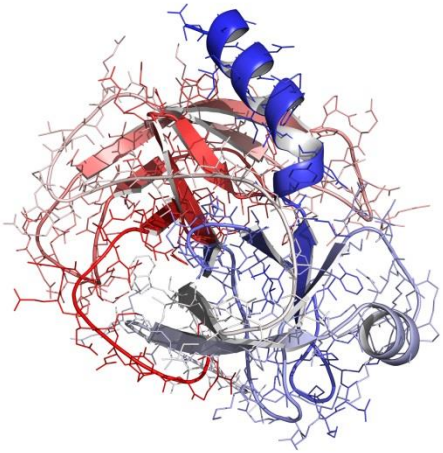
	% of market
• **Skin care products**	**25.7**
• **Hair products**	**23.7**
• **'Toiletries'**	**23.4**

	% production growth
• **Facial serviettes**	**4.9**
• **Whitening agents**	**6.0**
• **Anti-age/anti-wrinkle cream**	**0.5**

- **Trend towards 'natural products'**

Resilience™ by Estée Lauder contains anti-inflammatory pseudopterosin

Products contain blue-green algae extracts



Enzymes

Biopolymers
Biomaterials
Biochemicals

Biopolymers - biomaterials

Source organism	Biomaterial	Health application
Macro-algae	Polysaccharides, calcareous algae	Bone and tissue scaffold
Crustacean and Molluscs	Chitin, chitosan, protein-derived peptides	Tissue repair
Finfish	Protein - collagen	Tissue repair, collagen reinforced cements – bone repair
Sponges	Uses skeletal structure	Bone and tissue scaffold, tissue repair, bone grafting

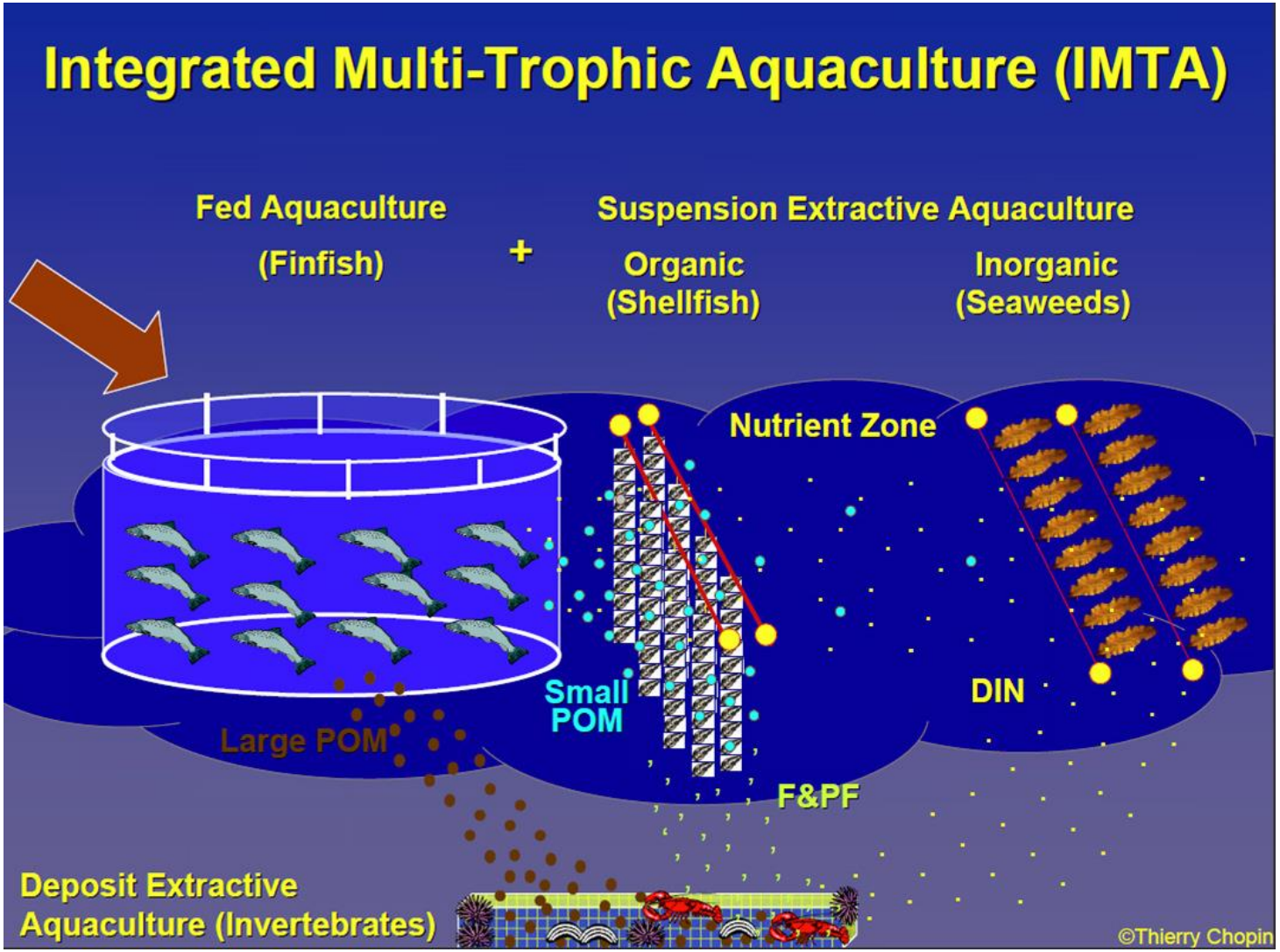
Dermot Hurst, Marine Institute, Ireland

Biopolymers - biomaterials

Source organism	Bioactive compounds	Health application
Molluscs Goose barnacle Mussels	Proteins Proteoglycans	Wound closure Orthopaedics Prosthetics Collection bags
Echinoderms Starfish Urchins	Proteins	Orthopaedics *Dermot Hurst, Marine Institute, Ireland*

