

Petroleum 101

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Petroleum 101

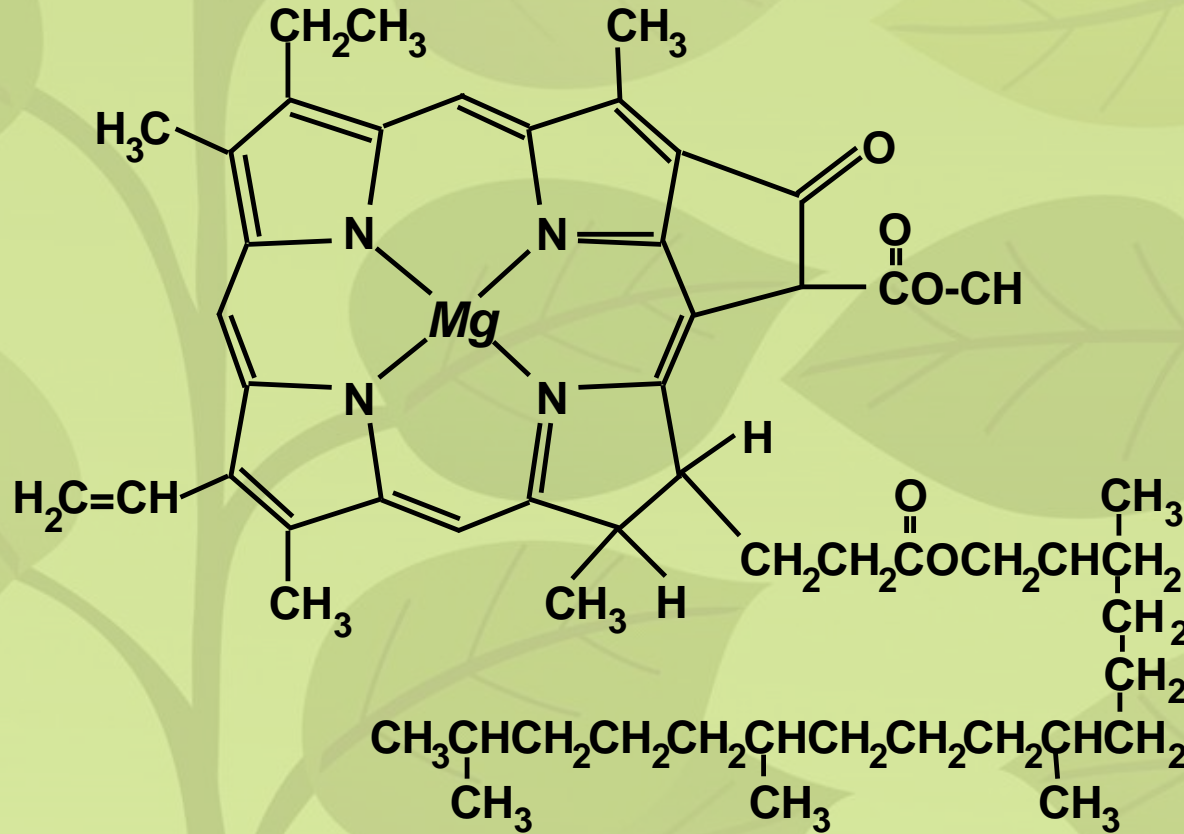
- **Origin**
- **Physical & Chemical Characteristics**
- **Classification**
- **Weathering**
- **Deepwater Horizon Spill**

Petroleum 101

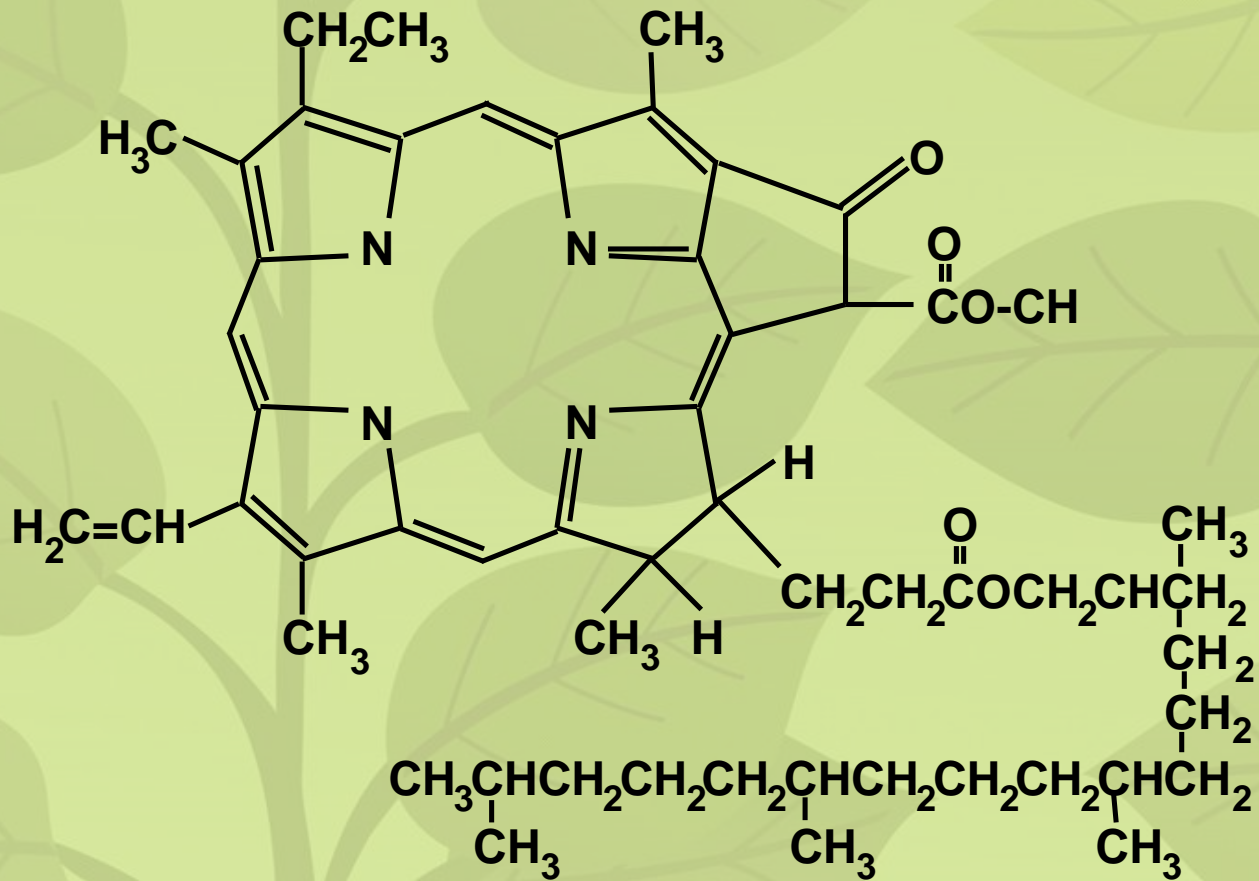
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Origin

