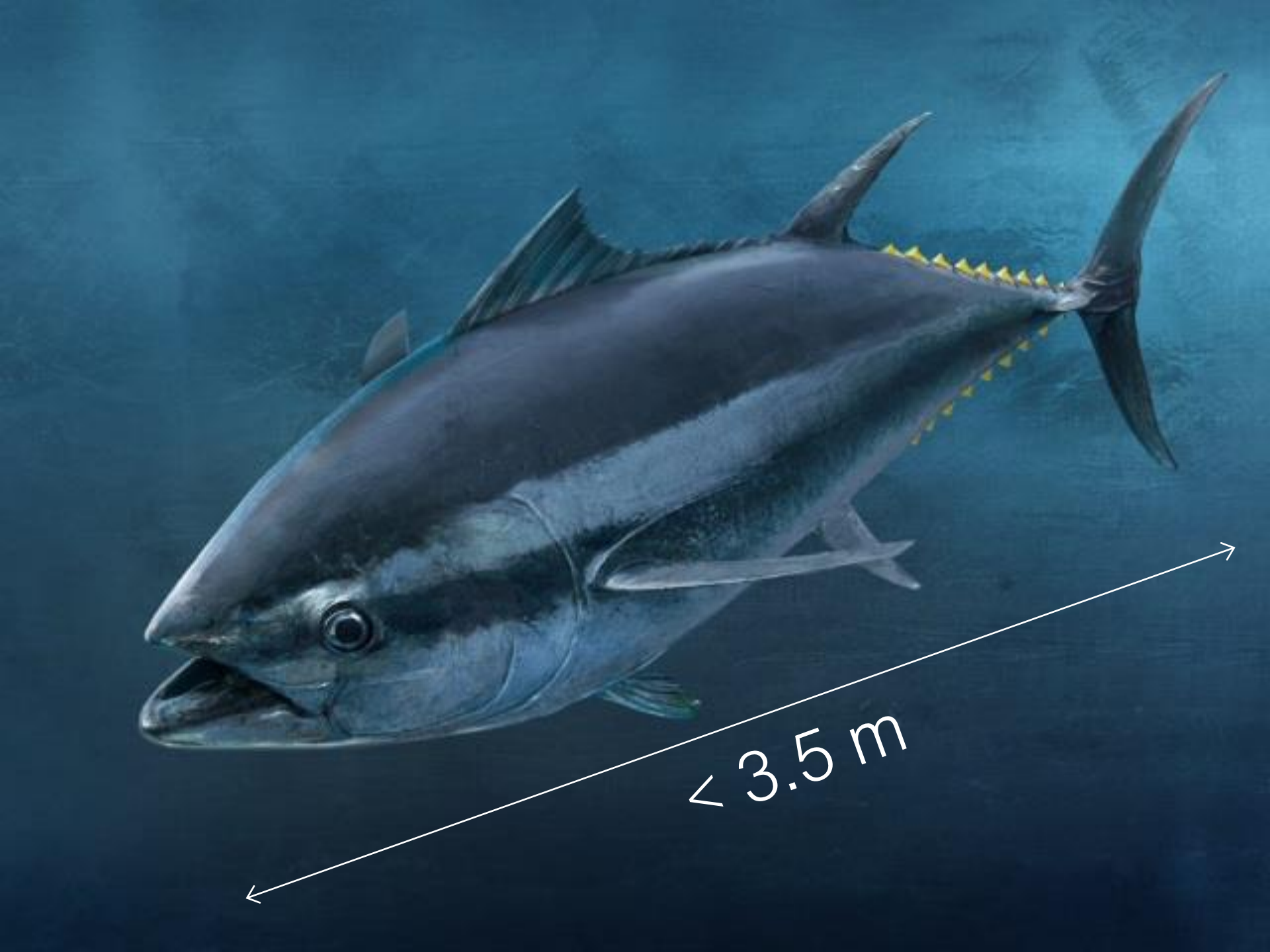
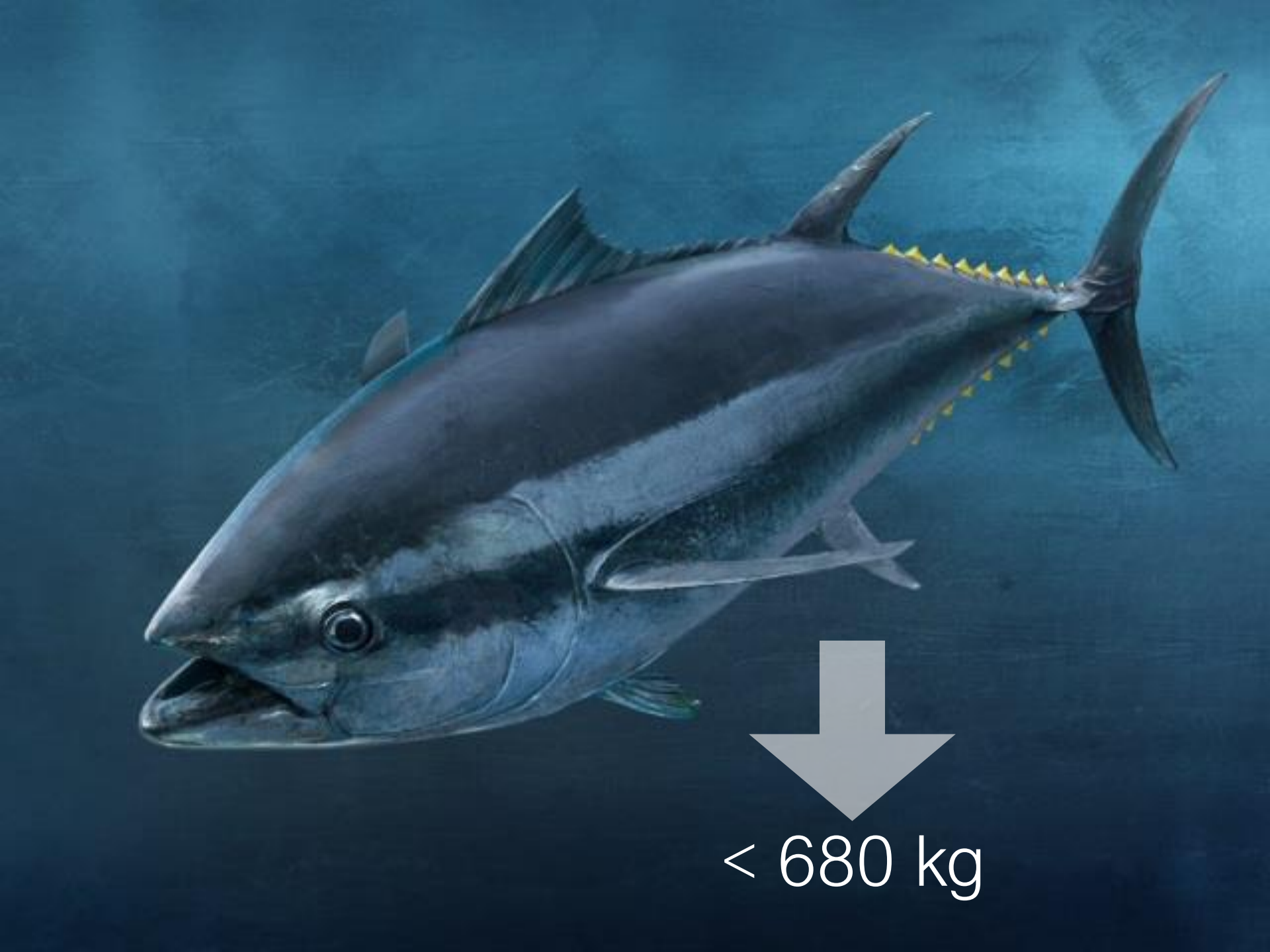
Atlantic bluefin tuna - a natural history

