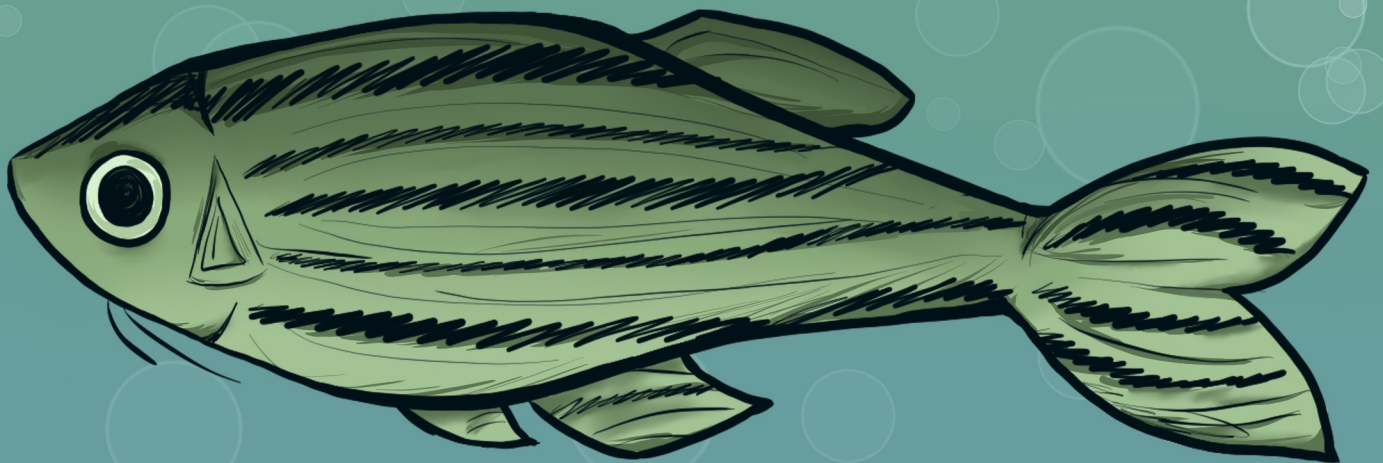


How Gut Microbiomes Influence Social Behaviors



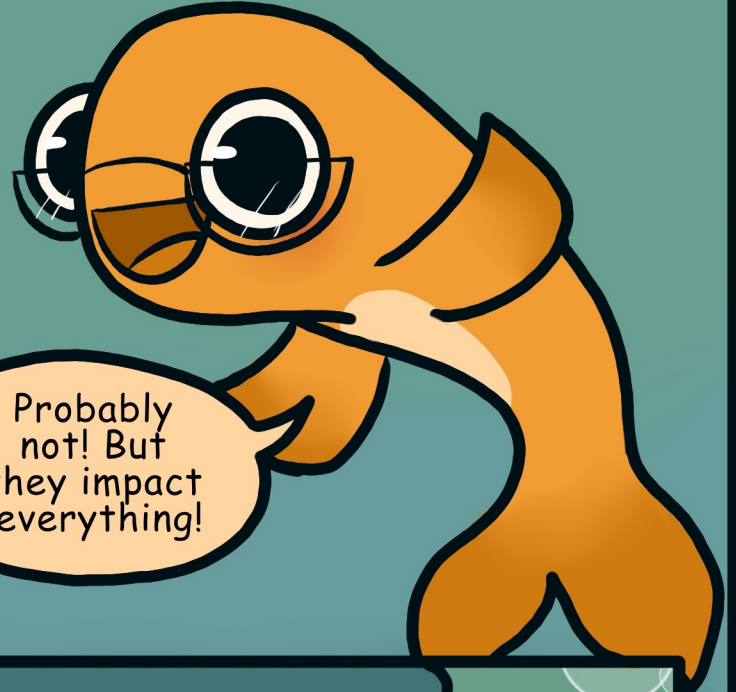
Illustrated by
August Reitan

Written in collaboration with
Judith Eisen

MICROBIOMES!

Have you ever wondered how the bacteria in your gut are connected to the development of your brain?