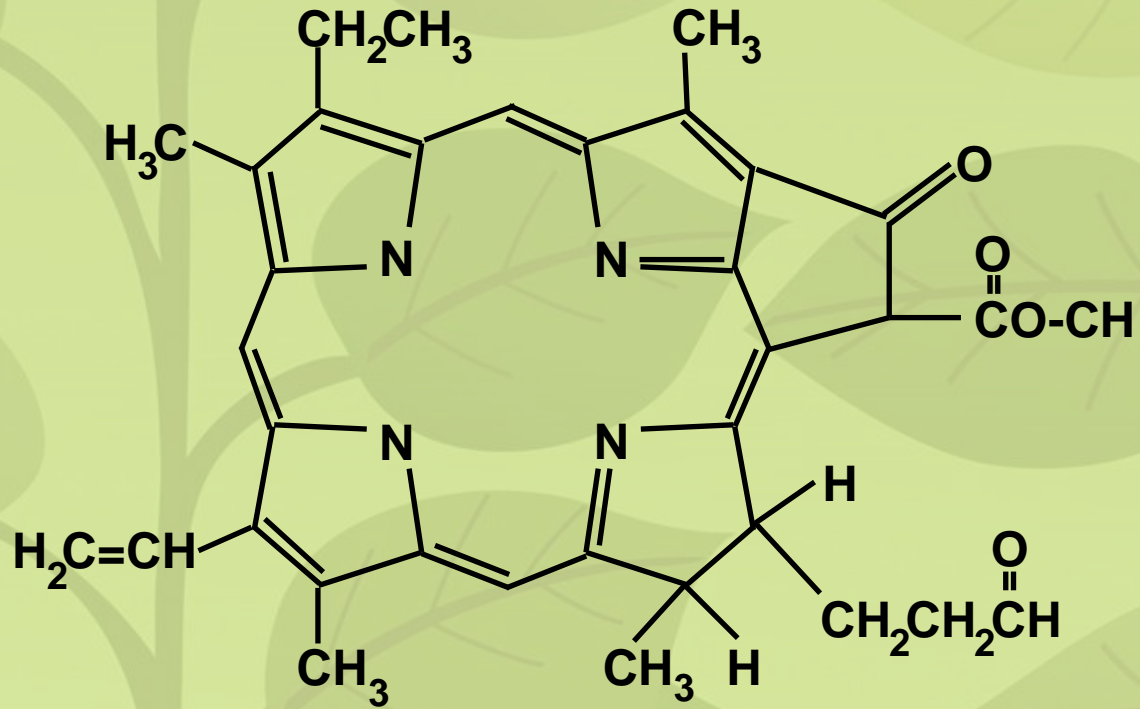
- **Formed in muddy marine sediments**
- **Low oxygen**
- **Rich in organic matter (mostly plant)**
- **Buried 10,000 ft deep for millions of years**
- **Kept under pressure**
- **Kept at temperatures 70°-120°C**