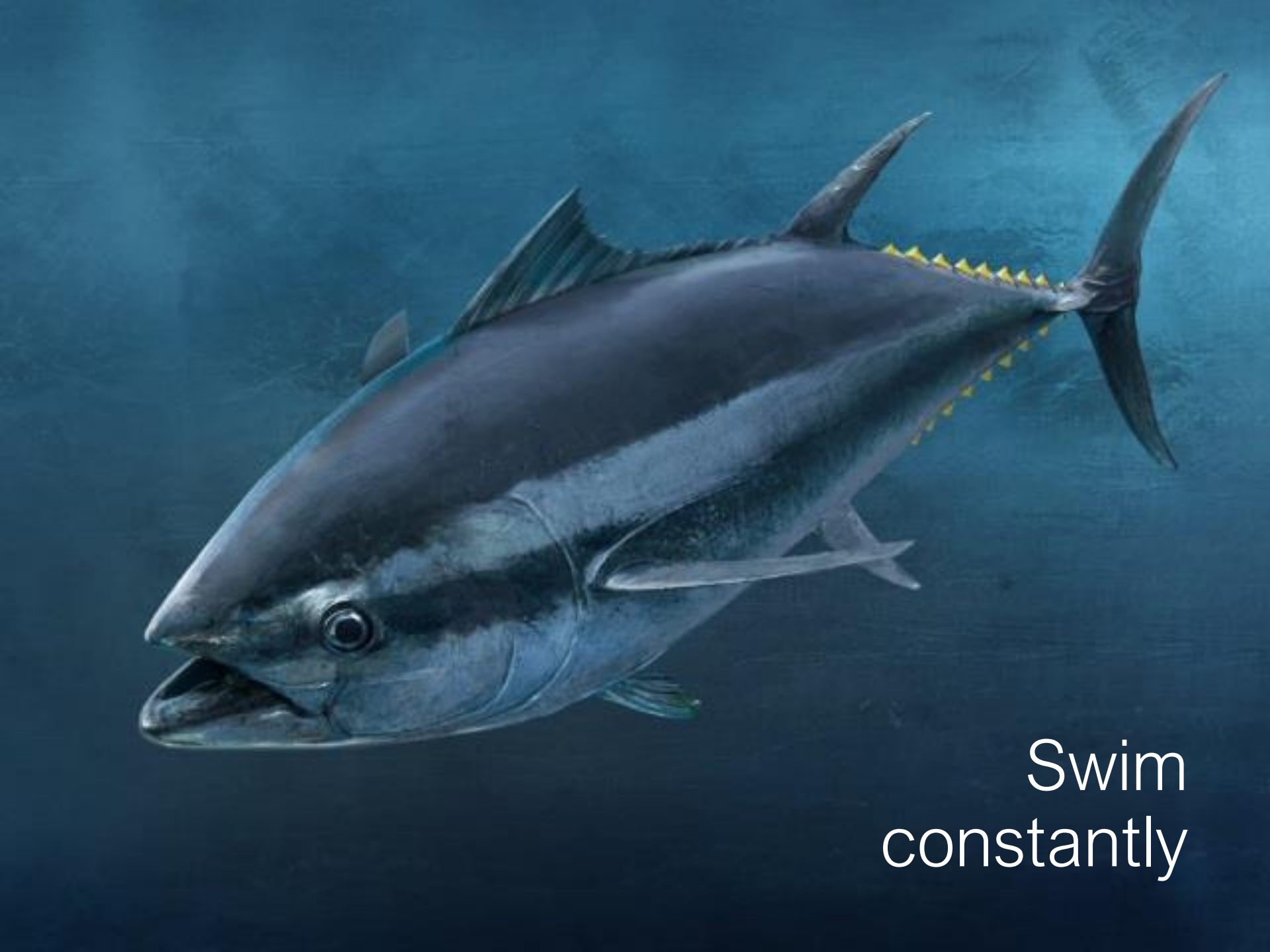
Dr Lucy Hawkes

UNIVERSITY OF EXETER
Cefas
HOPKINS MARINE STATION OF STANFORD UNIVERSITY

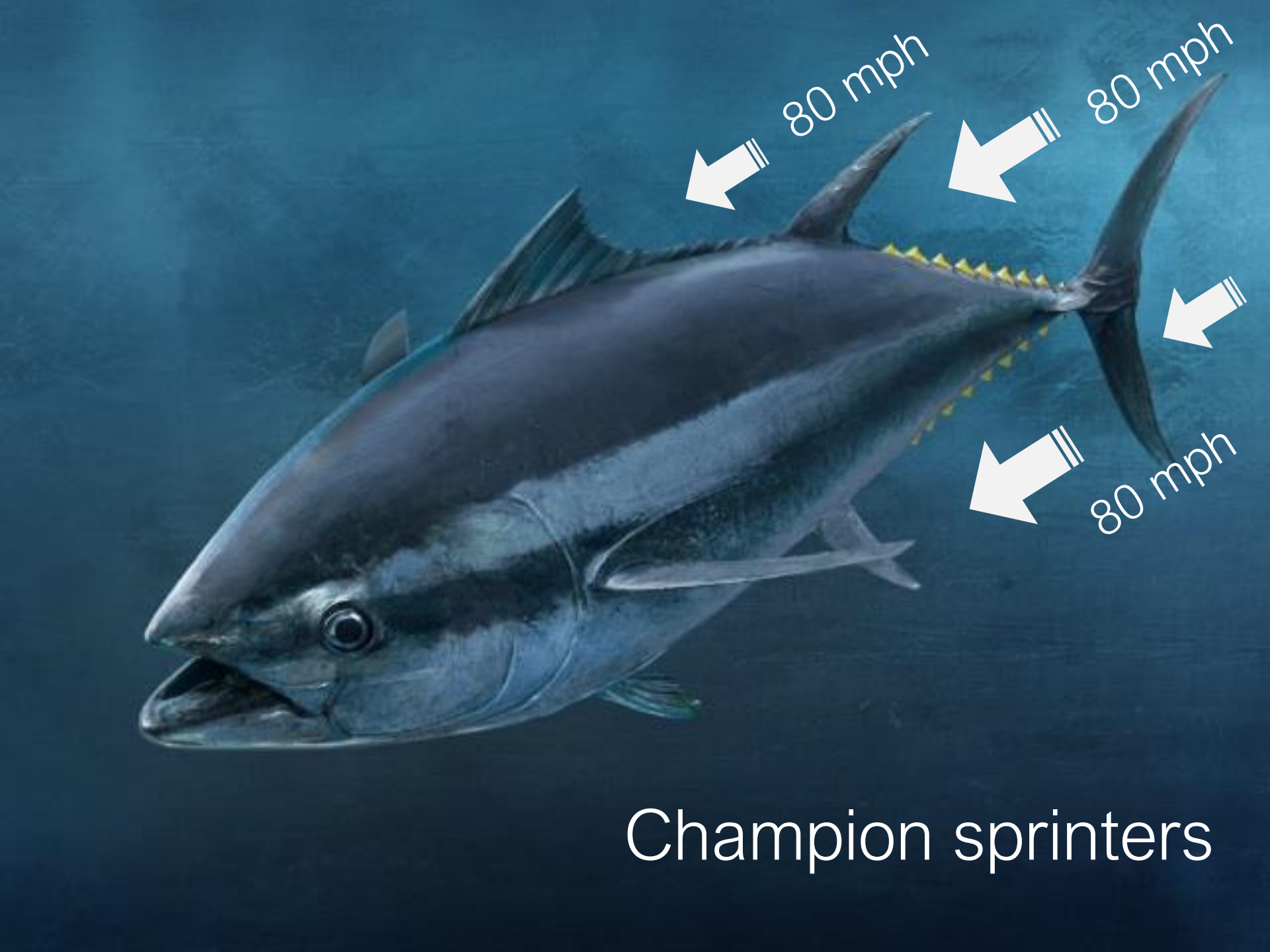
Image: National Geographic


< 3.5 m


< 680 kg


Swim
constantly

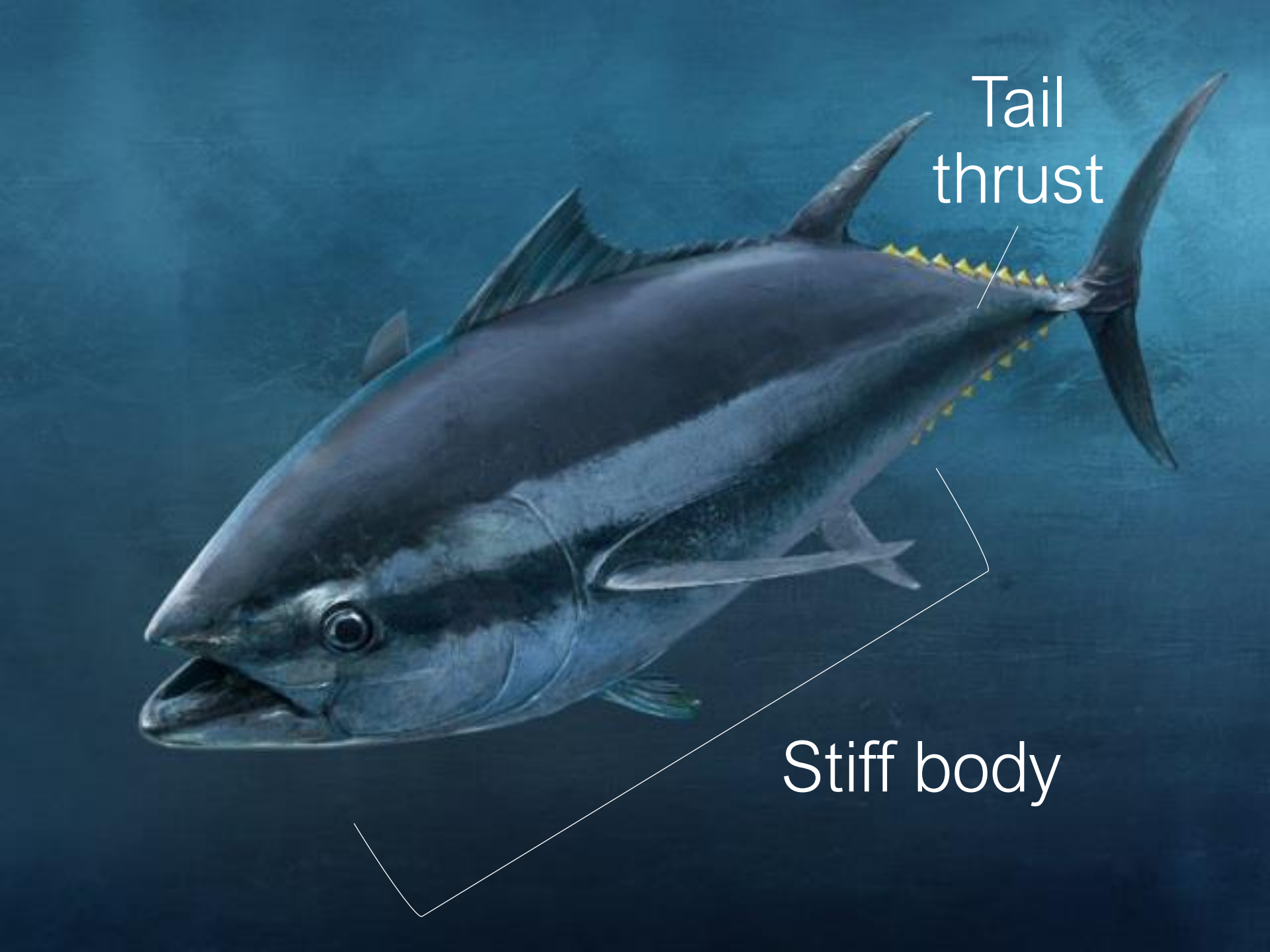
2.5 marathons per day
Elite endurance athletes