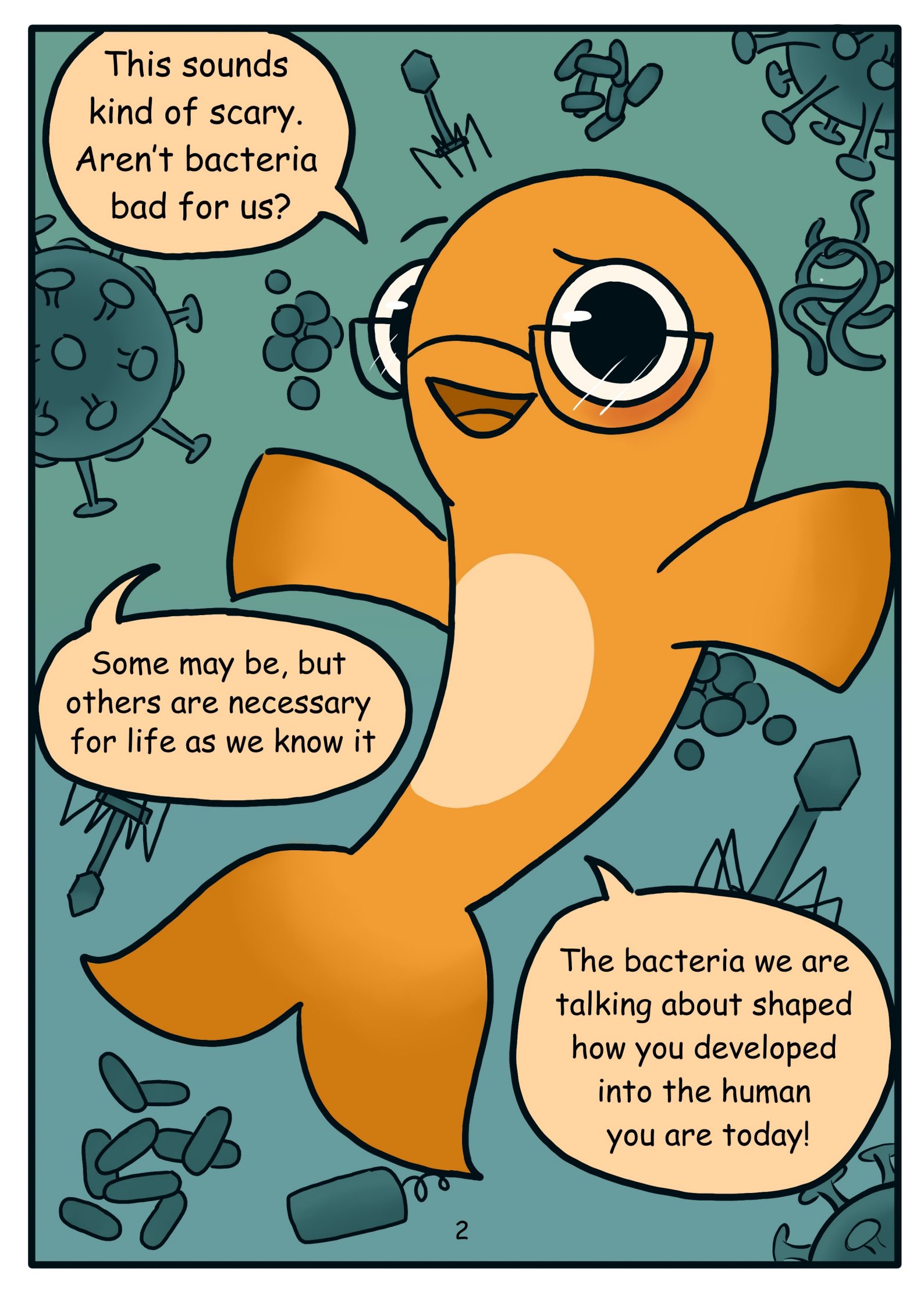
Probably not! But they impact everything!



Gut Microbiomes!

Your gut microbiome is a collection of organisms in the gut including bacteria and even fungi as well as viruses





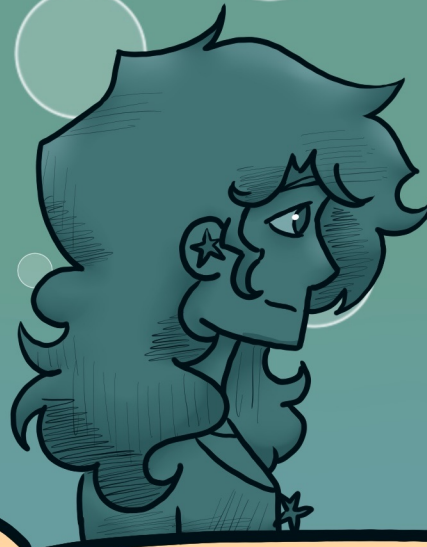
This sounds kind of scary. Aren't bacteria bad for us?