Chlorophyll molecule

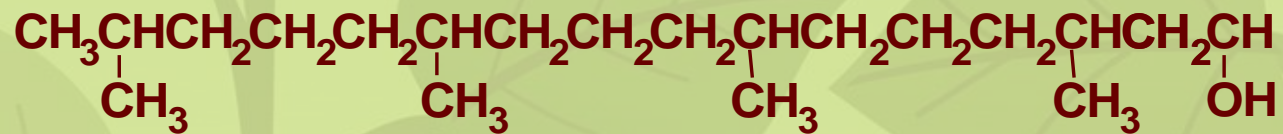


Magnesium lost



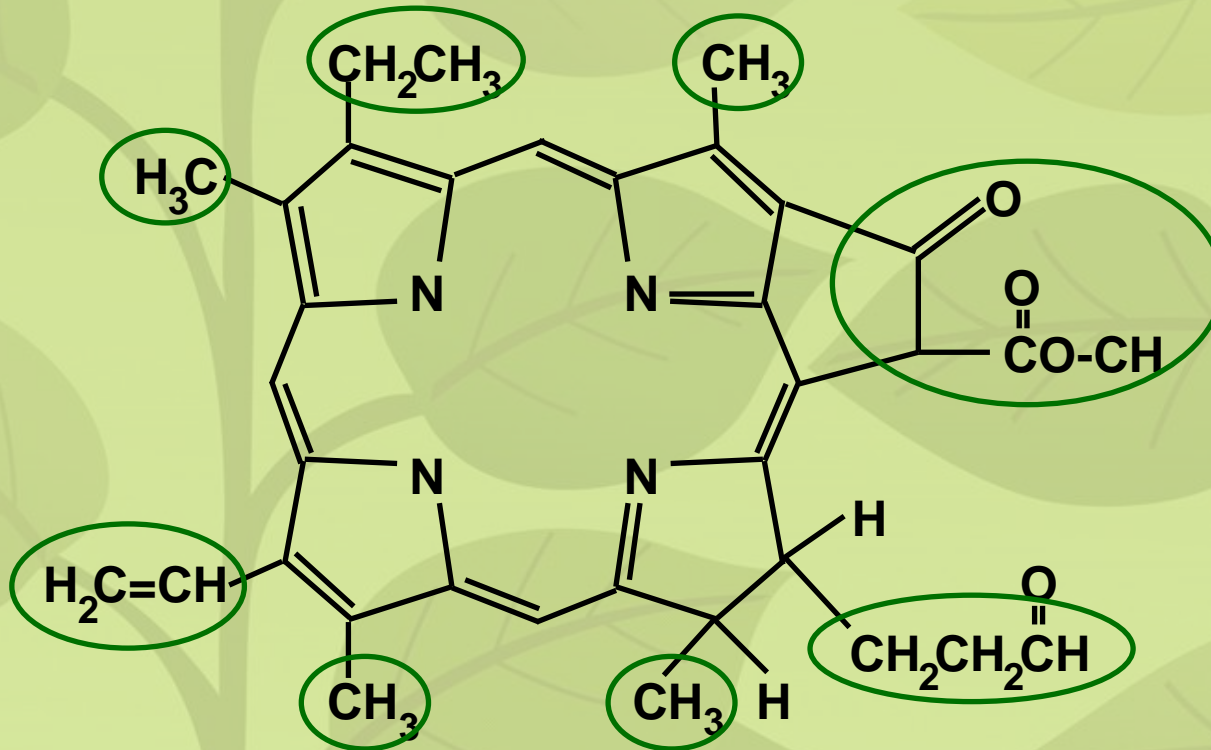
Phytol lost

phytol

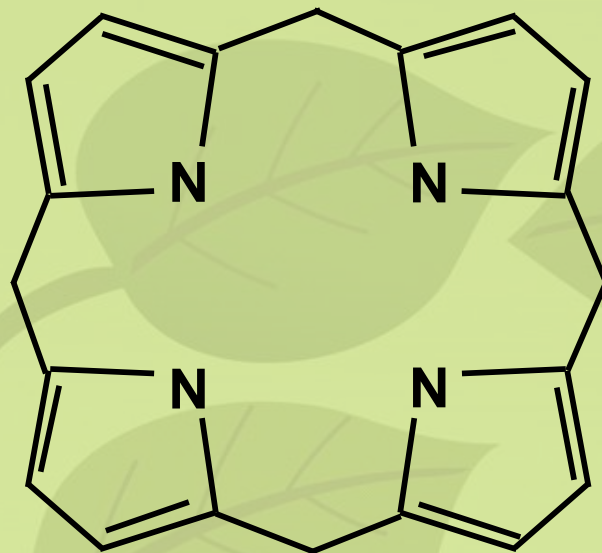


pristane and phytane

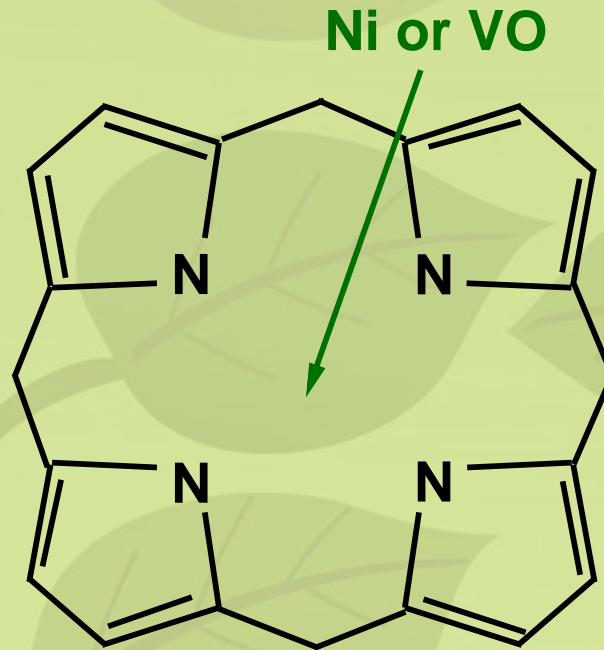
Chemical fossils found in petroleum



Side chains will be lost

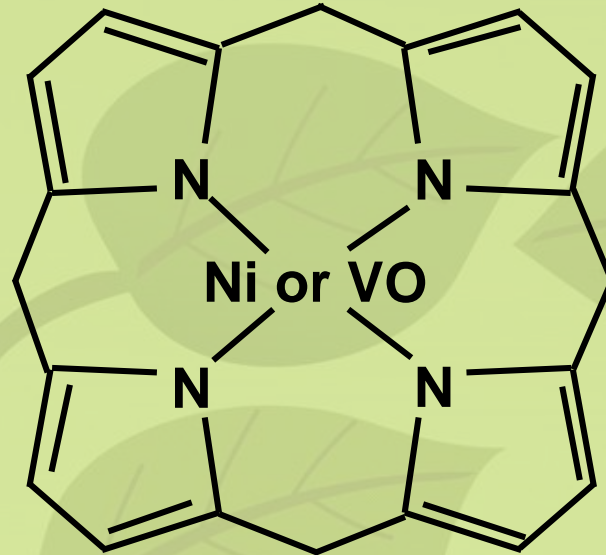


Millions of years



Nickel or Vanadium enters porphyrin ring

Chemical fossil of plants found in petroleum



Final porphyrin molecule

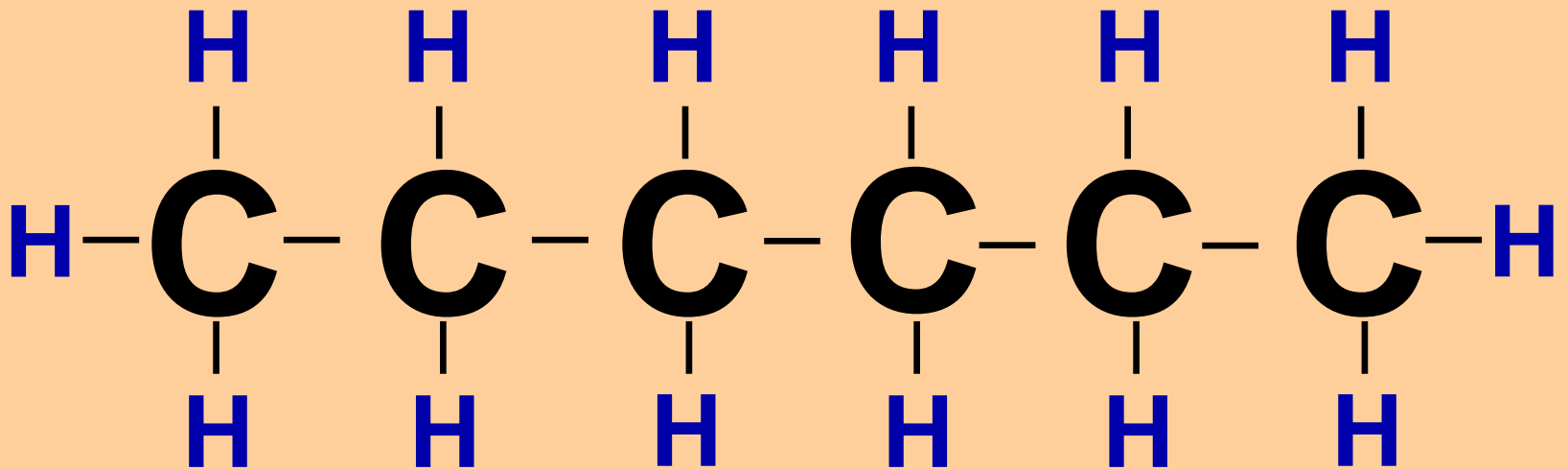
Petroleum 101

- Origin
- **Physical & Chemical Characteristics**
- Classification
- Weathering
- Deepwater Horizon Spill

Physical & Chemical Characteristics

- **Mixture of alkanes, cyclic alkanes & aromatic hydrocarbons**
- **Viscous fluid**
- **Density less than water**
- **Wide range of solubilities**
- **Wide range of volatilities**
- **Wide range of boiling points**