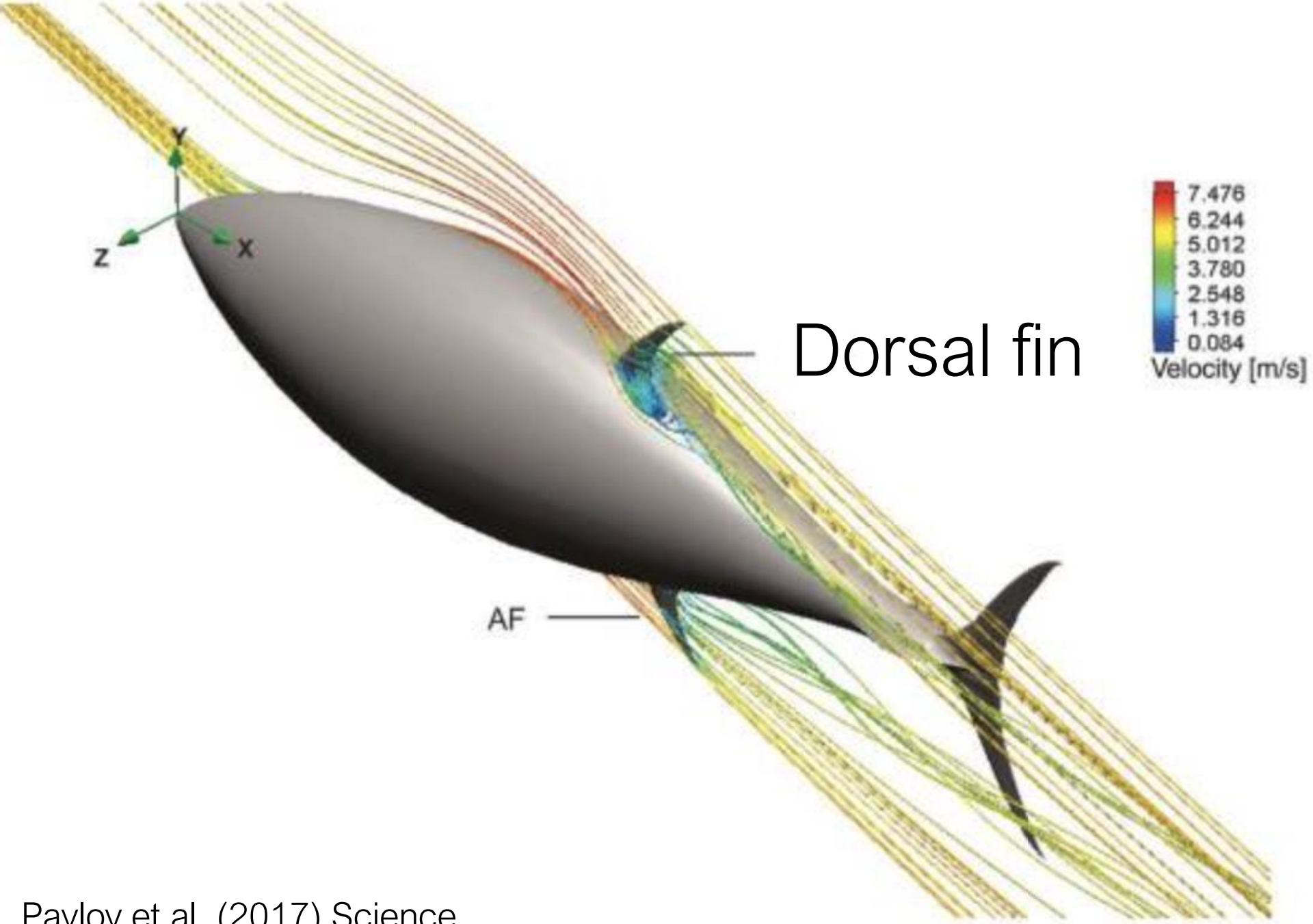

80 mph
80 mph
80 mph
Champion sprinters

Feeding frenzies

Photo: Tom Horton

Fusiform
body
shape

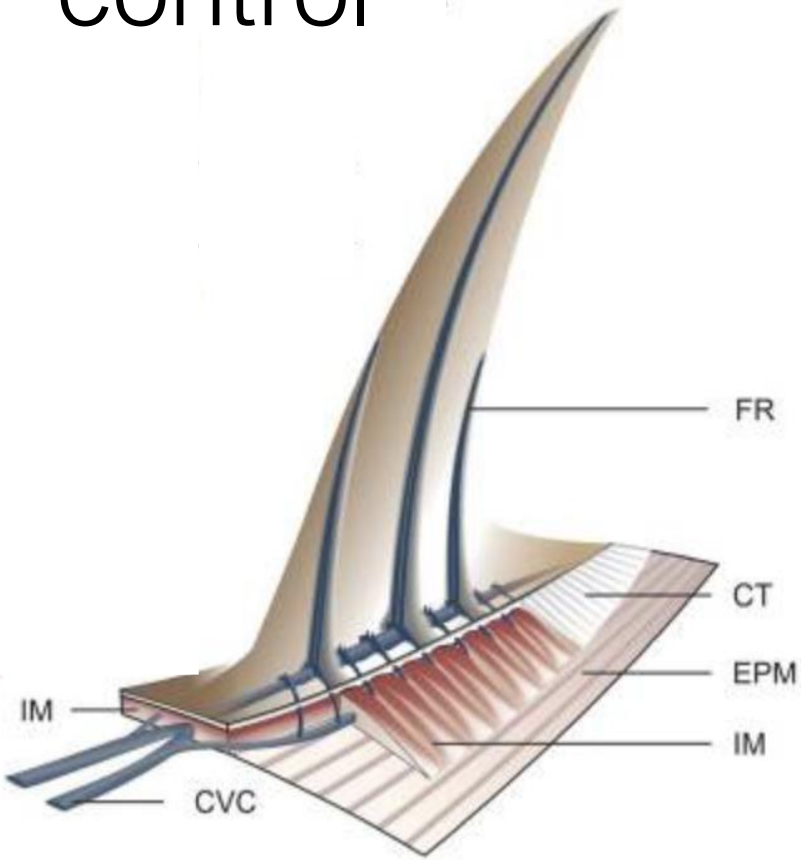

Tail
thrust
Stiff body



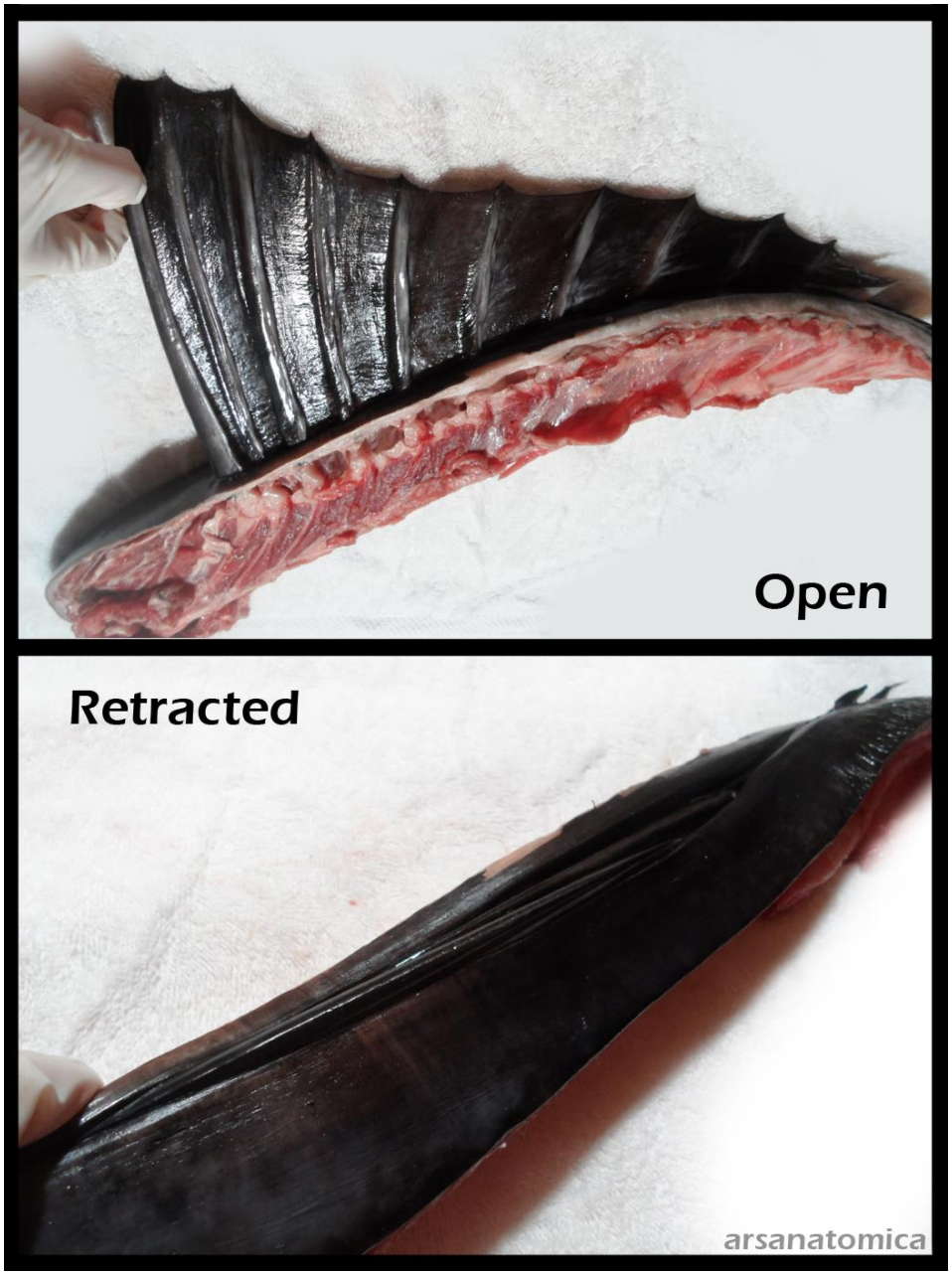
Pavlov et al. (2017) Science

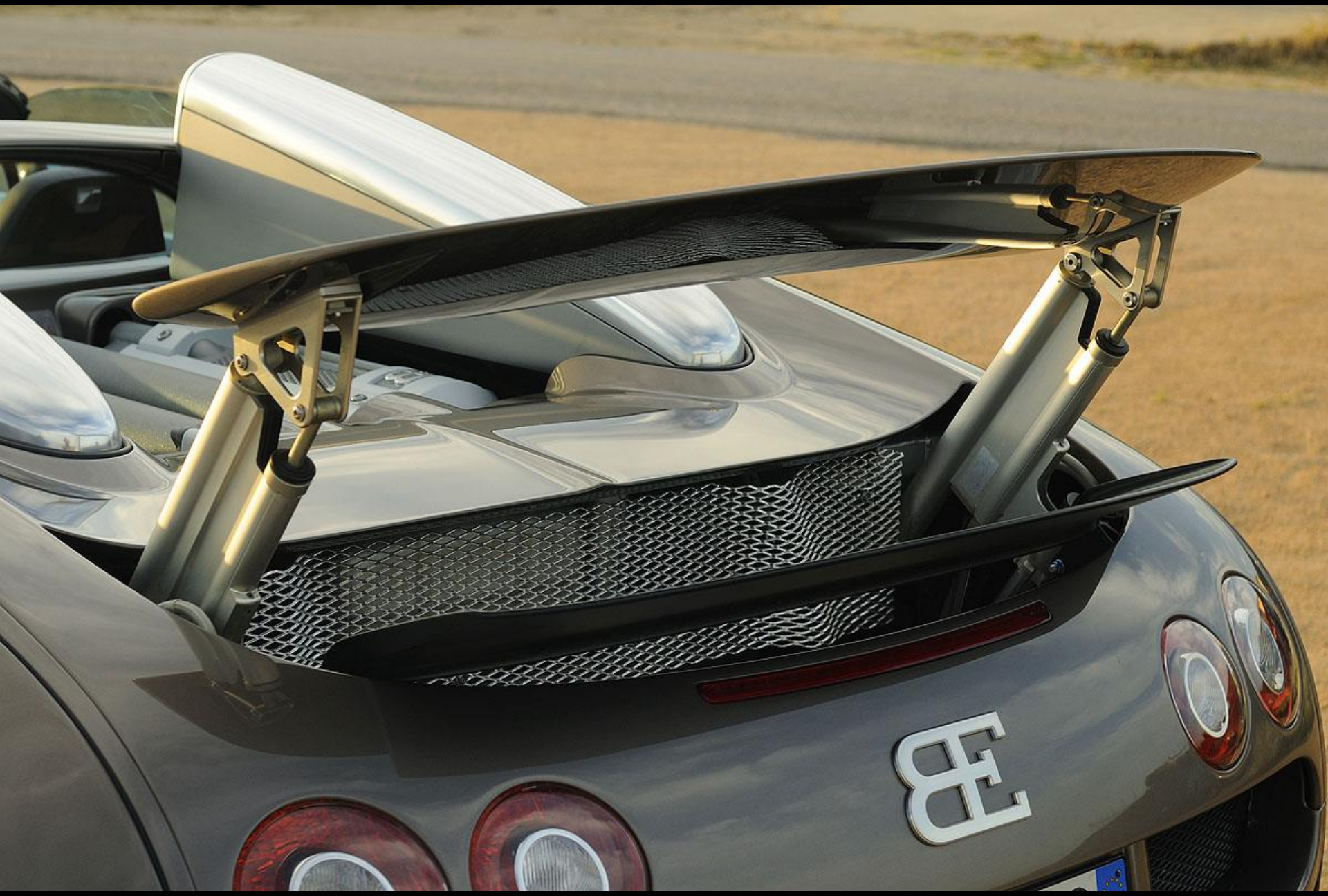
