

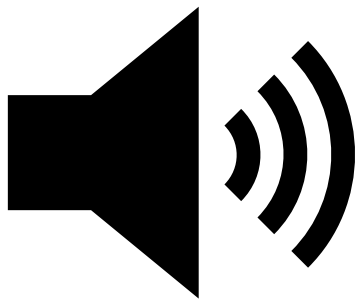
See elegance in a worm brain



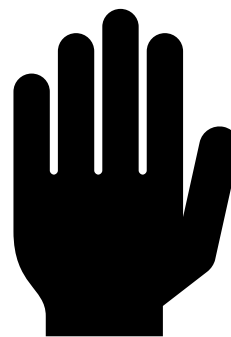
Designated assistant professor
Graduate school of Science, Nagoya University

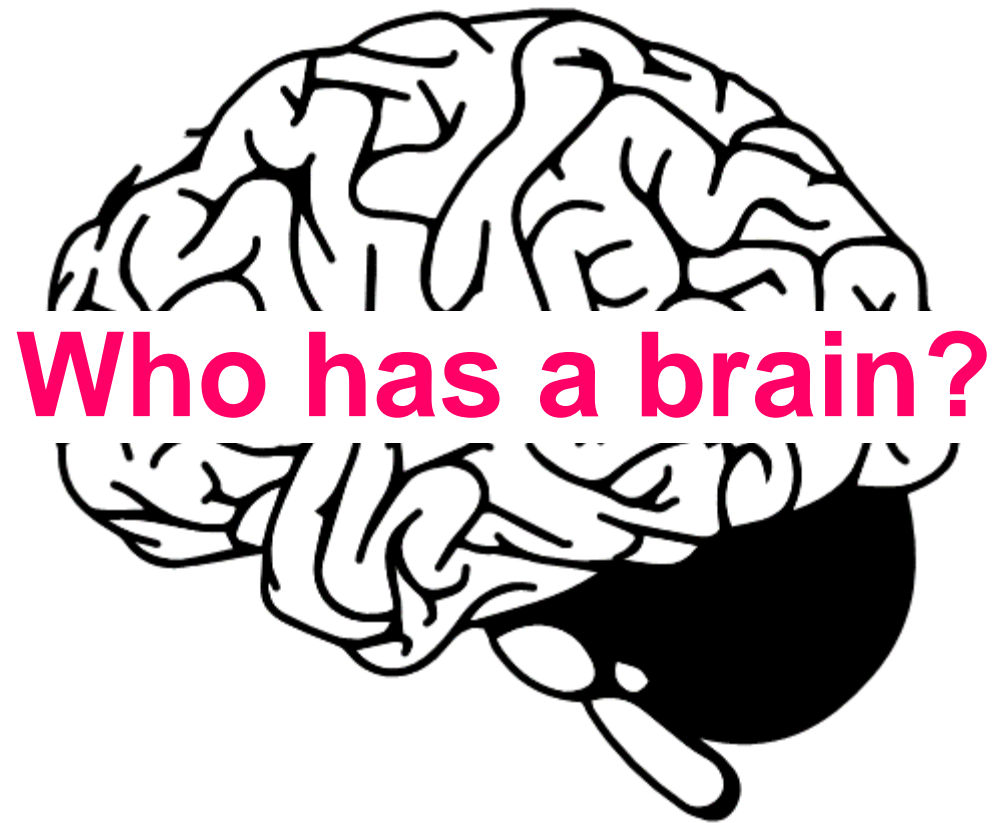
Ken Noma

Volume



STOP!





Who has a brain?

A black and white photograph of a starry night sky. The background is filled with numerous stars of varying brightness, some appearing as sharp points and others as soft, hazy clouds. In the upper left quadrant, there is a prominent, bright, and somewhat irregularly shaped nebula or star cluster, which is the most luminous feature in the image. The overall tone is dark and atmospheric, with a grainy texture characteristic of a night sky photograph.

Wonderful!!