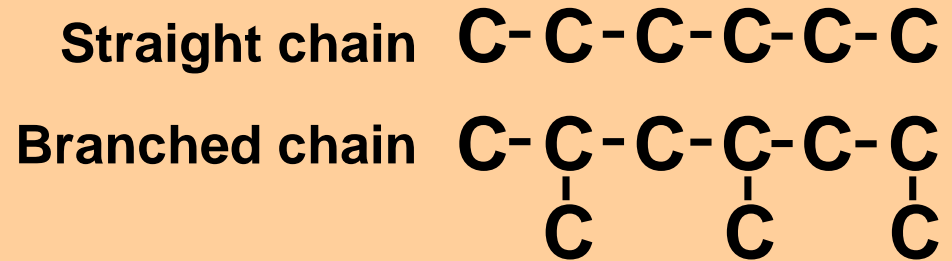
HYDROCARBONS



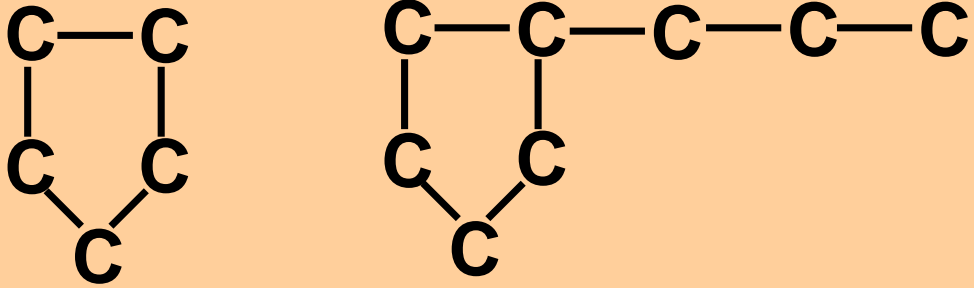
CRUDE OIL HYDROCARBONS

Class

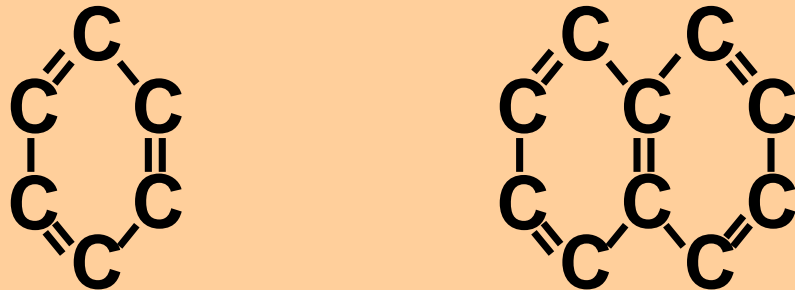
ALKANES
-or-
PARAFFINS



CYCLIC ALKANES
-or-
NAPHTHENES



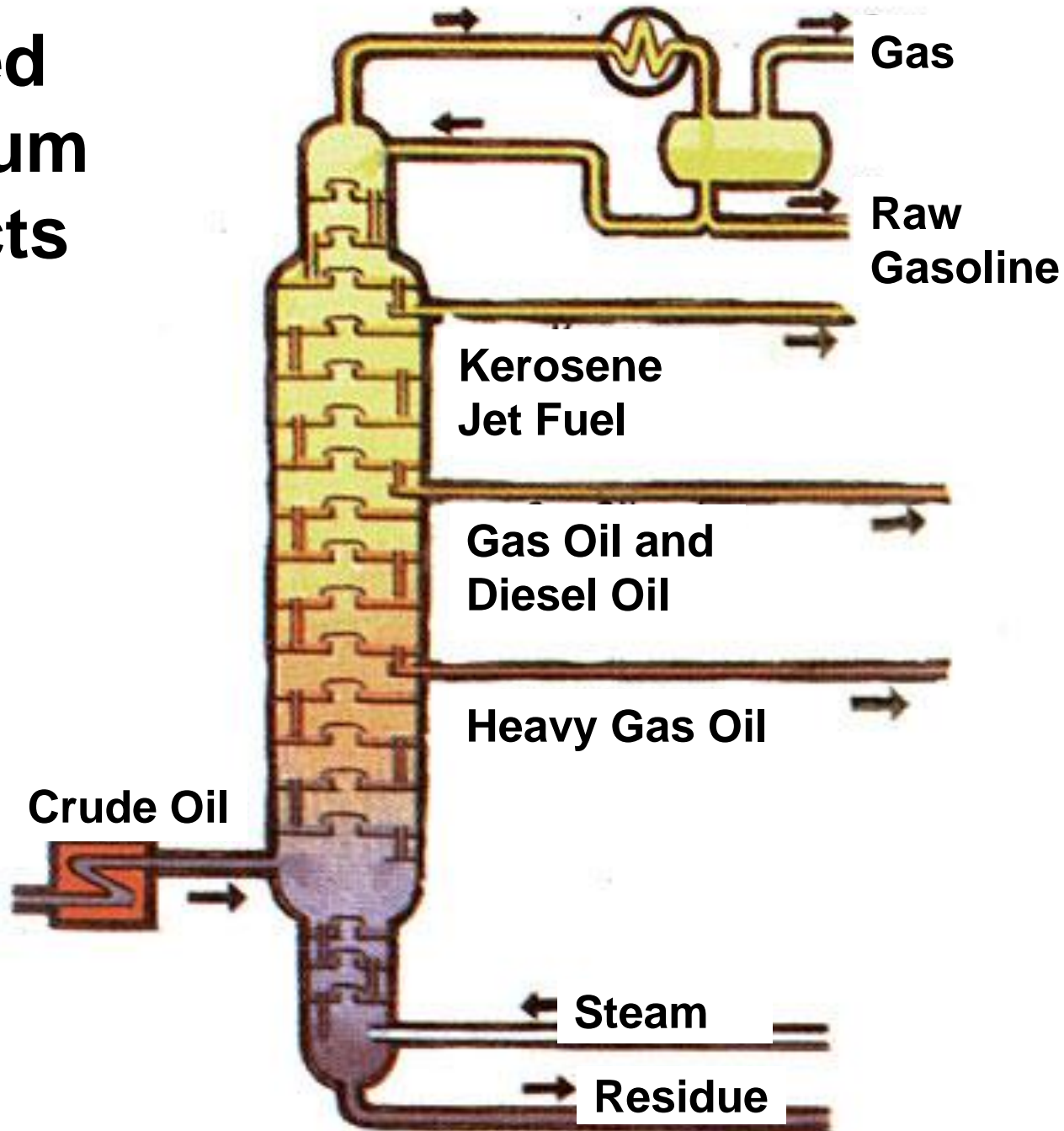
AROMATICS



Physical & Chemical Characteristics

- **Mixture of alkanes, cyclic alkanes & aromatic hydrocarbons**
- **Viscous fluid**
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- **Wide range of volatilities**
- **Wide range of boiling points**

Refined petroleum products



Petroleum 101

- Origin
- Physical & Chemical Characteristics
- **Classification**
- Weathering
- Deepwater Horizon Spill

Classification

- Light, medium, heavy (densities)