Retractable fins

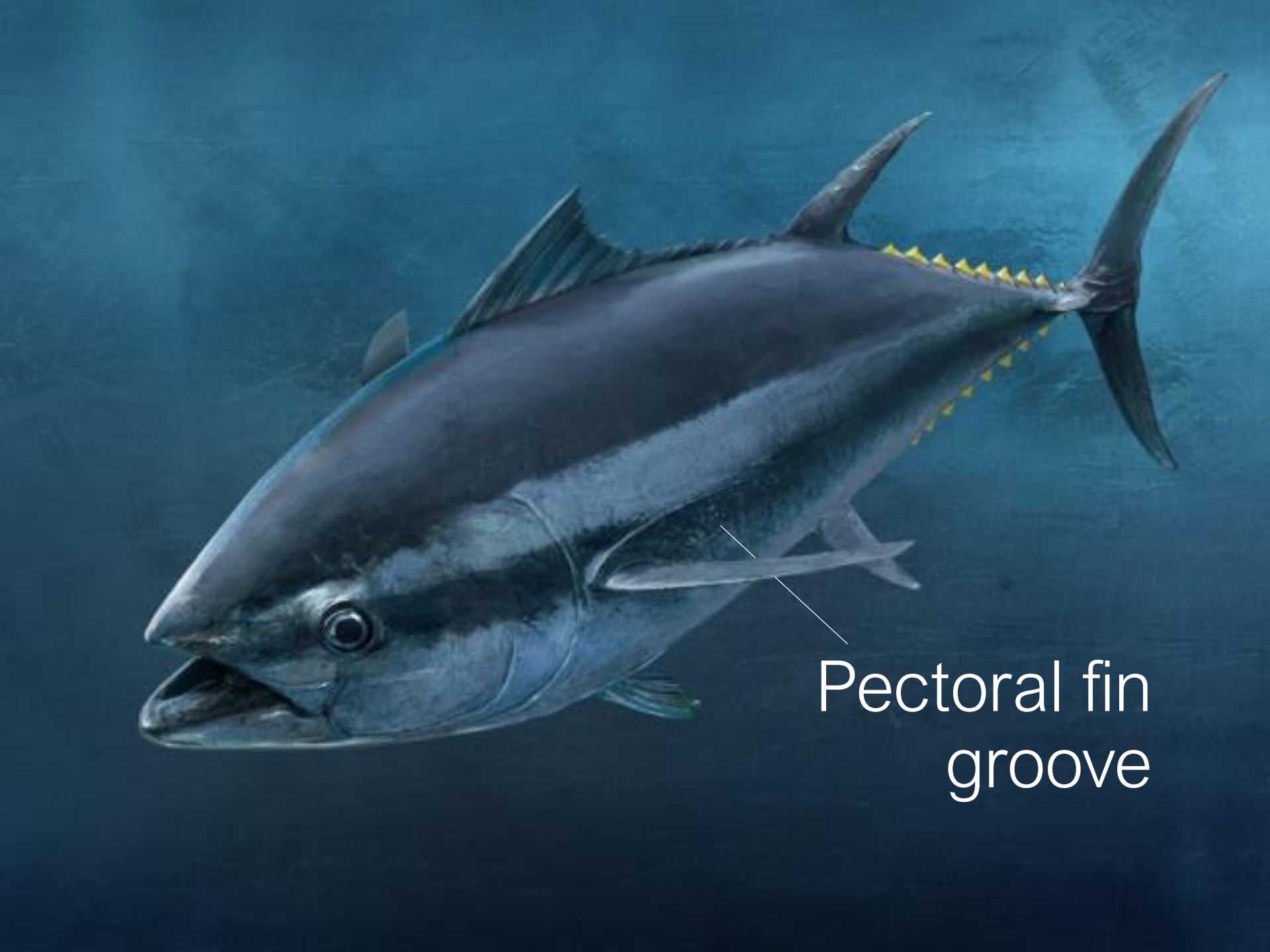
Pressured hydraulic control



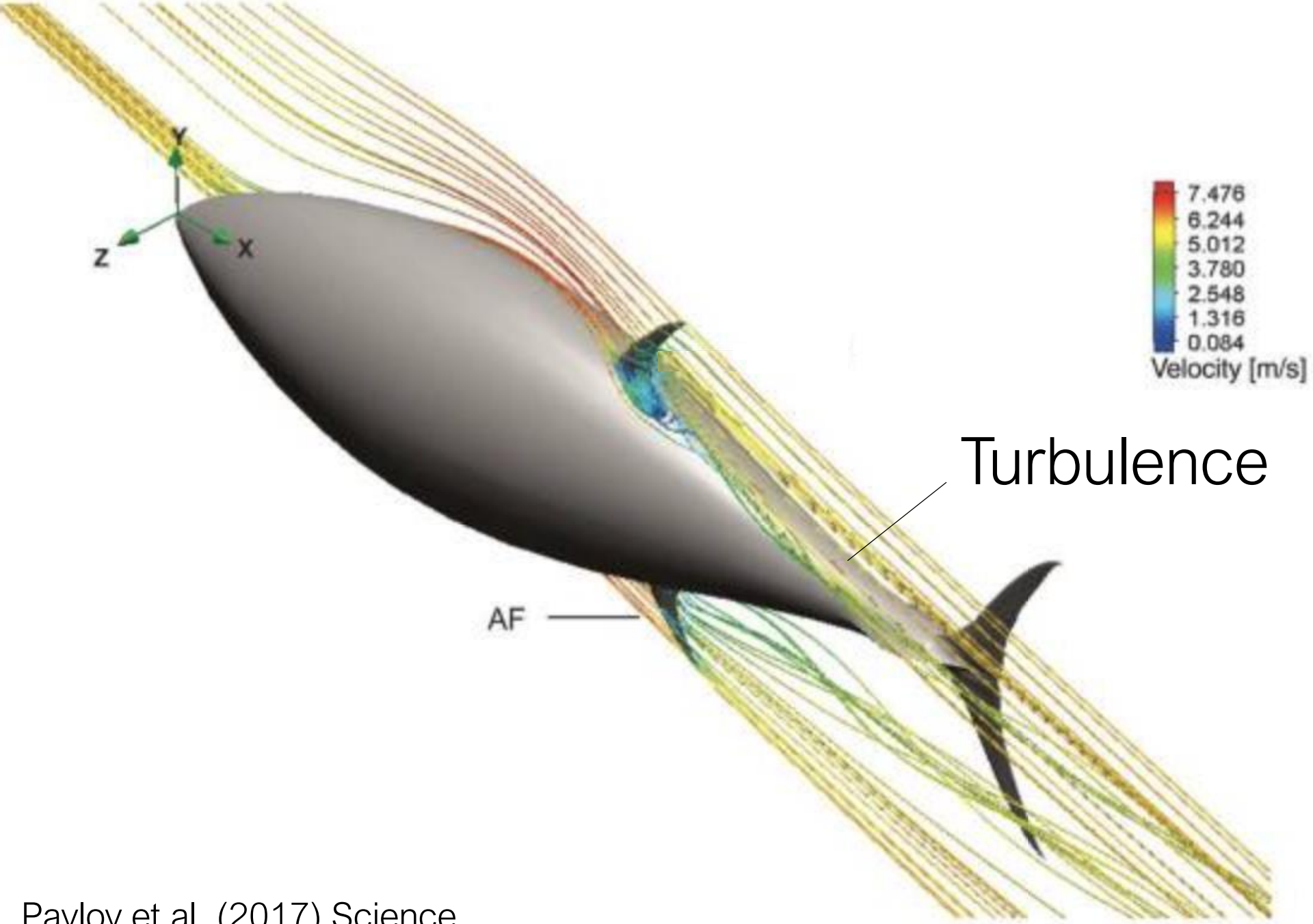
liquid filled cavity



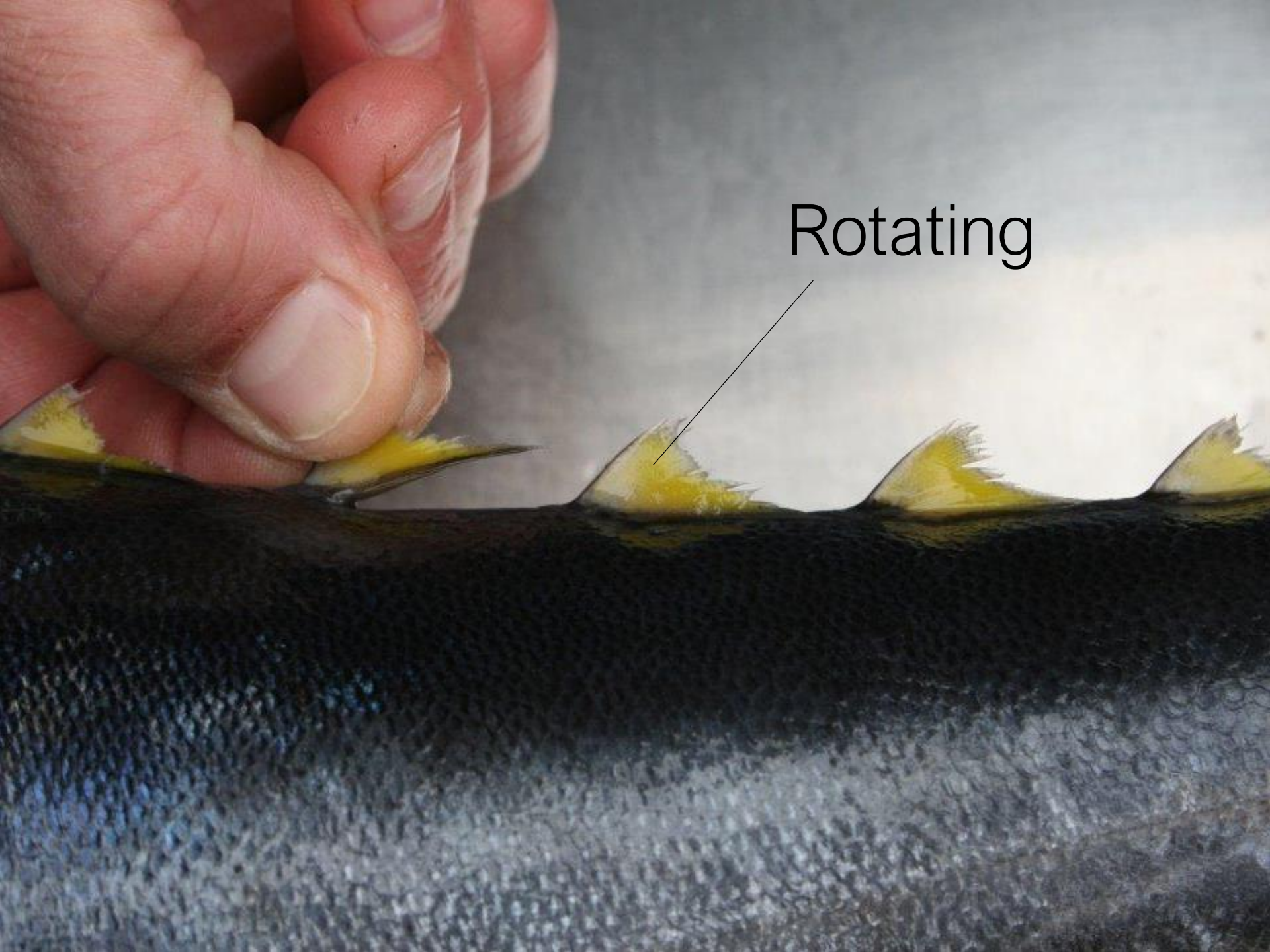


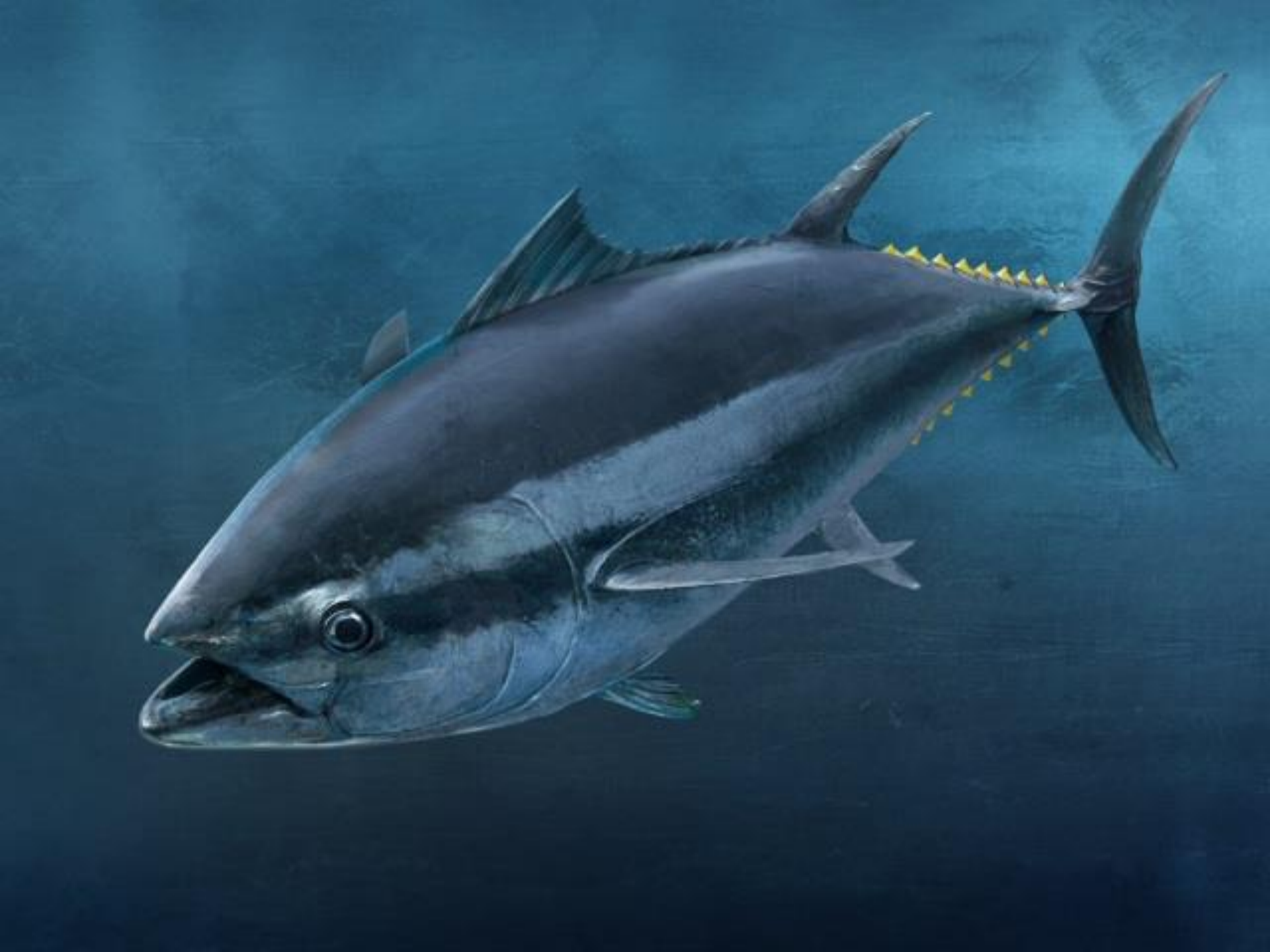

Pectoral fin
groove

Finlets

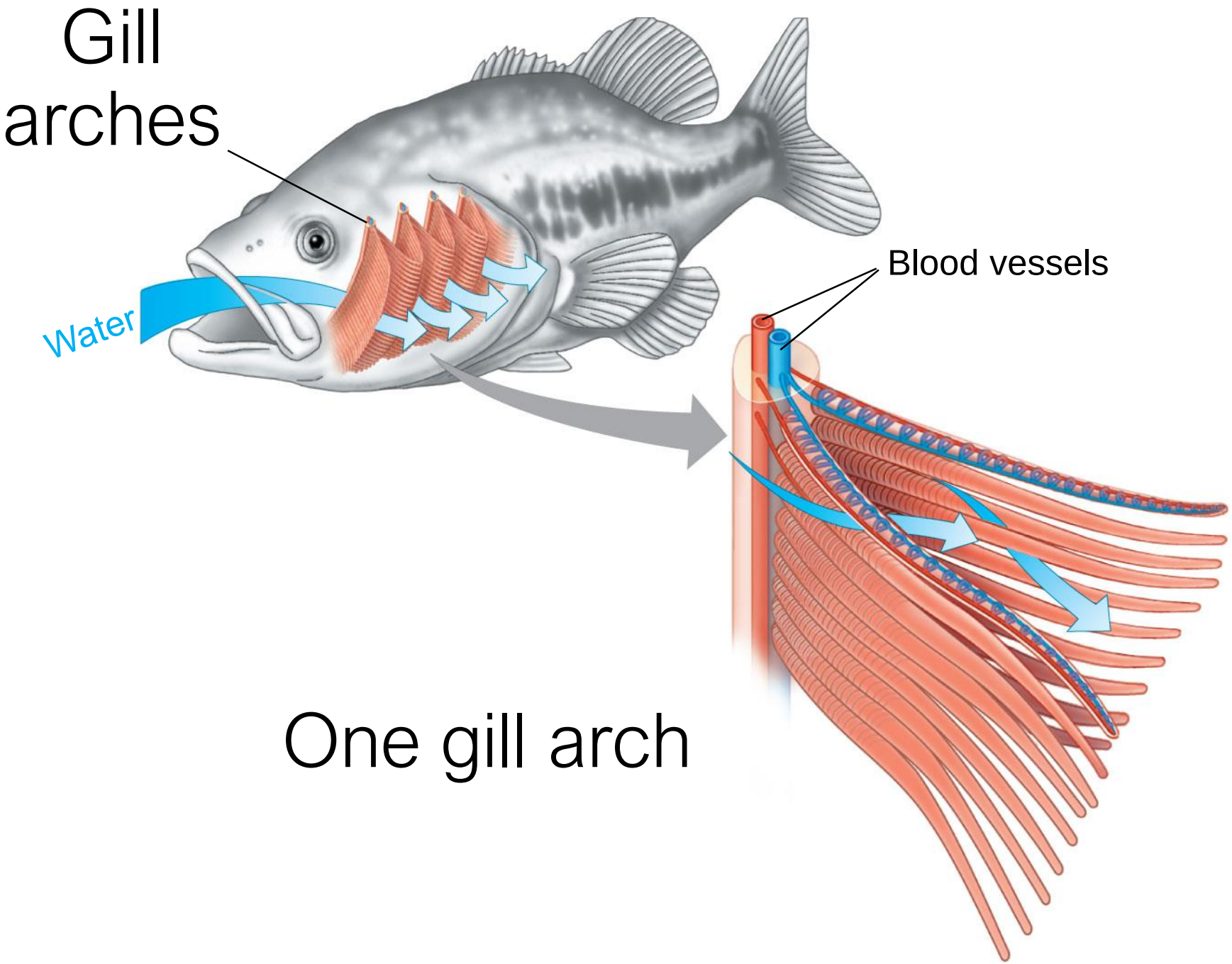


Pavlov et al. (2017) Science