Some may be, but others are necessary for life as we know it

The bacteria we are talking about shaped how you developed into the human you are today!

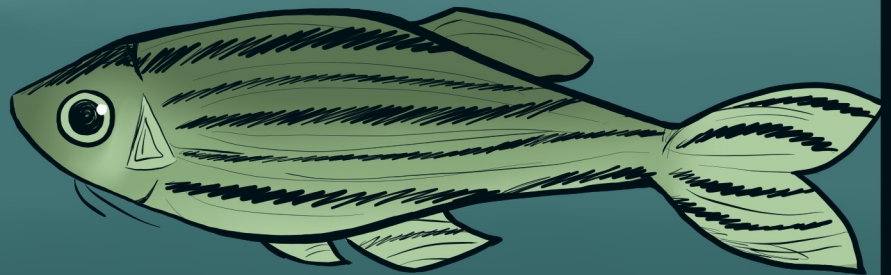
So why study this?

Scientists discovered our gut microbiomes affect our social behaviors and how we act



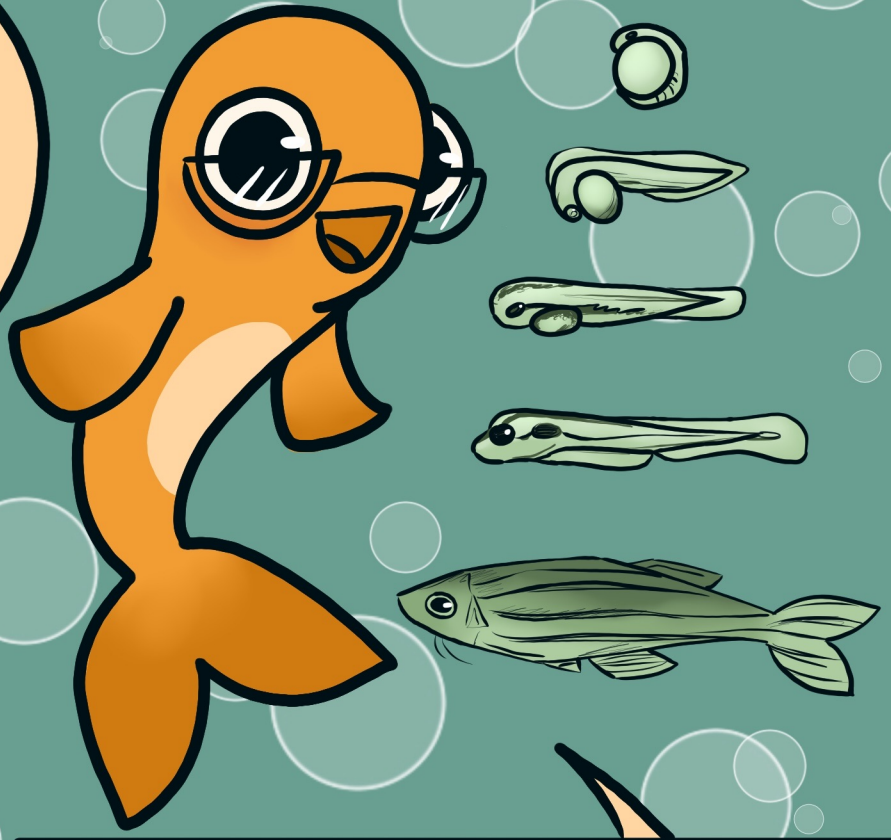
Let's talk about the experiments done to test this hypothesis

To do that, let's meet our trusty friend used in these experiments



Zebrafish!

Zebrafish are important in this research because they are good test subjects



Why?