Light

high evaporation rate

highly fluid

strong odor

flammable

may be highly toxic

Heavy

non volatile

tarry

little odor

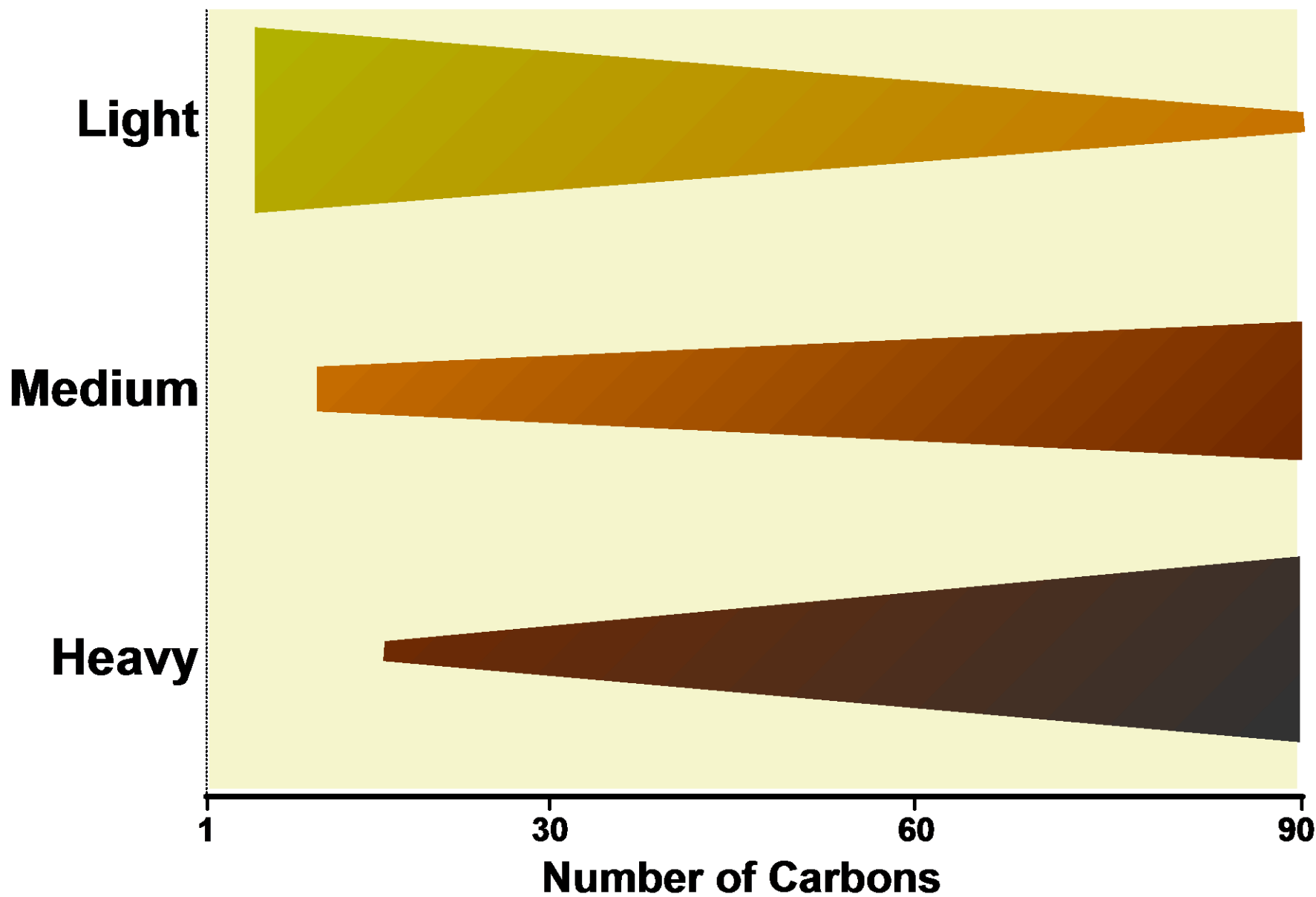
low flammability

low toxicity

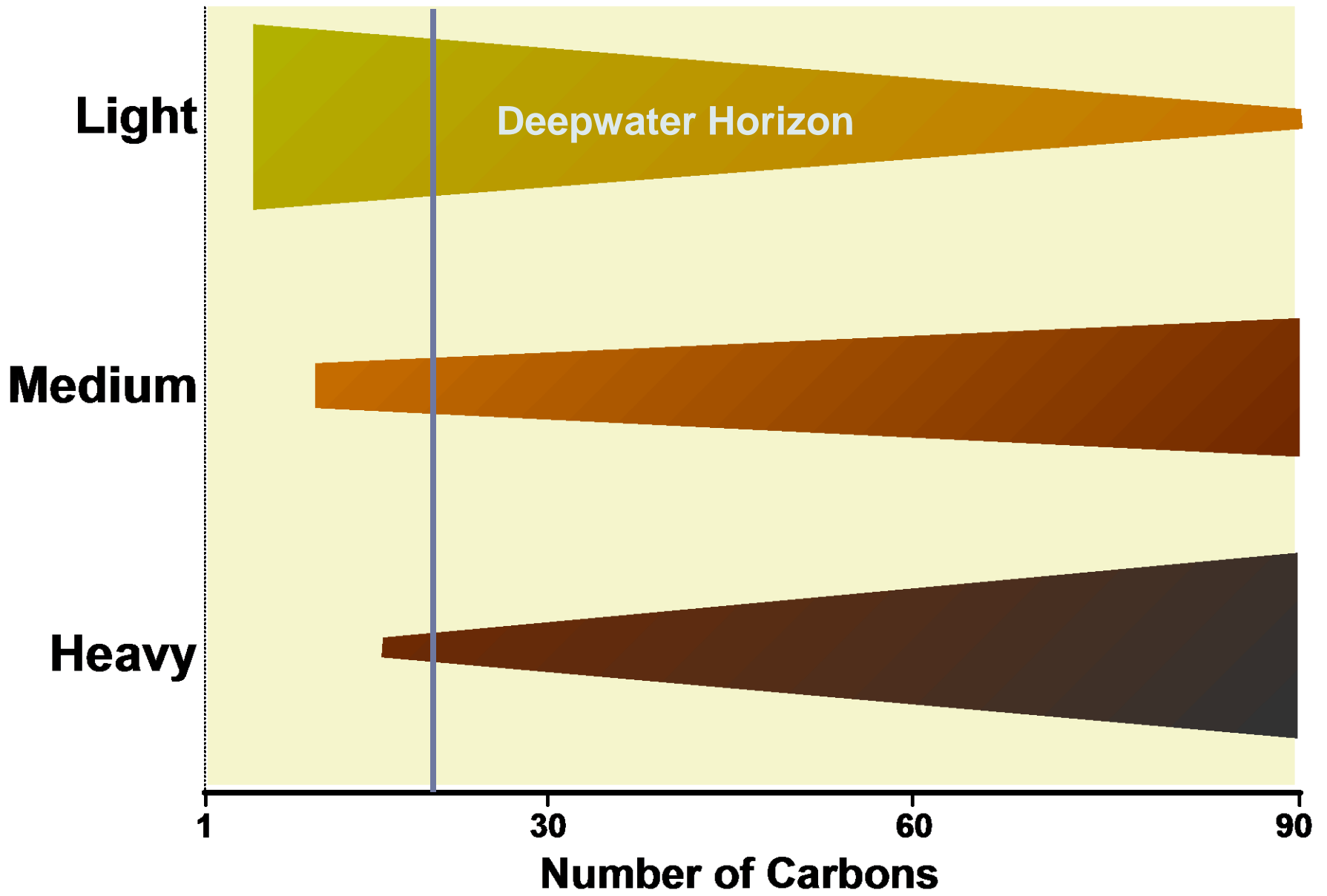
- Sweet or sour (amount of sulfur)