Rotating



Breathing


Gill arches
Water
Blood vessels
One gill arch

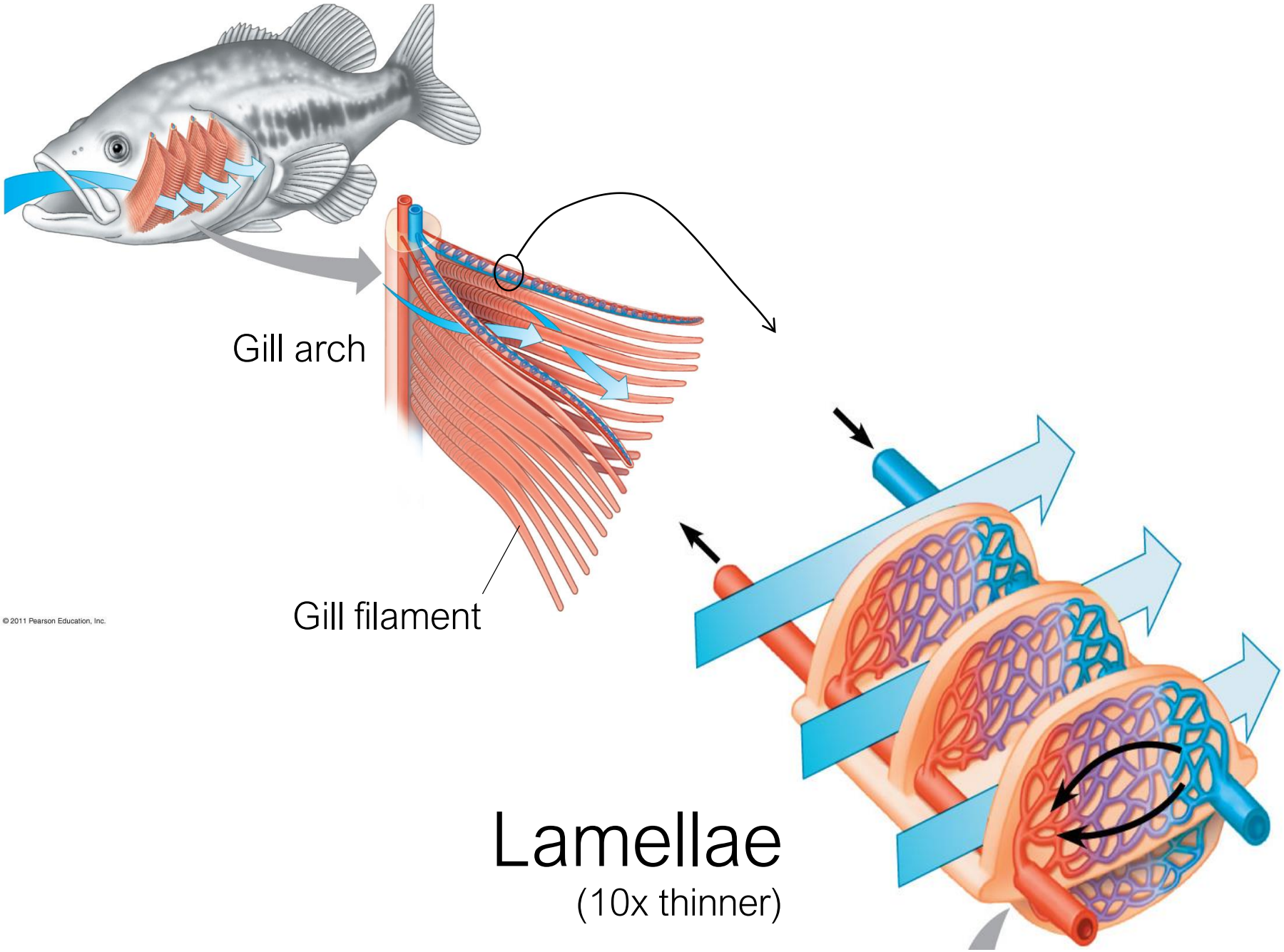
Cranial
cavity
Heart
Gills
34 to 43 gill arches

Brown trout
593 cm²
(24 x 24 cm)

Rainbow trout
1,767 cm²
(42 x 42 cm)

Common carp
2,177 cm²
(47 x 47 cm)

Bluefin tuna
2,870,000 cm²
(17 x 17 m)