Another example:
Slime eel used for new biomaterial
Source: Vancouver Aquarium (2014)
http://www.youtube.com/watch?v=pmaal7Hf0WA

Aquaculture


Integrated Multi-Trophic Aquaculture (IMTA)
Fed Aquaculture
(Finfish)
+
Suspension Extractive Aquaculture
Organic
(Shellfish)
Inorganic
(Seaweeds)
Nutrient Zone
Small
POM
DIN
Large POM
F&PF
Deposit Extractive
Aquaculture (Invertebrates)
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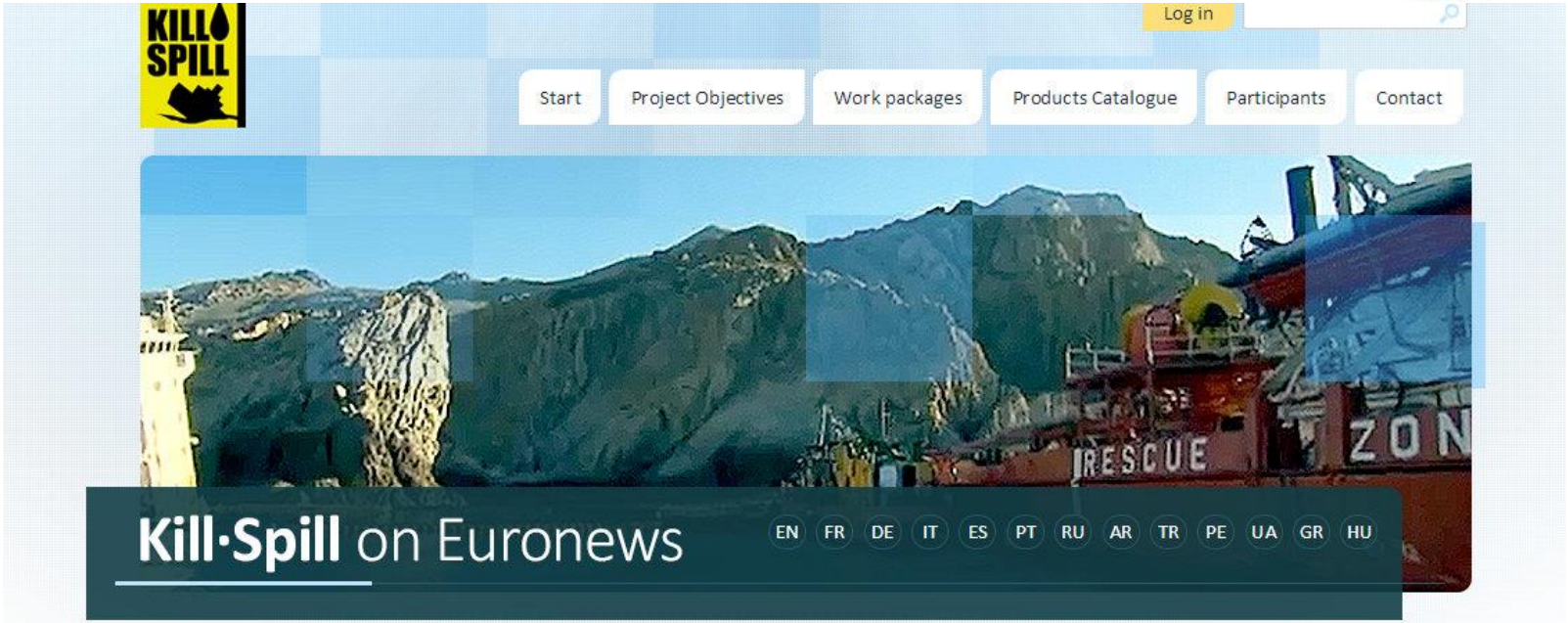
Bioremediation
Antifouling



Welcome to the web page of the Kill-Spill project

Kill-Spill is a European funded FP7 project focusing on the development of highly efficient, economically and environmentally viable solutions for the clean-up of oil spills caused by maritime transport or offshore oil exploration and related processes

It provides new tools to promote novel (bio)technologies in oil spills remediation. It aims at developing biosensors to monitor hydrocarbon degradation, novel environmentally friendly dispersants and adsorbents, combined microbial and additives formulations, multifunctional bioremediation agents and tools for sediments decontamination. The impact and toxicity of these newly developed products will be evaluated; and they will be validated in mesocosms and on real oil spills

Latest project news

Course Announcement

FACILIS 2014: http://www.facilis2014.unimi.it/

Kill•Spill represented at Spillex, Oceanology International 2014, Excel, London

The Kill•Spill project was represented by EPE from Greece and Ecots from Italy. In addition,

Time to market for new products

- 1-5 years
  - Food, nutraceuticals
  - Cosmeceuticals
  - Aquaculture products
- 5-10 years
  - Biomaterials
  - Biopolymers
  - Antifouling
- > 10 years
  - Pharmaceuticals
  - Bioenergy
  - Bioremediation

Investments

Conclusion

- The potential for MBT is great
- The challenges are
  - Upscaling from lab to industrial scale
  - A processor sourcing from a given raw material has to target several markets – multistream
  - Specialised processors to work together, targeting different applications and markets
- Any market success based on solid knowledge

Partners

The Research Council of Norway

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