Sweet----low sulfur

Sour----high sulfur



Composition of Crude Oils



Composition of Crude Oils

Classification

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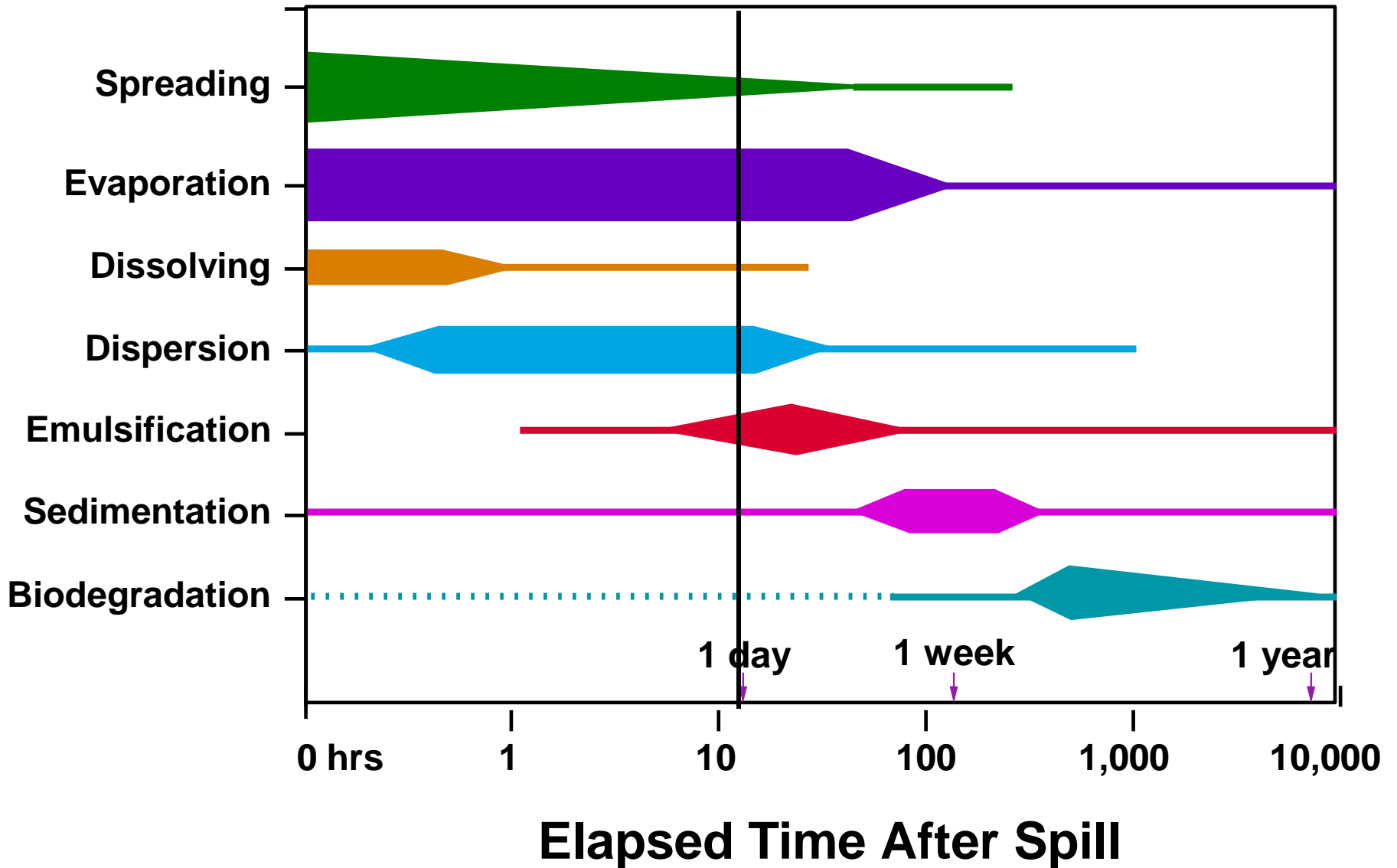
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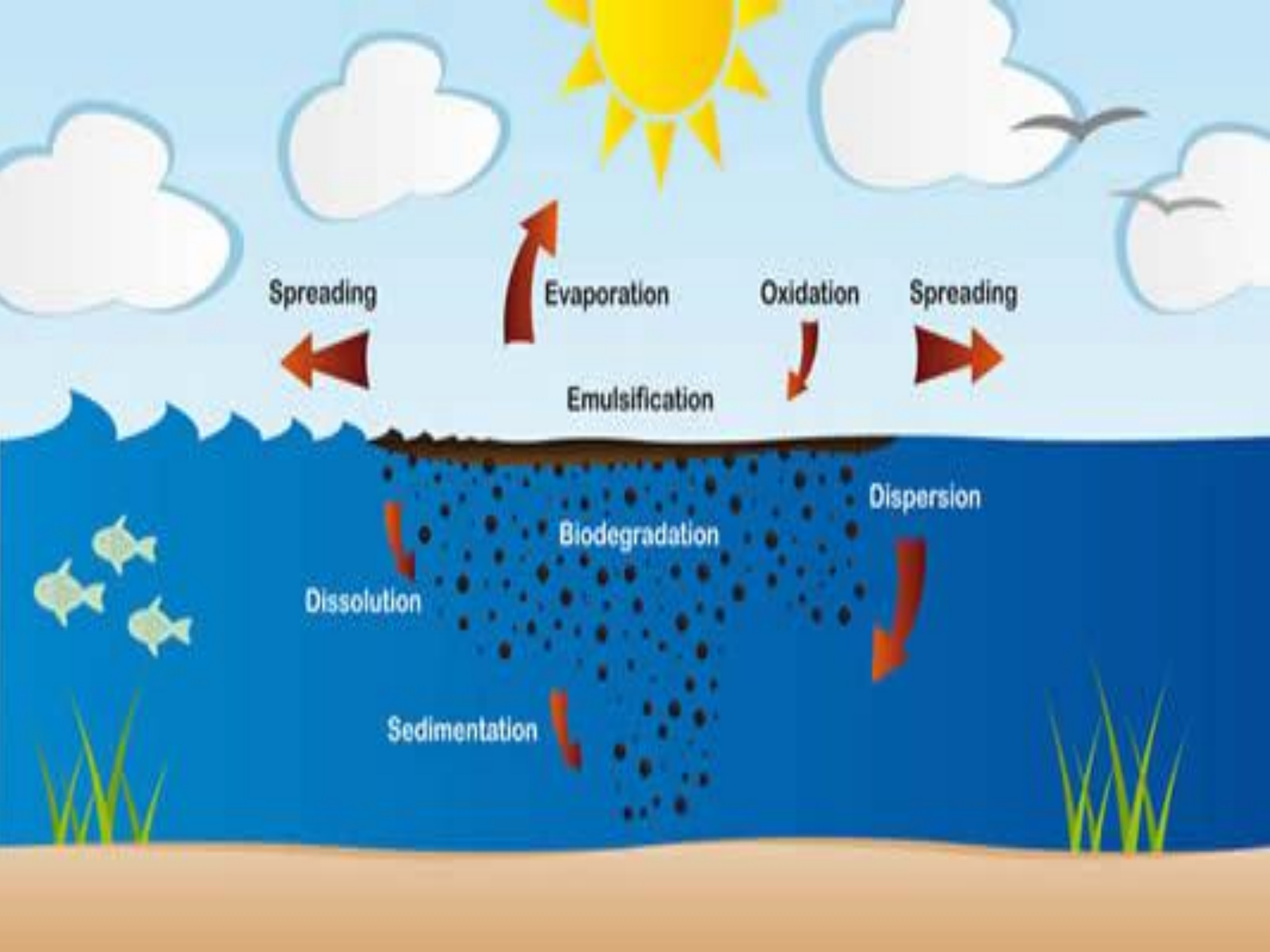
Weathering Processes