Today's menu

- *Appetizer* -
Brain



- *Main dish* -
Worm

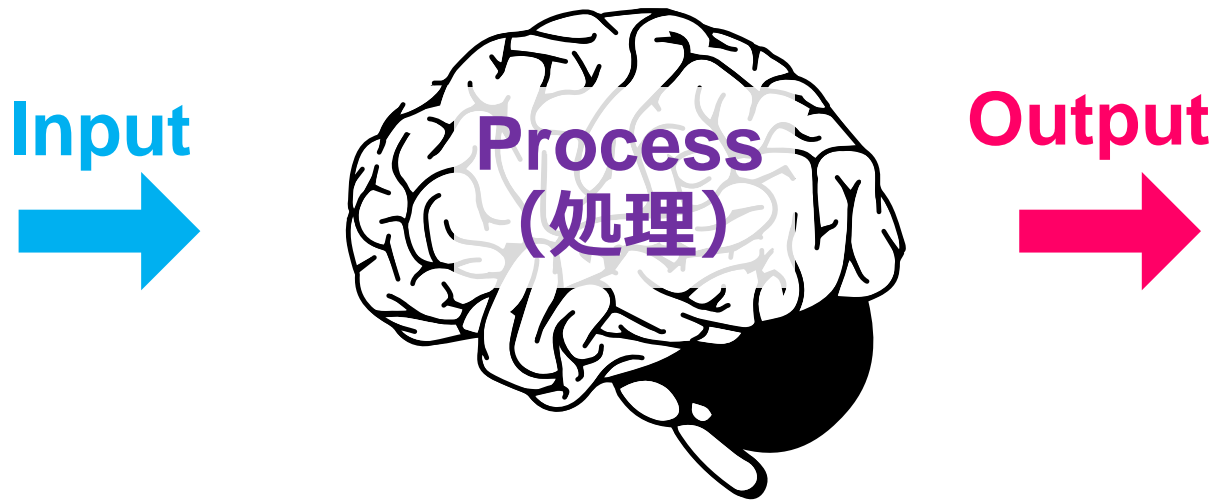


- *Dessert* -
Me



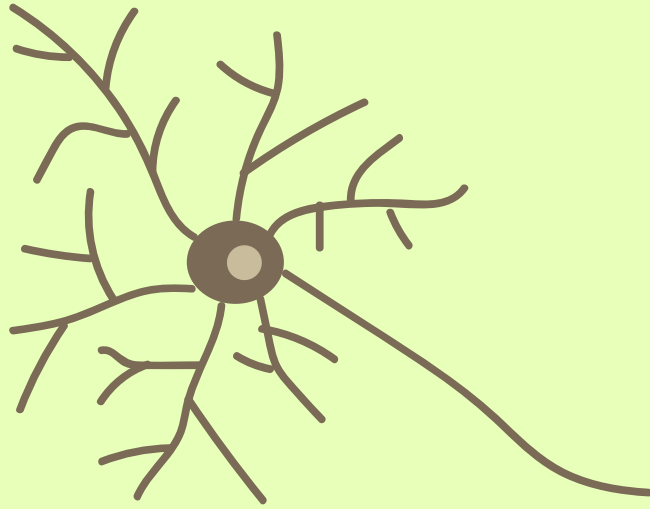
**8 elegant
things**

The brain is

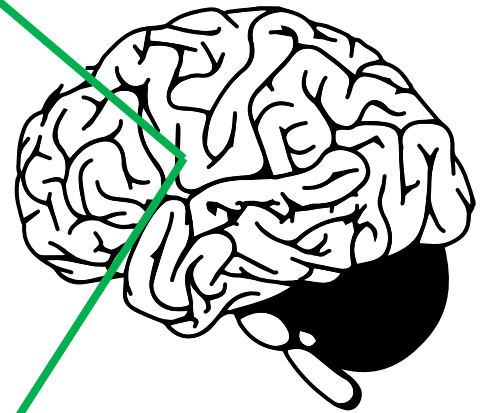


the organ inside the head that controls thought, memory, feelings, and activity. (Cambridge dictionary)

