Biology of the Oyster

Comparison with Higher Animals and Humans

Oysters (family Ostreidae) are marine bivalves with biological traits very different from those of higher animals, including humans. Their sessile, filter-feeding lifestyle in dynamic coastal environments has led to remarkable anatomical, physiological, and ecological adaptations.

Body Structure and Anatomy

- **Nervous system**: Oysters lack a brain or central nervous system. They possess a network of ganglia and nerve cords. Pain perception comparable to vertebrates is unlikely and remains a subject of scientific debate.
- **Circulation**: An open circulatory system with colourless haemolymph and a heart consisting of one ventricle and two atria (functionally "three-chambered"). Two kidney-like organs filter waste.

- **Gills and feeding**: Gills function in both respiration and filter-feeding. Cilia transport plankton to the mouth. The mantle can also provide limited gas exchange.
- **Shell**: The mantle secretes calcium carbonate, causing continuous shell growth. Growth lines indicate age roughly, but not precisely year by year.

Reproduction and Sexuality

What is "oyster milk"?

In summer, male oysters release whitish sperm, known as *oyster milk*. This sometimes gives the flesh a creamy appearance. The term refers only to sperm, not larvae or spat.

Species-specific reproduction

- **European flat oyster (*Ostrea edulis*)**: internal fertilisation. Sperm is drawn in via the inhalant siphon. Fertilisation takes place in the mantle cavity; larvae remain there for about 8–10 days (larval retention) before release.
- **Pacific oyster (*Crassostrea gigas*)**: external fertilisation. Both eggs and sperm are released into the water, where fertilisation occurs.

Larval phase

- Within 24 hours fertilised eggs develop into larvae.
- Larvae drift for 2–4 weeks as plankton in the water column.
- After this, known as the *spat* stage, they settle on hard substrate and metamorphose into juvenile oysters.

👉 **Key difference**:

1. *O. edulis* → internal fertilisation + short larval retention.
2. *C. gigas* → external fertilisation + no retention.

Sex change and fertility

Many oysters are sequential hermaphrodites: starting male, later becoming female depending on age and conditions. A female may produce up to 100 million eggs annually.

Age and Growth

- **Lifespan**:
    - *O. edulis*: usually 10–15 years, sometimes up to 20.
    - *C. gigas*: usually 5–10 years, sometimes up to 20.
- **Size**:
    - *O. edulis*: typically smaller (6–12 cm at market size).
    - *C. gigas*: faster grower, can exceed 30 cm exceptionally.
- **Consumption**: Most oysters eaten are young, 2–4 years old.

Immune System and Survival

- Oysters rely solely on innate immunity, with specialised haemocytes and antimicrobial compounds.
- Their immune genome shows remarkable diversity, with many variants offering protection against pathogens.
- Some studies suggest a form of “trained immunity” (memory-like response) within this innate system.

Environmental Adaptations

- **Tolerance**: Oysters endure wide fluctuations in temperature (short-term from –5 °C to ~43 °C) and salinity (11–34 ‰). Extremes vary by species and context.
- **Tides**: At low tide they can survive days without flowing water by closing their shells and temporarily switching to anaerobic respiration.
- **Attachment**: Oysters cement their lower shell permanently to hard substrate with calcite-rich “oyster cement”.

Senses and Behaviour

- Oysters have no eyes or ears, but sensory cells in the mantle detect light, touch, and chemical cues.
- They respond reflexively, for example by closing the shell in reaction to vibrations or shadows.
- Larvae often settle near conspecifics, promoting reef formation.

Ecological Role

- **Filtration**: Adult oysters filter tens of litres of water daily, depending on size, temperature, and food supply.
- **Reef building**: Oyster beds form reef structures that provide habitat for fish, crabs, and other species, while stabilising shorelines against erosion.
- **Food web**: They convert plankton into biomass and serve as a key food source for animals and humans alike.

Evolutionary and Genetic Advantages

- Low energy use due to sessile existence and passive filter-feeding.
- Extremely high reproductive capacity offsets high larval mortality.
- Strong genetic diversity supports adaptation to disease and pollution.

Threats and Conservation

- **Threats**: overfishing, habitat loss, pollution, and climate change.
- **Restoration**: reef creation, habitat protection, and breeding of disease-resistant populations.

Key Differences with Humans

Trait	Oysters	Humans / Higher animals
Nervous system	No brain, simple ganglia	Complex brain
Circulation	Open, colourless haemolymph	Closed, red blood
Reproduction	External or internal, larval stage	Internal, direct growth
Sexuality	Sex change possible	Fixed
Immune system	Only innate, highly diverse	Innate + adaptive
Tolerance	Broad, anaerobic possible	Limited
Ecological role	Water filter, reef builder, ecosystem	Indirect
Senses	Light, touch, chemical receptors	Complex sensory organs

Conclusion

Biologically simple yet ecologically invaluable, the oyster thrives without a brain or mobility, but with enormous fertility, wide tolerance, and a key role in ecosystems. It is a striking example of how evolution can shape extreme specialisation.

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