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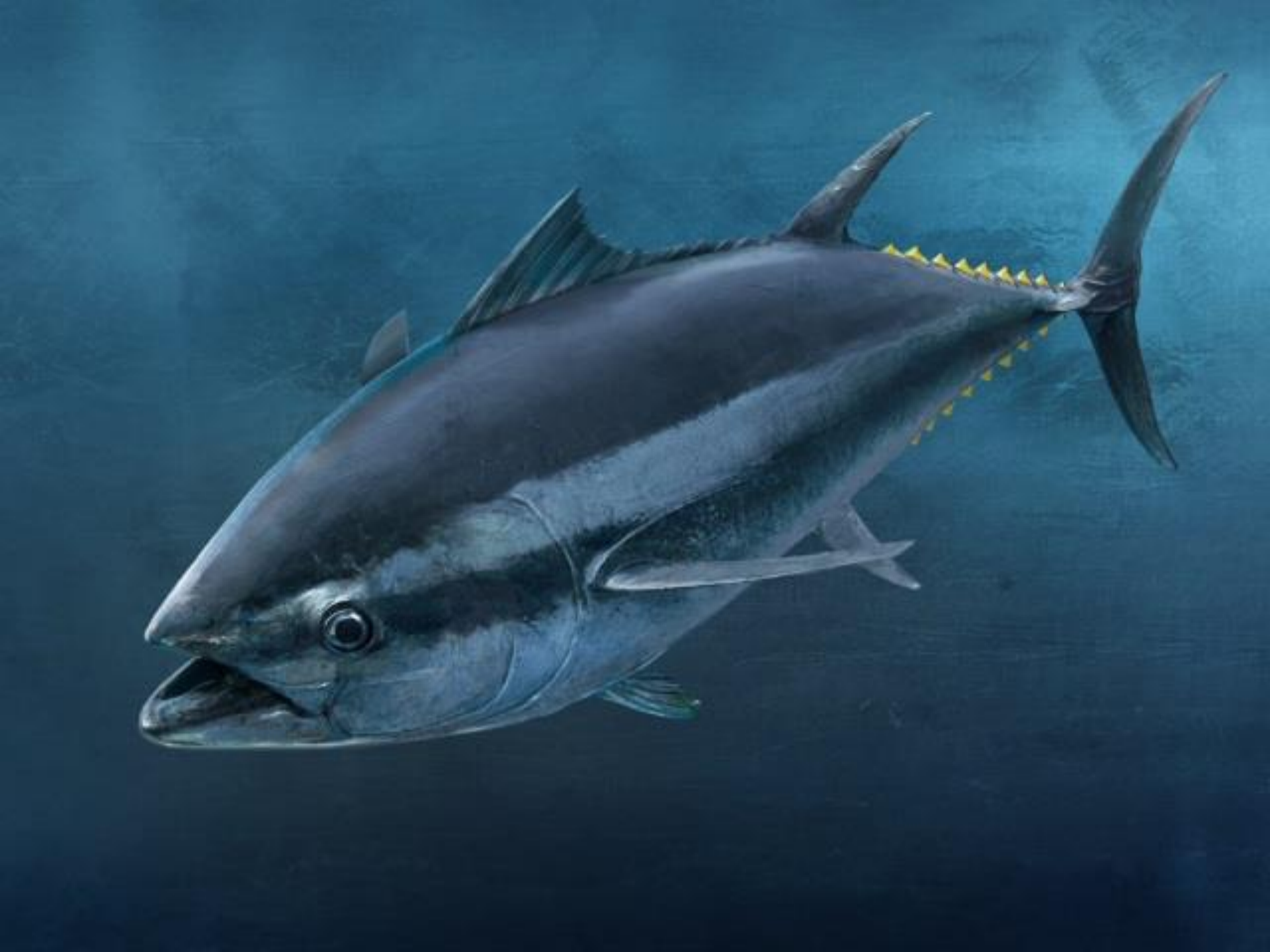
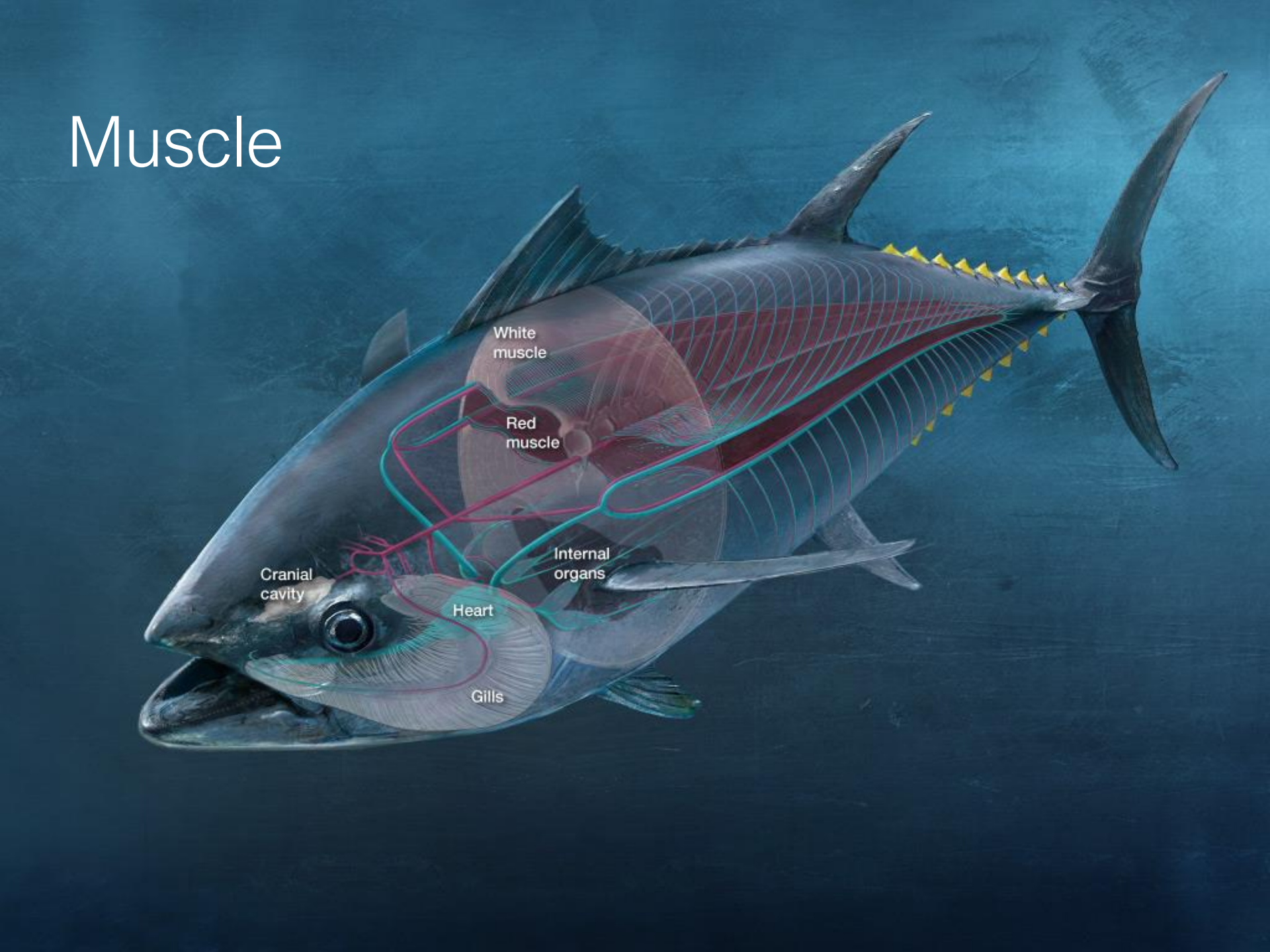