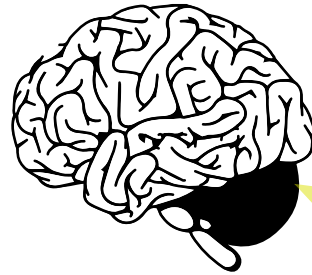
Neurons are the functional units of the brain



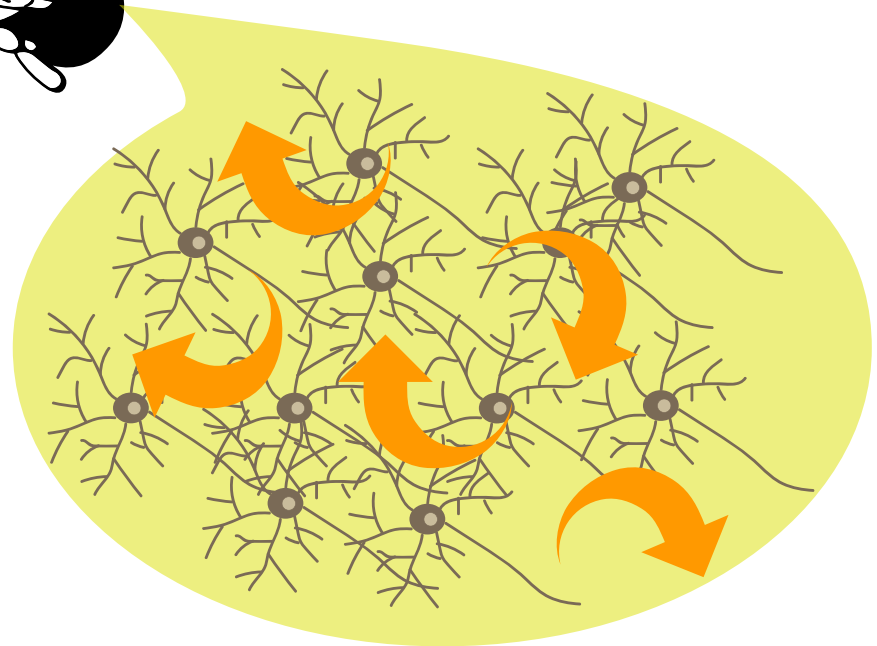
Neuron 神經細胞
(a type of the cell)



Neurons communicate with each other to process information



Communication



Exciting questions about the brain

How do neurons process information?
処理する

How is the brain formed?

What is the consciousness?
意識

A black and white photograph of a starry night sky. In the upper left corner, there is a large, bright, and somewhat diffuse galaxy or nebula. The rest of the sky is filled with numerous stars of varying brightness, some appearing as sharp points of light and others as faint, hazy clouds. The overall tone is dark and grainy, typical of a long-exposure astronomical photograph.

The problem

Our brain is too complex

Quiz

How many neurons in our brain?