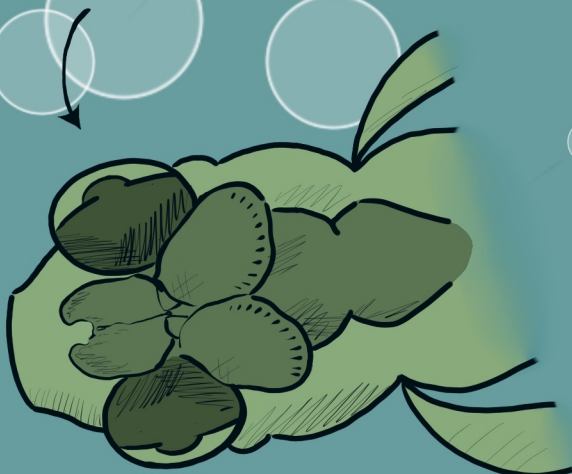
- They reproduce fast
- They are naturally social creatures
- Young zebrafish are transparent, so scientists can see their internal organs without dissection

It is important to study social animals for this experiment



This way we can see how removing the microbiome affects them

A young zebrafish brain



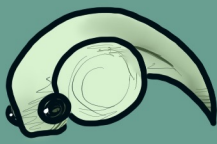
In this experiment, the goal was to see if the microbiome is critical during the first week of life for normal brain development

Scientists
sterilized the gut
microbiomes of
day-old zebrafish

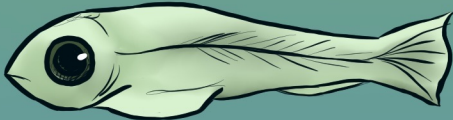


1 day old embryo

Day 1



Day 14



Day 30+



They immediately
gave the control
group fish normal
gut bacteria

These fish developed
normally with
gut microbiomes

The scientists
waited a week to
give a microbiome
to the other fish.
All fish were tested
at two weeks old



The control fish, with a microbiome from the start, were social. But the fish who only had a microbiome for a week were not

Controlled group of zebrafish (with a microbiome from the start)

These fish went up to the glass to interact with each other more

These images show computer tracking of the fish's movement. In this experiment, these fish were placed in tanks beside each other, visible to one another

Zebrafish that only acquired a microbiome after their first week of life

This result suggests that the microbiome is necessary during the first week of life for fish to become social

What causes
this change
in social
development?

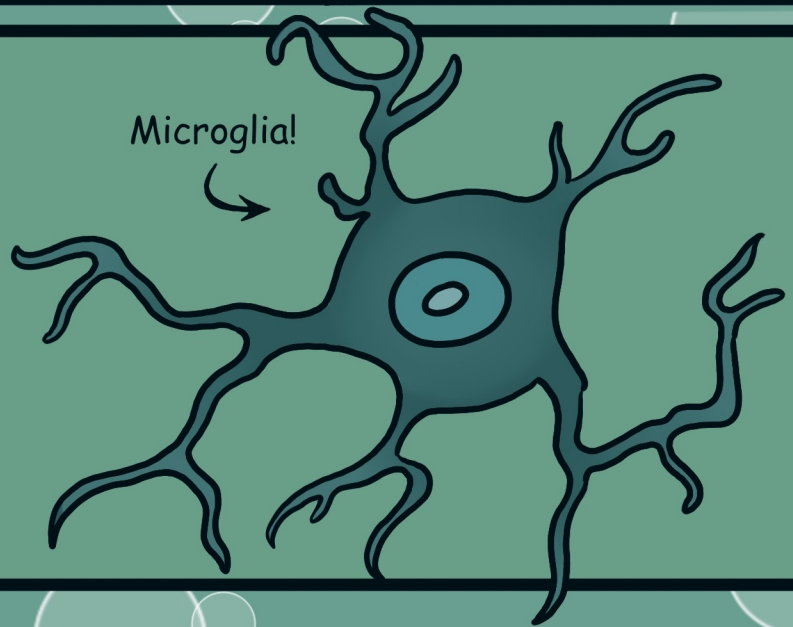
The development
of social skills
require neurons
in the ventral
forebrain

Without a
microbiome,
these neurons
grow larger
than normal

These larger
neurons
may form
synapses with
neurons located
in inappropriate
brain regions

Thus
ventral
forebrain
neurons
cannot
carry out
their normal
functions

Microglia are immune cells that reside in the brain and normally prune overgrown neurons

