See elegance in a worm brain

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Who has a brain?
Wonderful!!
Today’s menu

- Appetizer -
  Brain

- Main dish -
  Worm

- Dessert -
  Me

8 elegant things
The brain is the organ inside the head that controls thought, memory, feelings, and activity. (Cambridge dictionary)
Neurons are the functional units of the brain.

Neuron 神経細胞
(a type of the cell)
Neurons communicate with each other to process information.
Exciting questions about the brain

How do neurons process information?

How is the brain formed?

What is the consciousness?
The problem

Our brain is too complex
Quiz

How many neurons in our brain?

1. 1000 (thousand)
2. 1000,000 (million)
3. 1000,000,000 (billion)
Quiz
How many neurons in our brain?

1. 1000 (thousand)
2. 1000,000 (million)
3. 1000,000,000 (billion)
4. 100,000,000,000 (100 billion)
1,000,000 times this

Barack Obama attracted 100,000 people
(Wordpress.com)
That's... too... complicated...
Problems of the human brain as a research subject

Human brain is

1. too complicated
2. hard to see
3. hard to manipulate
What should we do?

We need a hero...
Worm the hero
Today’s menu

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The worm
Caenorhabditis elegans
(C. elegans)

Model organism
Simple and easy!!

Core principle
The worm

*Caenorhabditis elegans* (C. elegans)

1974

THE GENETICS OF *CAENORHABDITIS ELEGANS*

S. BRENNER

Medical Research Council Laboratory of Molecular Biology,
Hills Road, Cambridge, CB2 2QH, England

Nobel prize in 2002

by nobelprize.org
You are going to receive this

*C. elegans* is **NOT** parasitic **NOR** harmful.

寄生性
Elegance 1

*C. elegans* is easily maintained (飼育)

Hermaphrodite

雌雄同体

6/16

3 days

~1000 worms
The worm show
Elegance 2

*C. elegans* senses and responds to stimuli

Input → Touch → Movement → Output
Elegance 3

*C. elegans* has memory
Elegance 3

*C. elegans* has memory

Hedgecock and Russell, *PNAS*, 1975
Mori and Ohshima, *Nature*, 1995
Elegance 4

*C. elegans* has a brain

Head

Tail
Elegance 5
Every *C. elegans* is the same

302 neurons

😊 Good for experiments!!
Well, *C. elegans* seems to be good for experiments, but...  

Who cares?  

What can we learn?
Exciting questions about the brain

How do neurons process information?

How is the brain formed?

What is the consciousness?
C. elegans is transparent

You can see neurons and neuronal activities!
Whole brain activities can be imaged in a freely moving animal

Neuronal activity = What *C. elegans* is “thinking”.

Nguyen et al., *PNAS*, 2016

Neuronal activity  Core principle of information processing
Exciting questions about the brain

How do neurons process information?

How is the brain formed?

What is the consciousness?
The brain is formed, based on the genome

Genome DNA
(Blueprint 設計図)

HOW???
Genes are the functional units of the genome.

Genome DNA (Blueprint 設計図)

Gene (Functional unit)

20,000 genes in *C. elegans*

Which gene is important for the brain??
Elegance 7

*C. elegans* is easily manipulated
Elegance 7

*C. elegans* is easily manipulated

**Blueprint** 設計図

- Gene A
- Gene B
- Gene C

**Forward genetic screen**

Important for the brain!
Elegance 7

*C. elegans* is easily manipulated

**Blueprint**

- Gene A
- Gene B
- Gene C

**Forward genetic screen**

*not photoshopped*

Important for the brain!
Example: a gene, *unc-13*
important for neuronal communication
Elegance 8
Important genes are conserved

The blueprint
unc-13

https://books.google.co.jp/books/about/Twist_of_Gold.html?id=LJKkJqis8-xE&source=kp_cover&redir_esc=y
2018/10/18

2018/10/18
Take-home message

“Model organisms” are powerful!!

Choose a right tool!!
Today’s menu

- Appetizer -
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- Dessert -
  Me
C. elegans genes
~20,000

64%

36%

Uncharacterized

I want to find and characterize new genes!!

Forward genetic screen
$0 + 0 = 1$

**Blueprint**

Gene A

Gene B

Gene C

Well characterized
Combination is challenging

Combination of two genes

\[ 20,000 \binom{2}{} = 199,990,000 \]

NEW
Forward genetic screen
I can do it with *C. elegans*!

1. Maintenance
2. Sensation
3. Memory
4. Brain
5. Stereotype
6. Transparency
7. Manipulation
8. Conservation

8 elegant things
I hope you see elegance in the *C. elegans* brain.
Thanks!

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feeling like a worm…

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