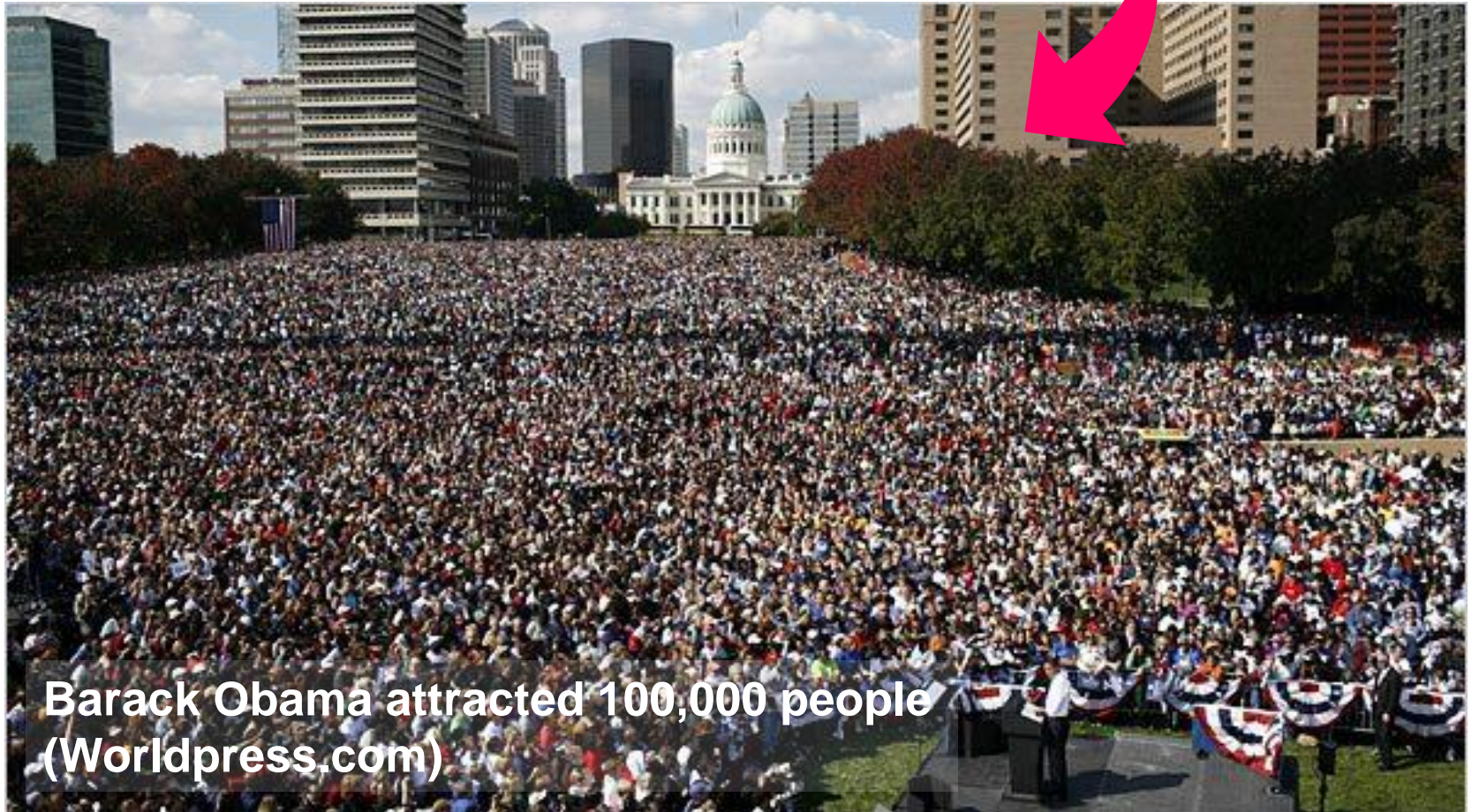
1. 1000 (thousand)
2. 1000,000 (million)
3. 1000,000,000 (billion)

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
(Worldpress.com)



by Chip Somodevilla/Getty.

**That's...
too...
complicated...**

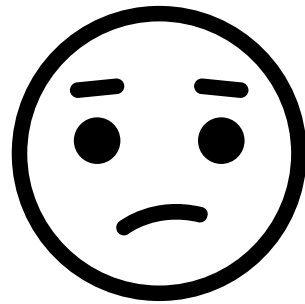
Problems of the human brain as a research subject