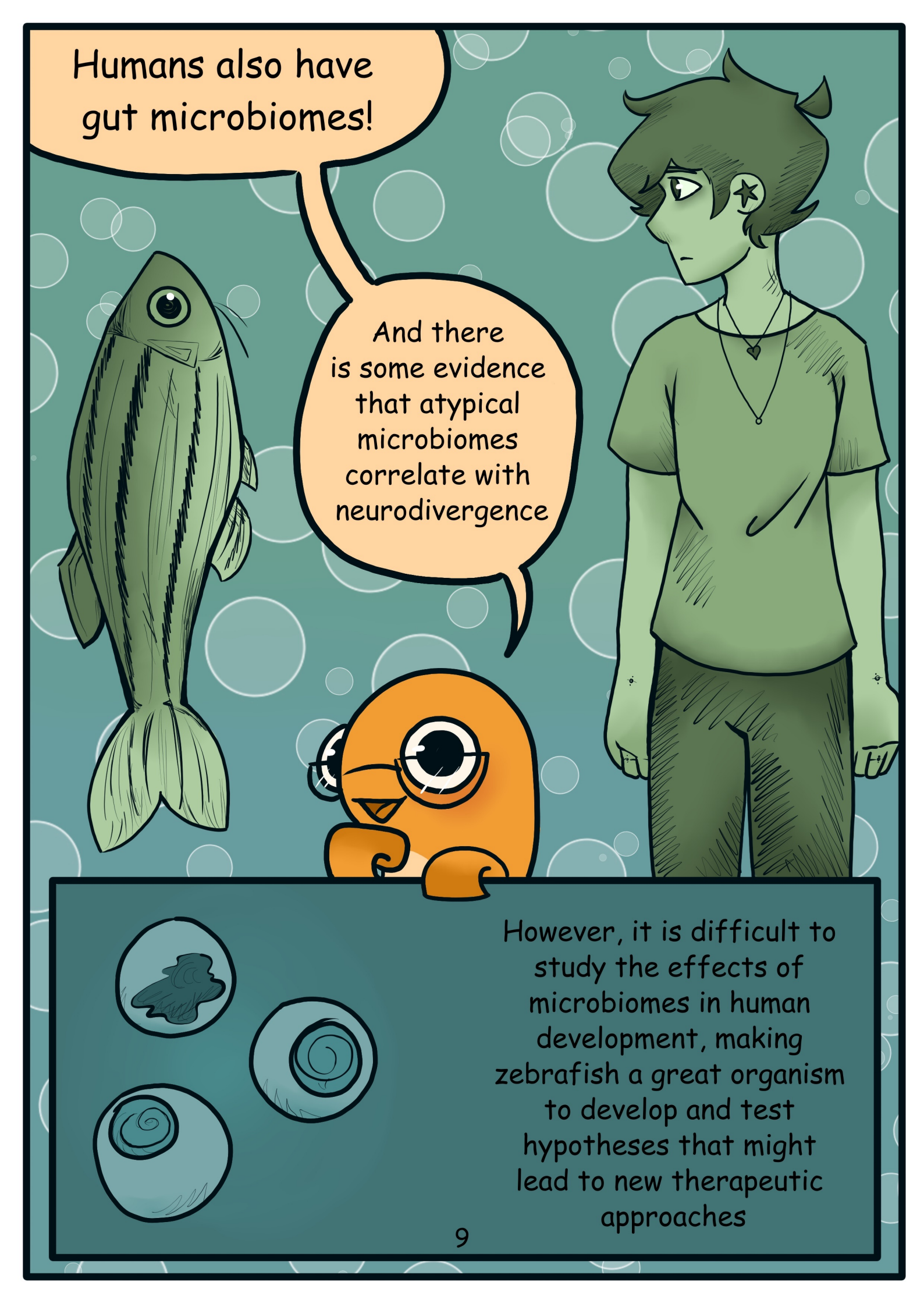


Without the microbiome, there are fewer ventral forebrain microglia and they produced less of a protein required for pruning



This suggests that the gut microbiome influences ventral forebrain neurons' circuitry by regulating microglial activity





Humans also have
gut microbiomes!

And there
is some evidence
that atypical
microbiomes
correlate with
neurodivergence



However, it is difficult to
study the effects of
microbiomes in human
development, making
zebrafish a great organism
to develop and test
hypotheses that might
lead to new therapeutic
approaches

Some questions that still
need to be answered:

What molecules
are created
by gut bacteria?

How do fish sense
these molecules?

How do these
molecules influence
microglia and neurons
in the brain, changing
social behavior?

Thank you
for
Reading!



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Microbiomes in our gut can affect how our brain develops. In this comic, learn about the experiments that show the connection between the gut microbiome and social development. And learn how atypical gut microbiomes might be connected to neurodivergence!

A cartoon orange fish with large eyes and glasses, swimming and talking. The fish is orange with a white belly and is wearing black-rimmed glasses. It has a speech bubble coming from its mouth. The background is a teal color with white circles of various sizes, resembling bubbles.

Let me take you through this journey involving gut microbiomes, zebrafish and you!

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