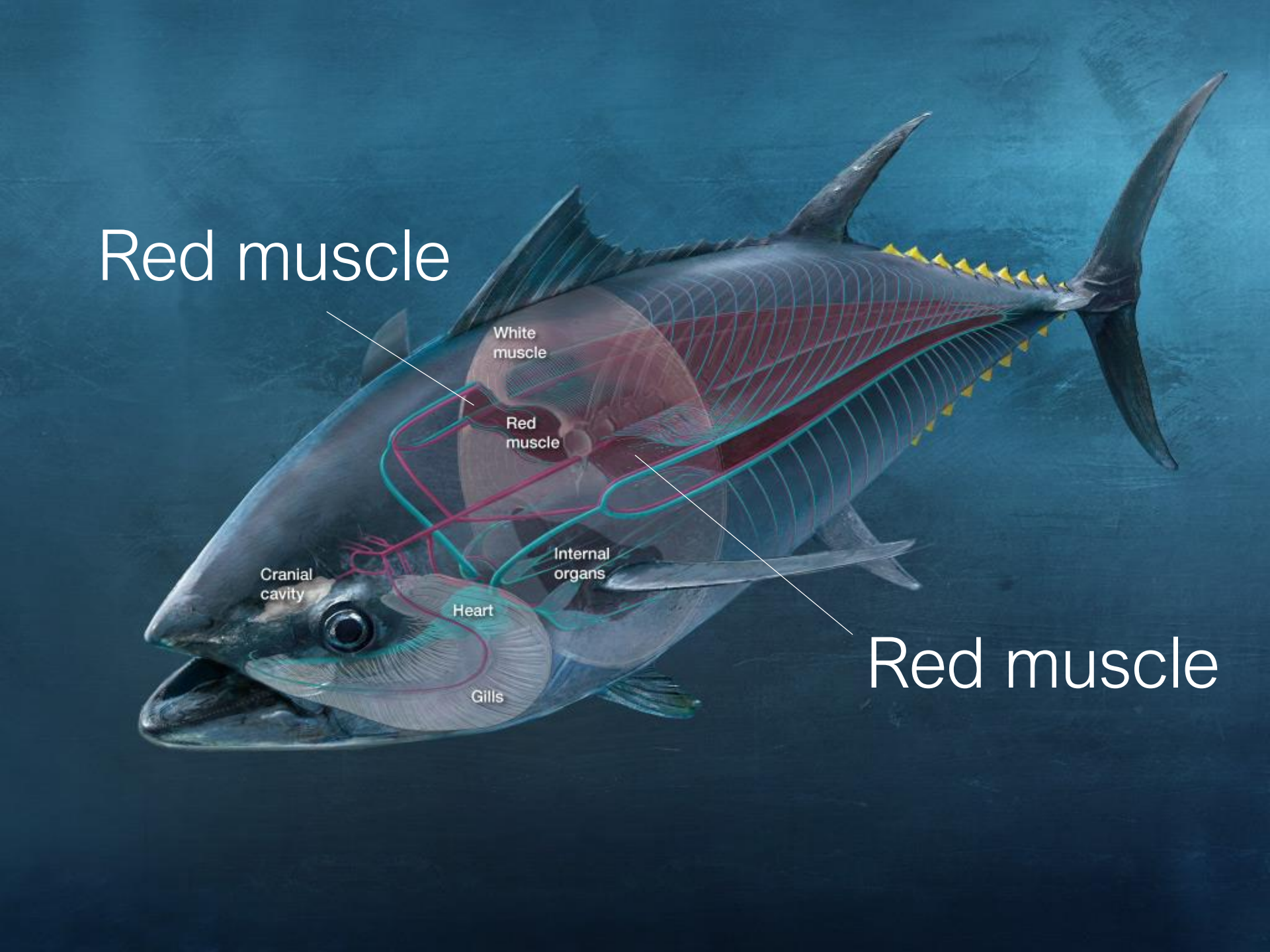
Muscle

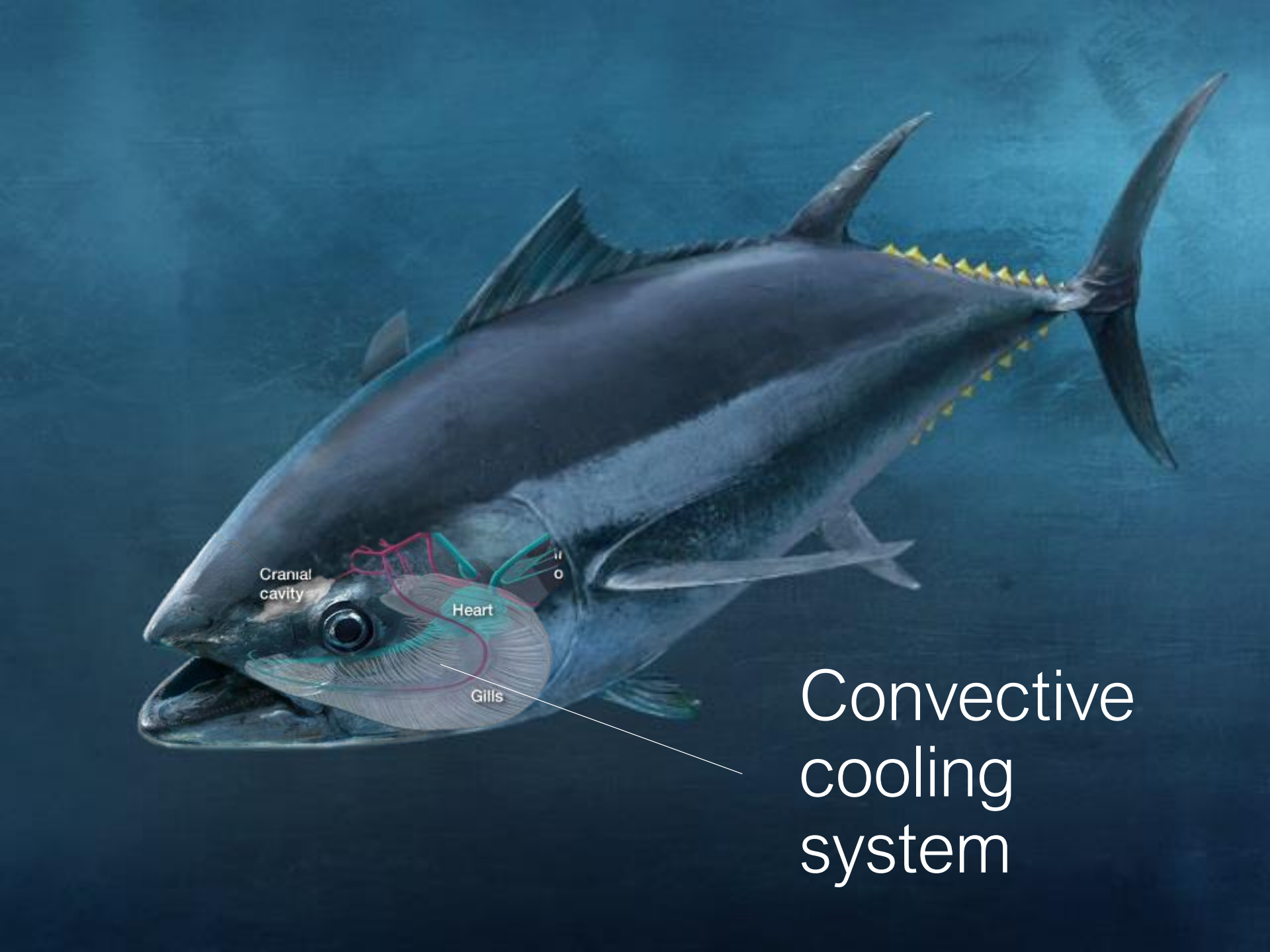

White muscle
Red muscle
Internal organs
Cranial cavity
Heart
Gills

Not all muscle is equal

	Type I	Type II a	Type II b
Colour	Dark red	Red	White
Used for	Aerobic Endurance	Long-term anaerobic	Anaerobic Sprint
Contraction	Slow	Fast	Very fast
Fatigues	Slowly	Moderate	Quickly

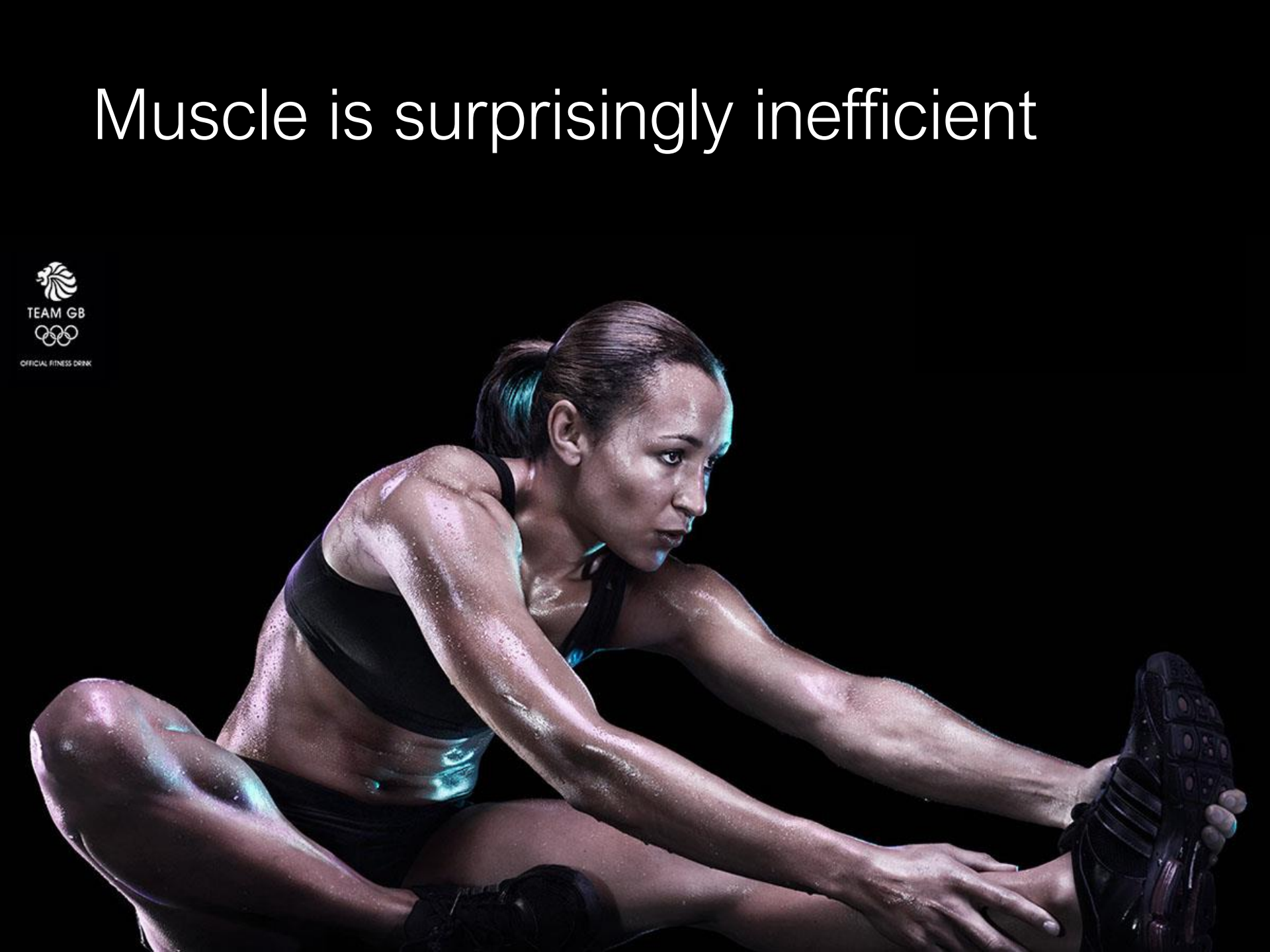
Myoglobin

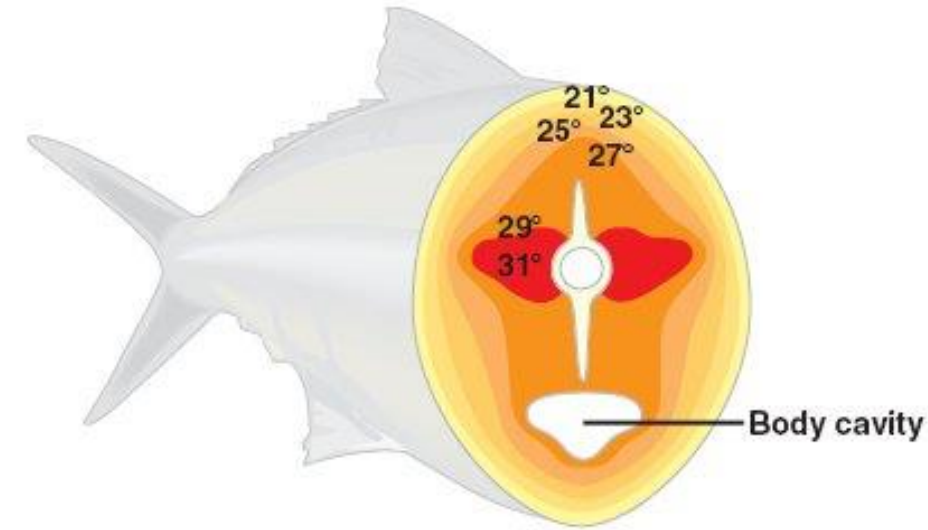

Red muscle
White muscle
Red muscle
Internal organs
Cranial cavity
Heart
Gills
Red muscle