Human brain is

1. too complicated
2. hard to see
3. hard to manipulate

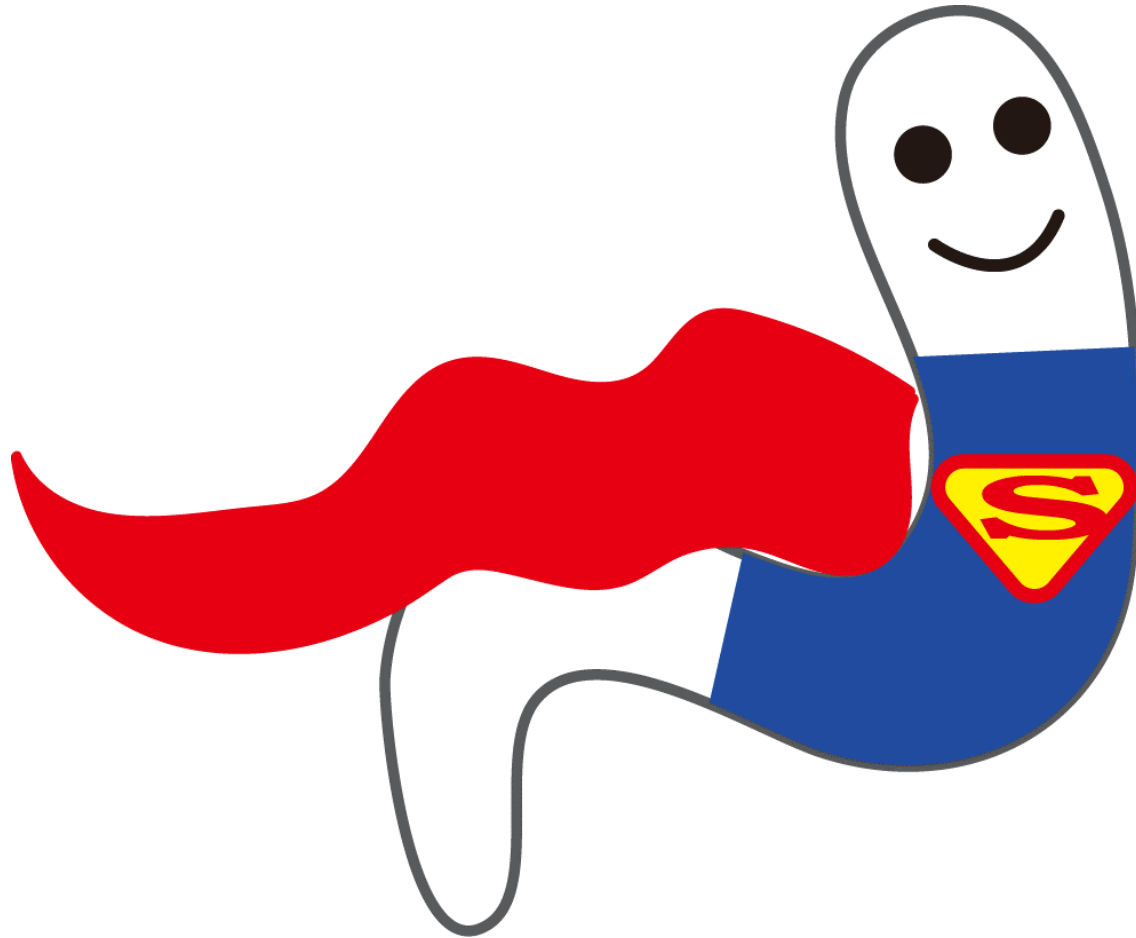


What should we do?



We need
a hero...

Worm the hero



Today's menu

- *Appetizer* -

Brain



- *Main dish* -

Worm



- *Dessert* -

Me

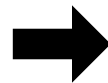


The worm

Caenorhabditis elegans (*C. elegans*)

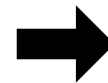
Model organism

Simple and easy!!



Core principle

原理



The worm

Caenorhabditis elegans (*C. elegans*)