(In order of time)

- **Spreading**
- **Evaporation**
- **Dissolution**
- **Dispersion**
- **Emulsification**
- **Sedimentation**
- **Microbial degradation**

Weathering Oil Processes





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Single most important weathering process

Evaporation



- Air temperature
- Wind speed
- Surface roughness
- Area of spread



Spreading oil



- **More loss by evaporation**
- **Weathers rapidly by UV light**
- **Possible impact on marsh**
- **Possible impact on near-shore birds, fish and animals**

Water dissolution



Poses short-term risk to aquatic organisms

- Benzene compounds
- Short chain alkanes
- Low-molecular weight cyclic alkanes

Use of dispersants

1,100 million gallons of dispersants were used

Puts petroleum into solution

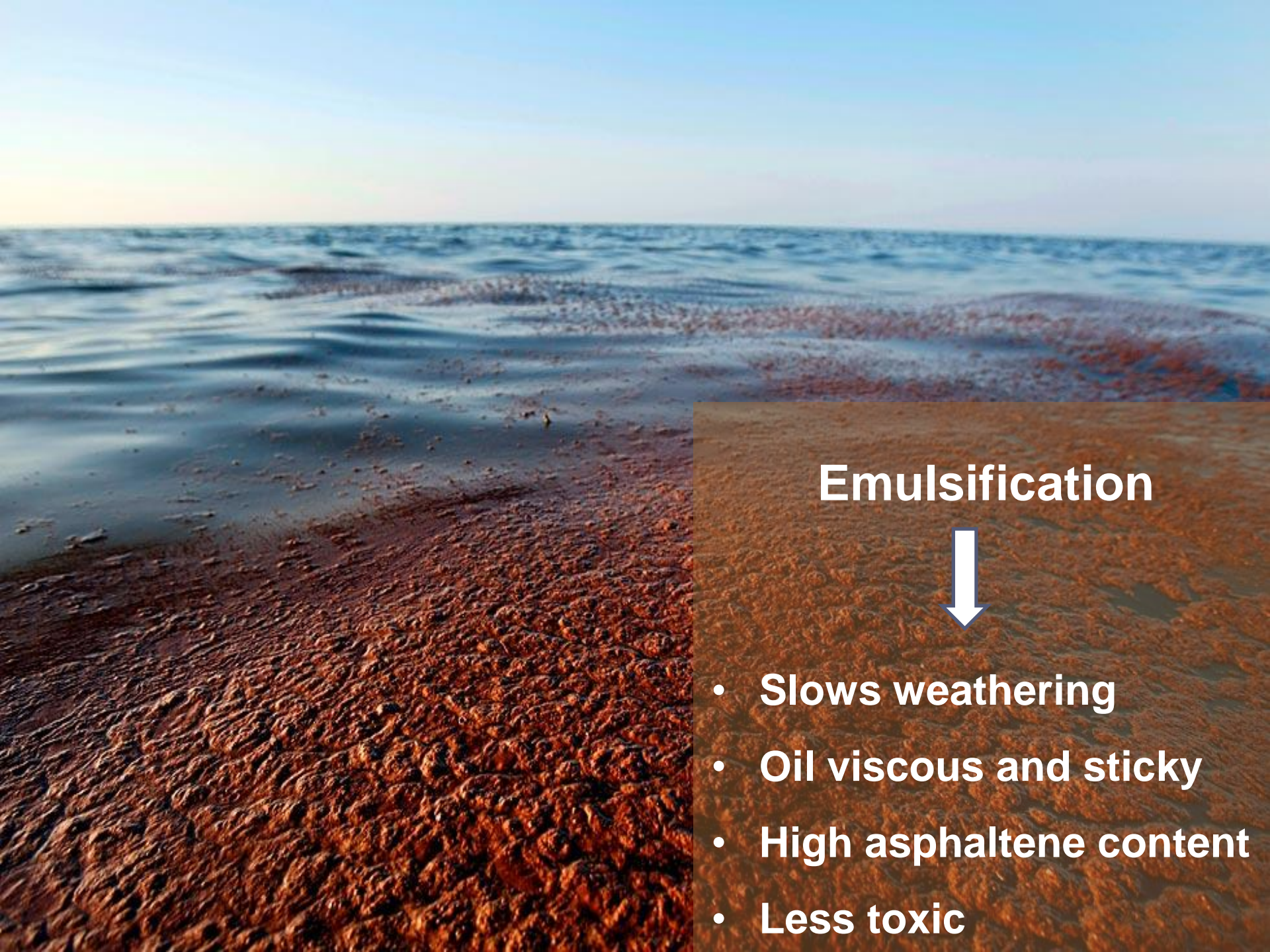


Degradation slows in deep cold water

Prevents oil from rising to surface

Prevents evaporation

Increases toxicity



Emulsification



- Slows weathering
- Oil viscous and sticky
- High asphaltene content
- Less toxic











Sedimentation



- Low oxygen conditions preserve HCs thus very slow weathering
- Buried oil can remain toxic for long periods of time