Convective cooling system

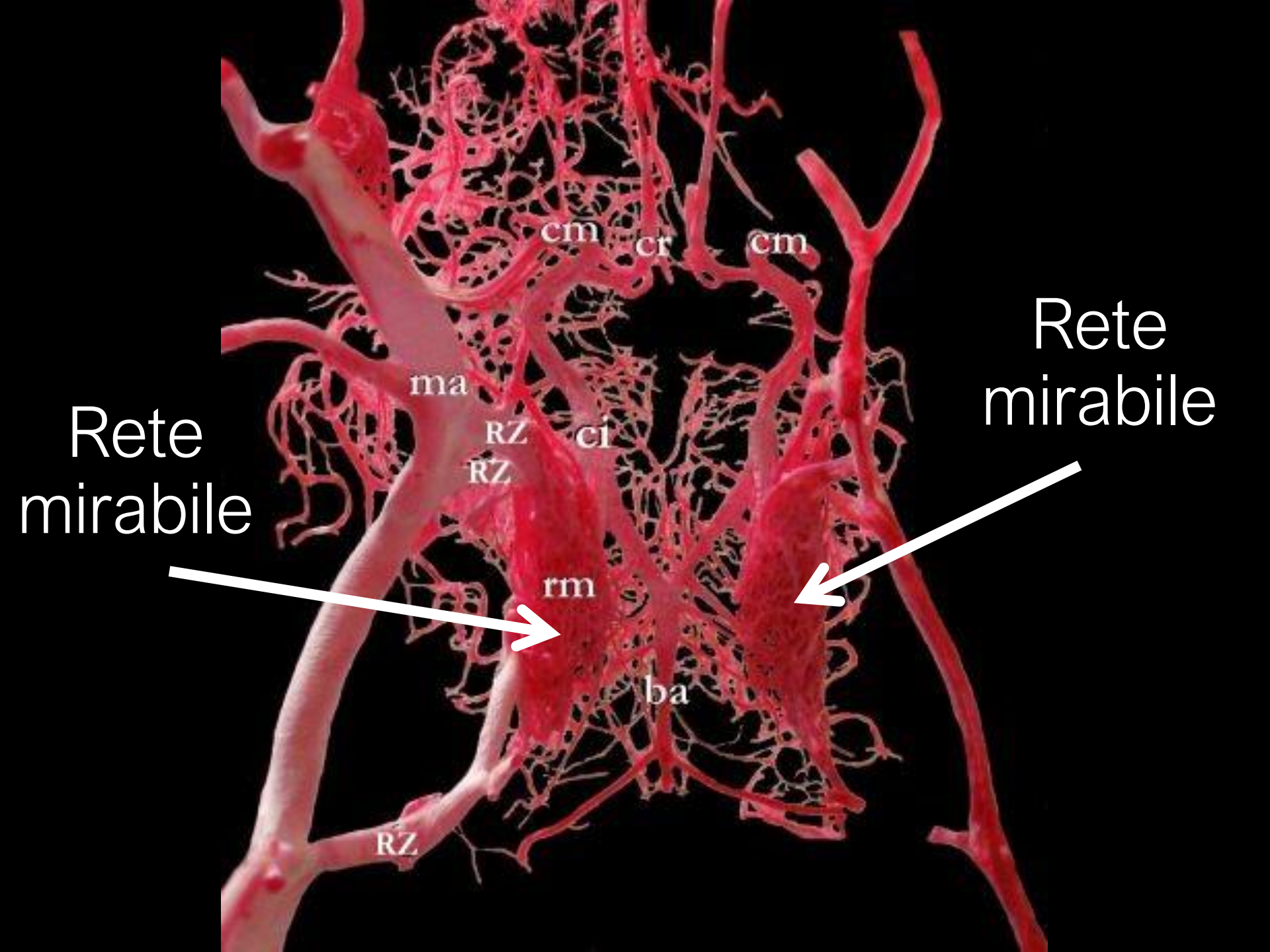
Muscle is surprisingly inefficient



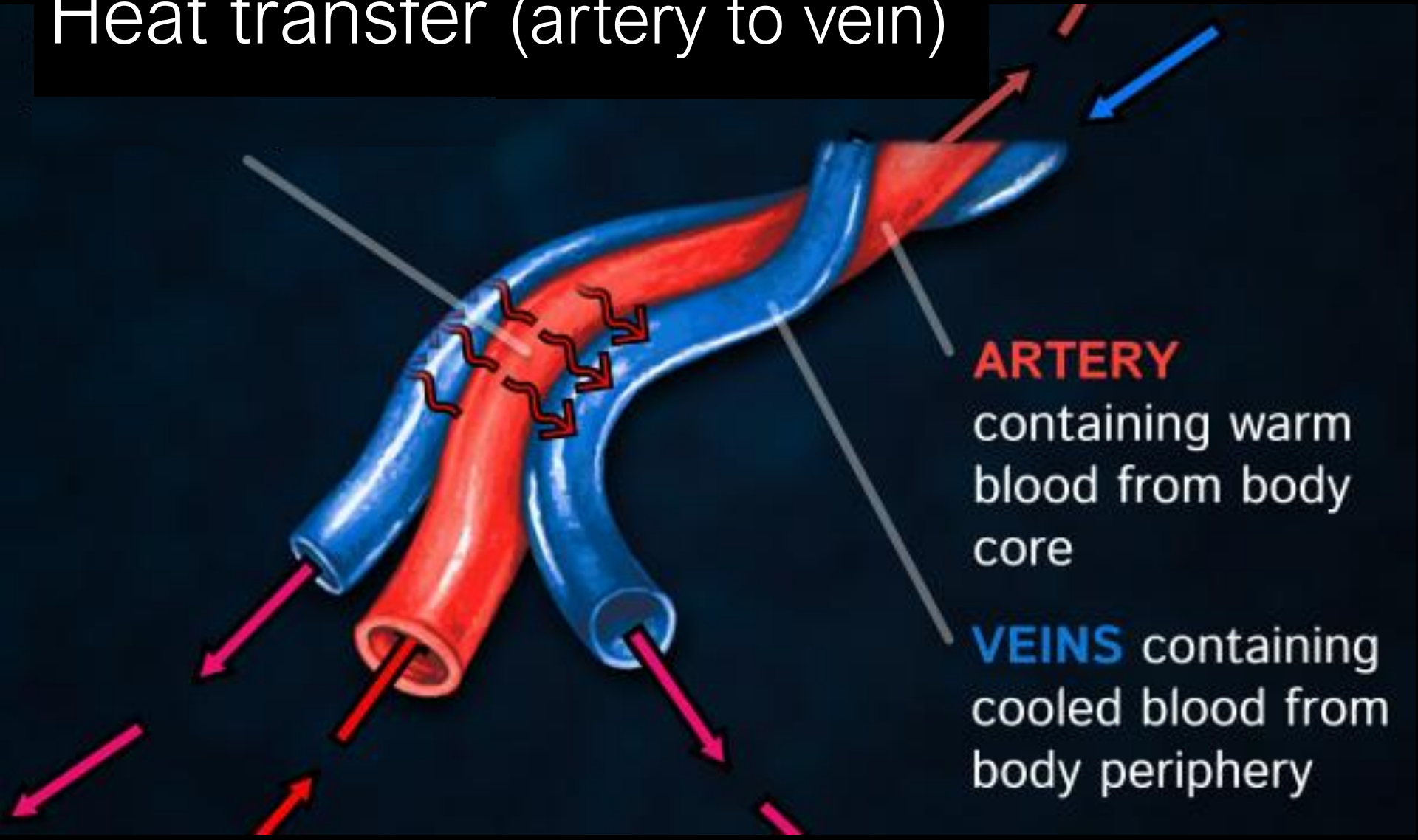


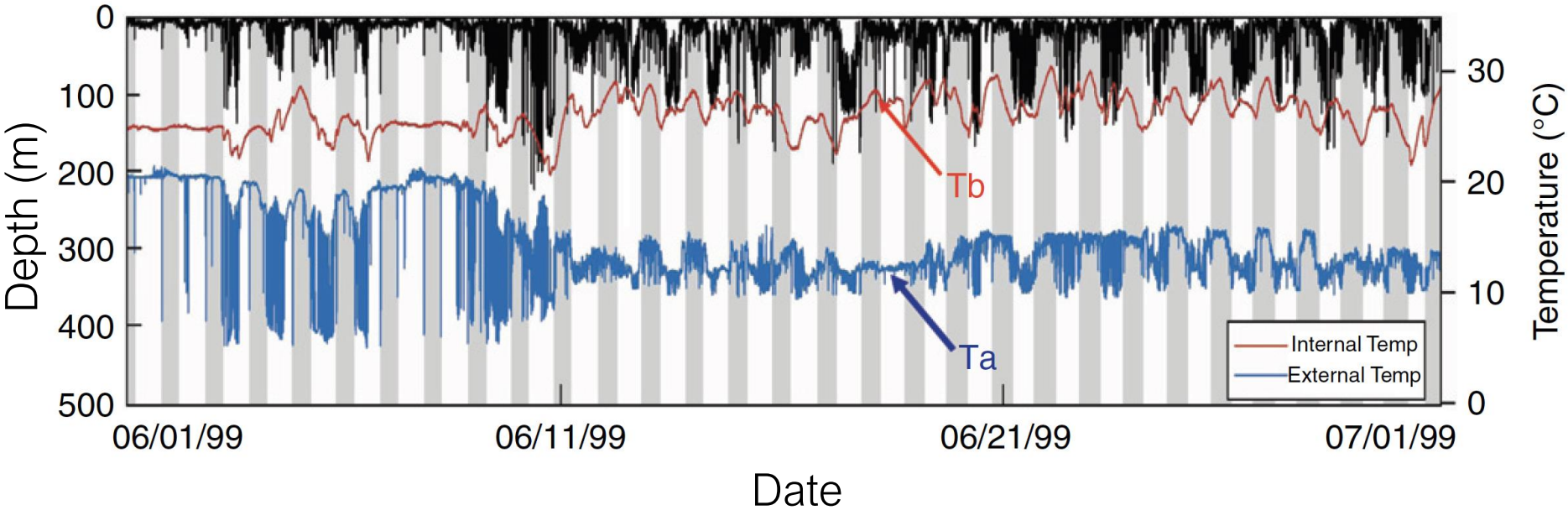
(a) Bluefin tuna

Block et al. (2011) EncFishPhysiol


cm
cr
cm
ma
RZ
RZ
ci
rm
ba
RZ
Rete mirabile
Rete mirabile

Heat transfer (artery to vein)



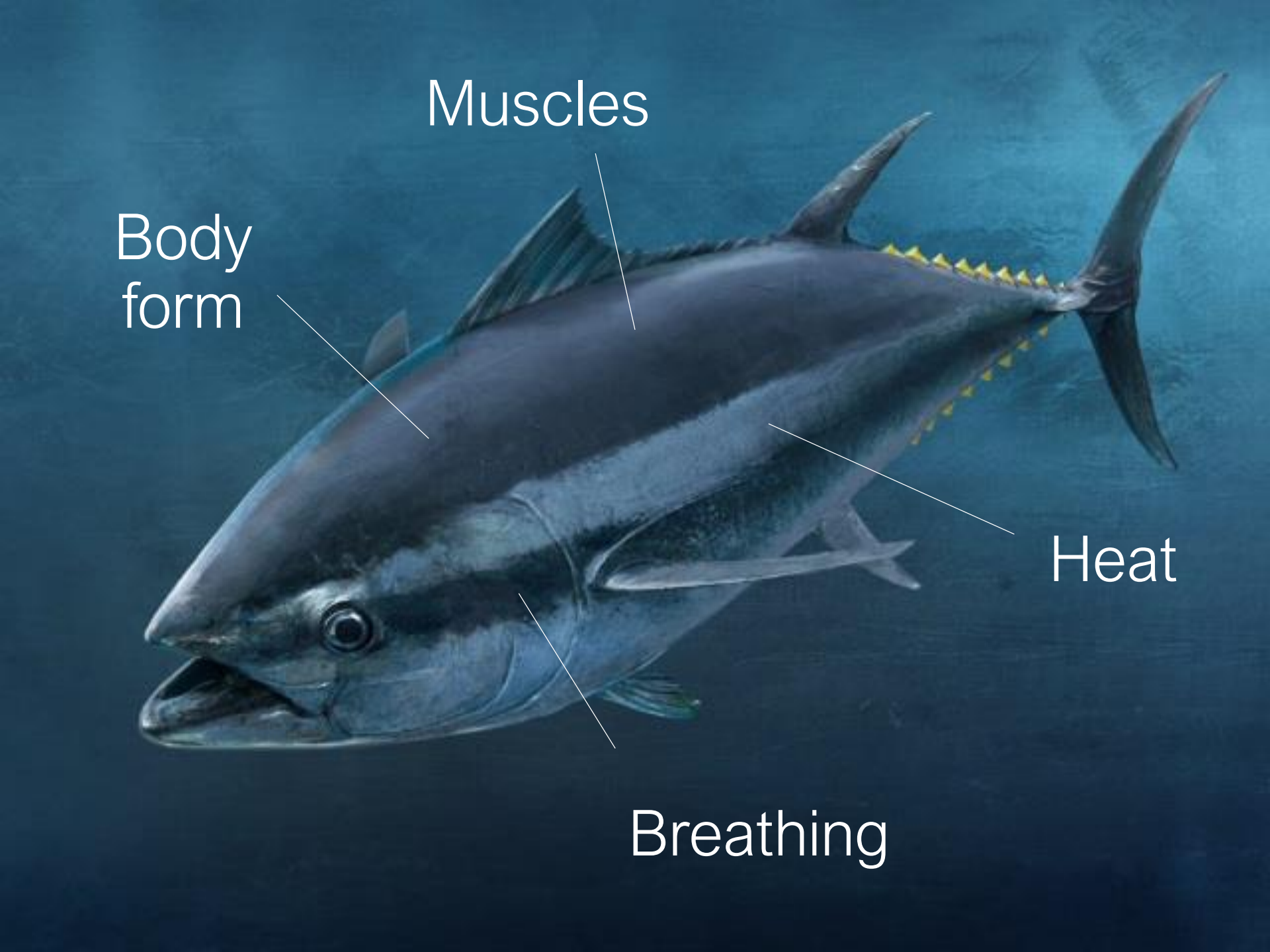


+20 °C

Walli et al. (2010) PLoS One

Why stay warm?

- Muscles perform better
- Digestion better
- Visual acuity improved
- Brain functions better


Muscles
Body form
Heat
Breathing

Questions?

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…but any highly adapted machine can go wrong in an unfamiliar environment

Boston Engineering
Advanced Systems Group
BIOswimmer UUV