Sydney Brenner

1974

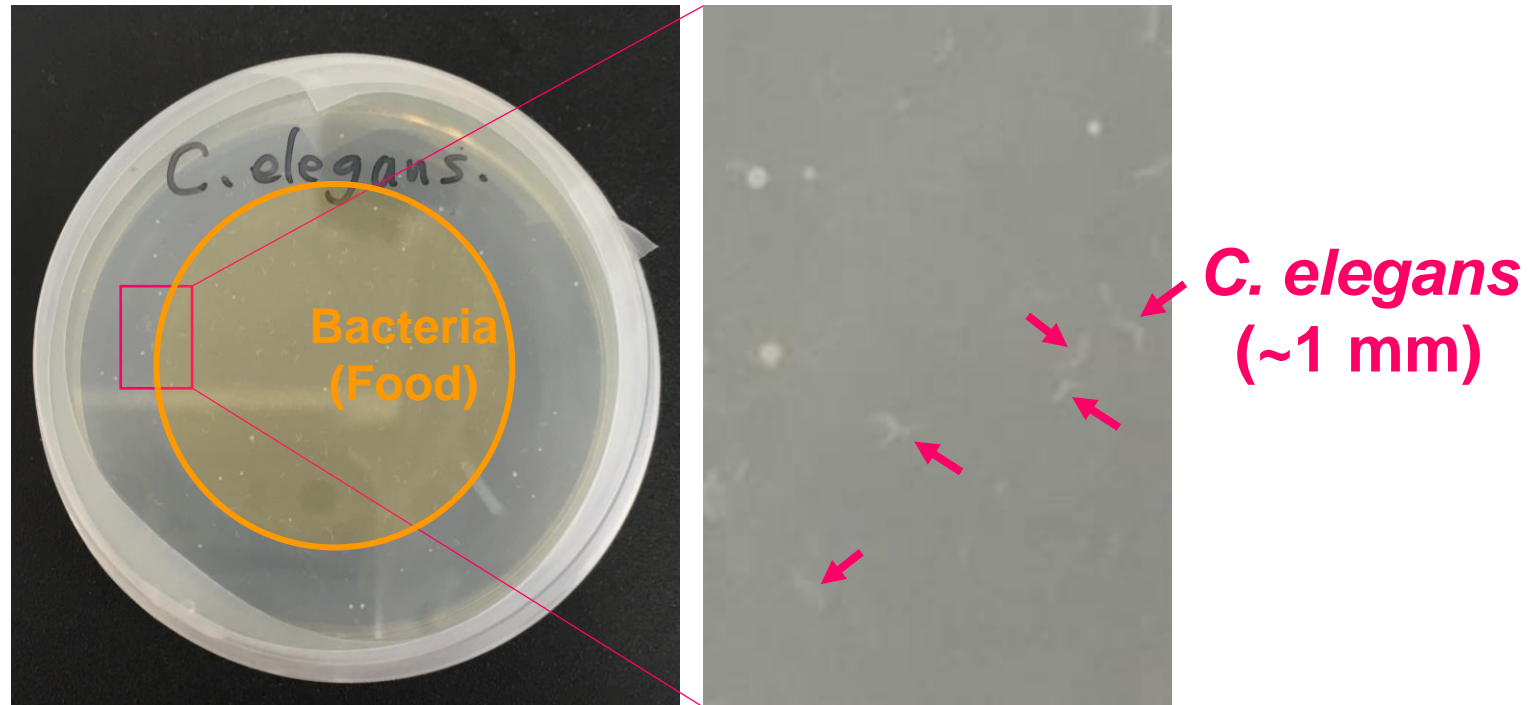
THE GENETICS OF *CAENORHABDITIS ELEGANS*

S. BRENNER

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

Nobel prize in 2002

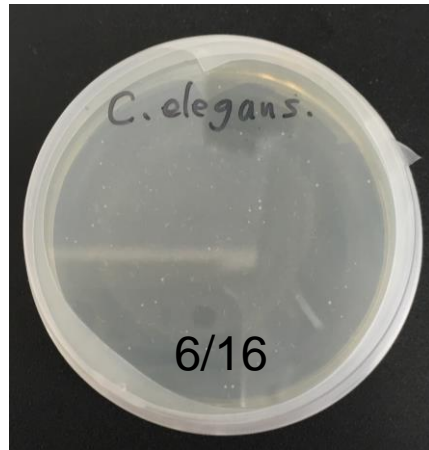
You are going to receive this



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

Elegance 1

C. elegans is easily maintained (飼育)

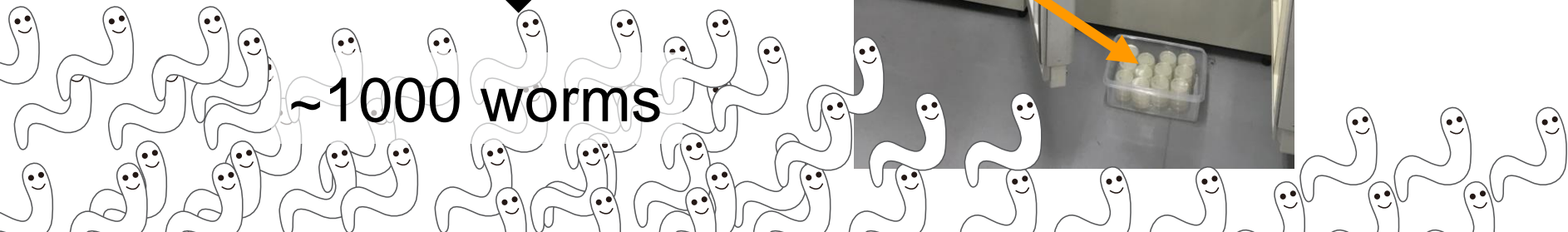


Hermaphrodite
雌雄同体



3 days
↓

~1000 worms



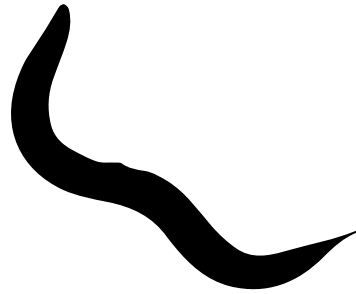
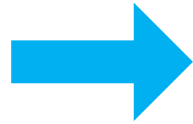
The worm show