Microbial degradation



All favor short chain HC

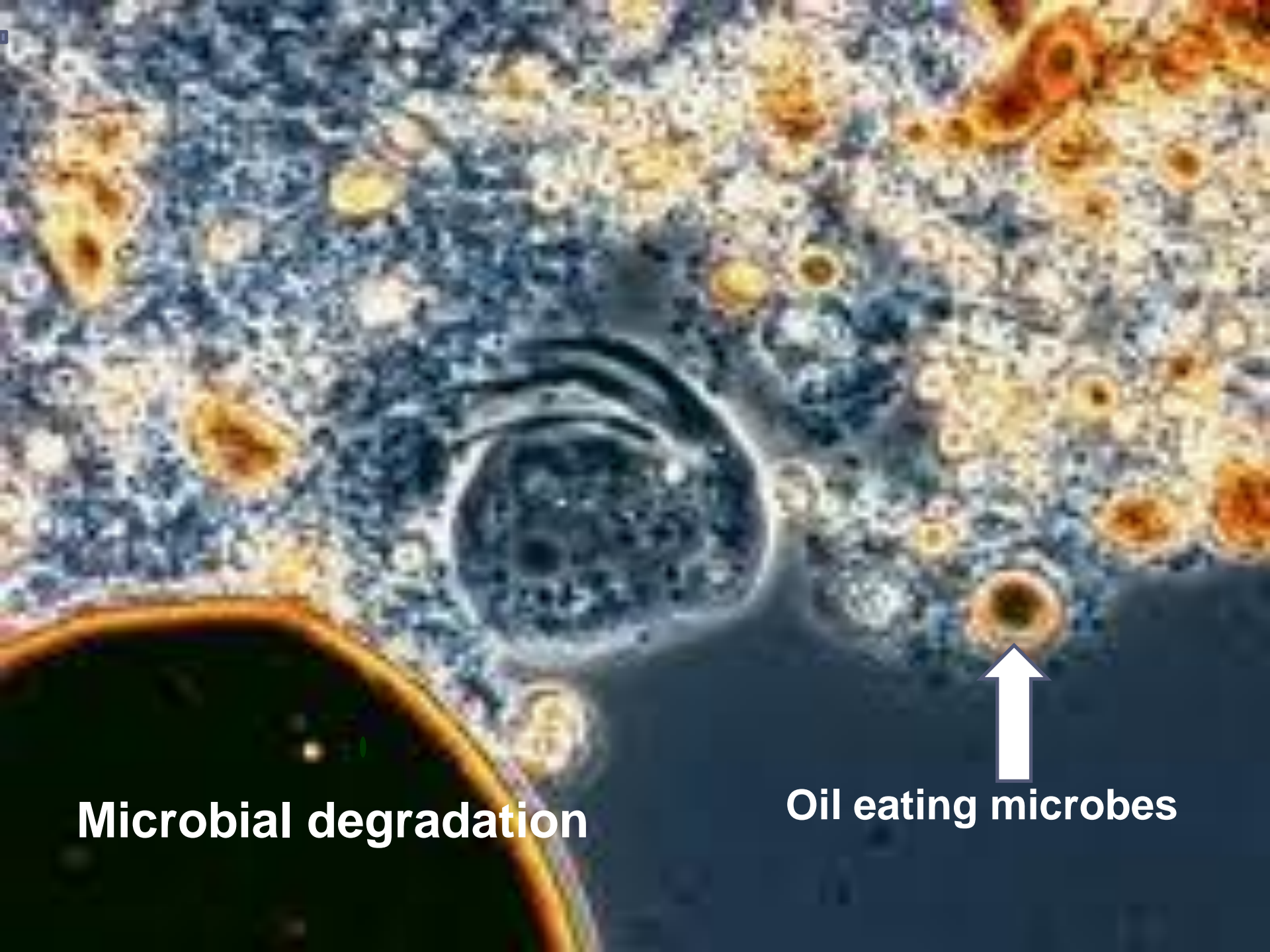
Species specific for certain HC

Suite of microbes necessary

Straight chains

Cyclics

Branched chains



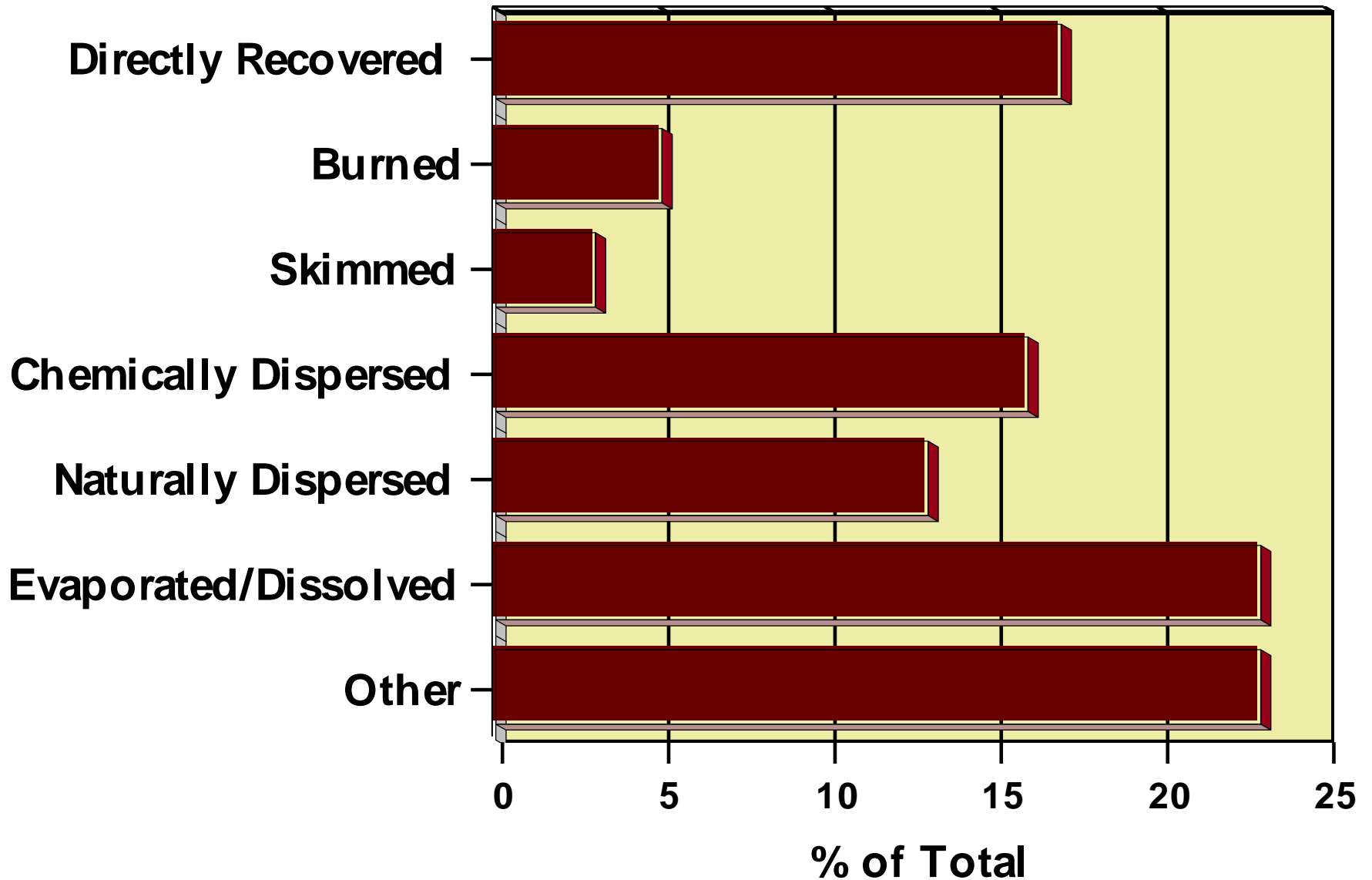
Microbial degradation

Oil eating microbes



Tarballs wash ashore

Deepwater Horizon Oil Budget Nov 2



SUMMARY

- **Large fraction of oil remains in the Gulf—most likely as dispersed plumes, in and on sediment & tar balls**
- **Oil remaining is weathering at different rates—some will be very persistent**
- **Weathered oil is less toxic**
- **Long range studies are needed to follow degradation and environmental impacts**