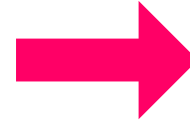
Elegance 2

C. elegans senses and responds to stimuli
(刺激)

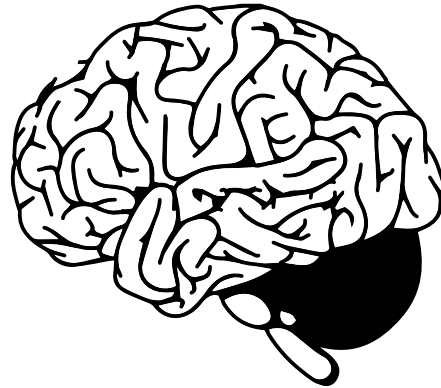
Touch



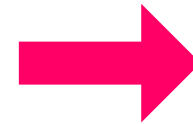
Movement



Input

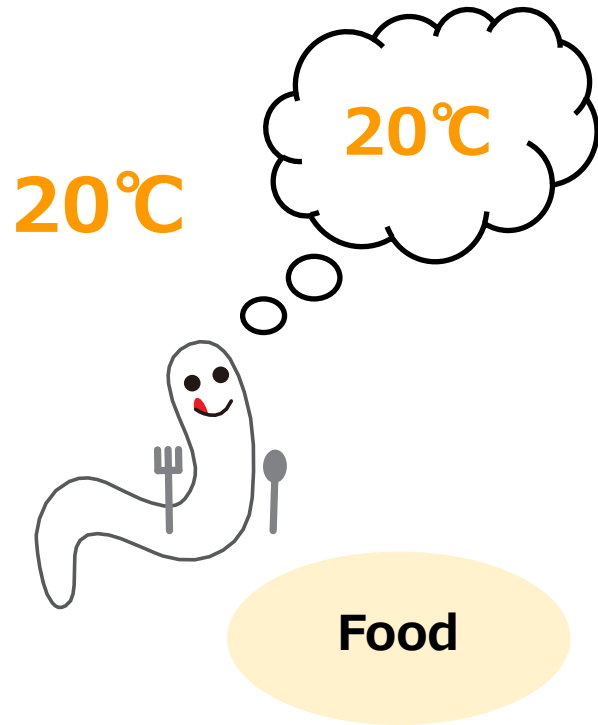


Output



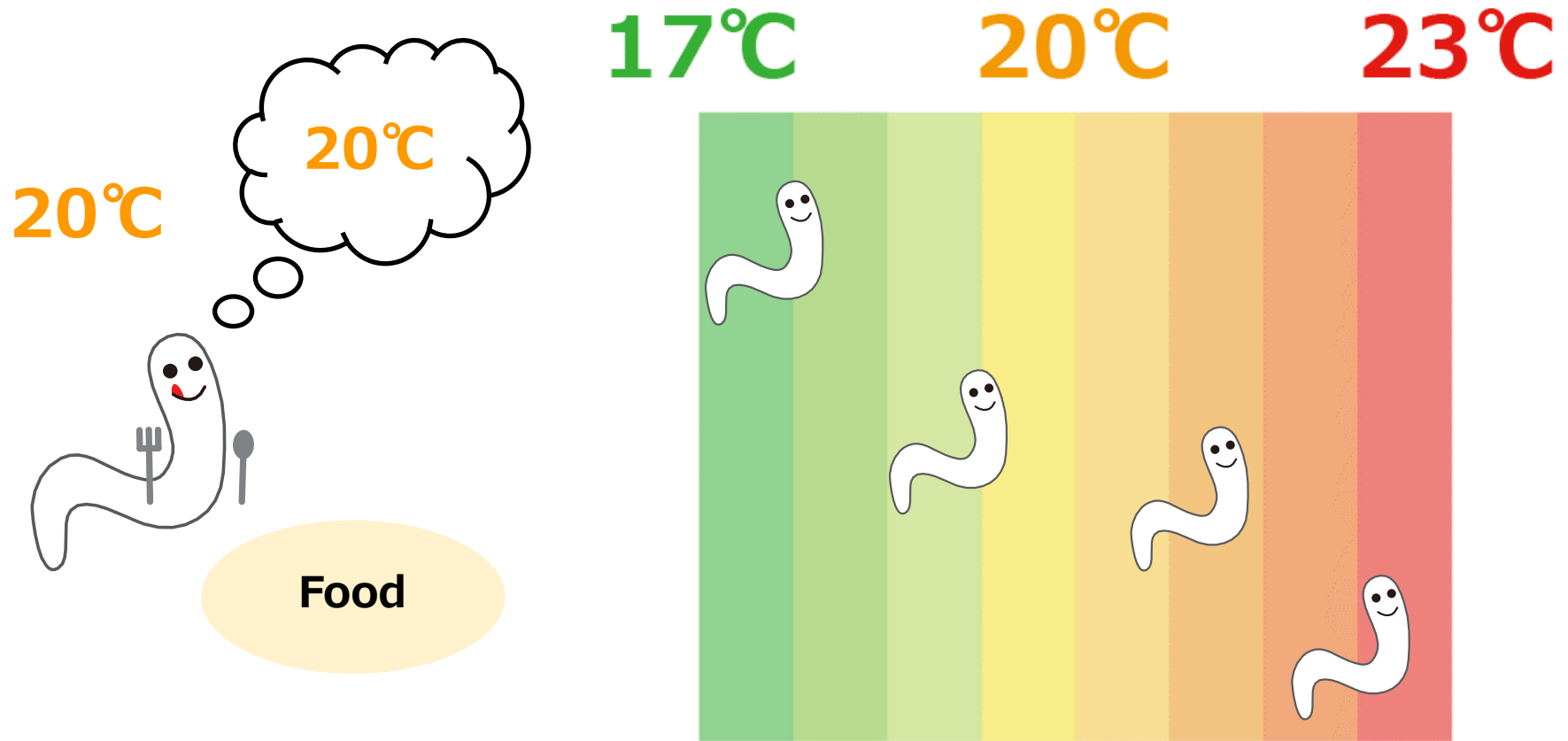
Elegance 3

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



Elegance 5
Every *C. elegans* is the same

302 neurons

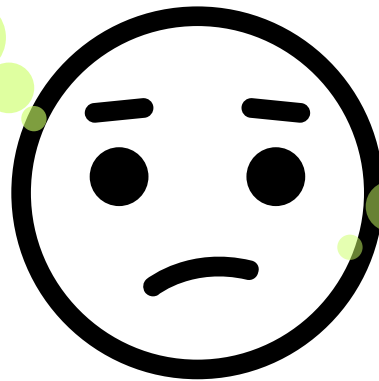


Good for experiments!!

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

Who cares?

What can we learn?



Exciting questions about the brain

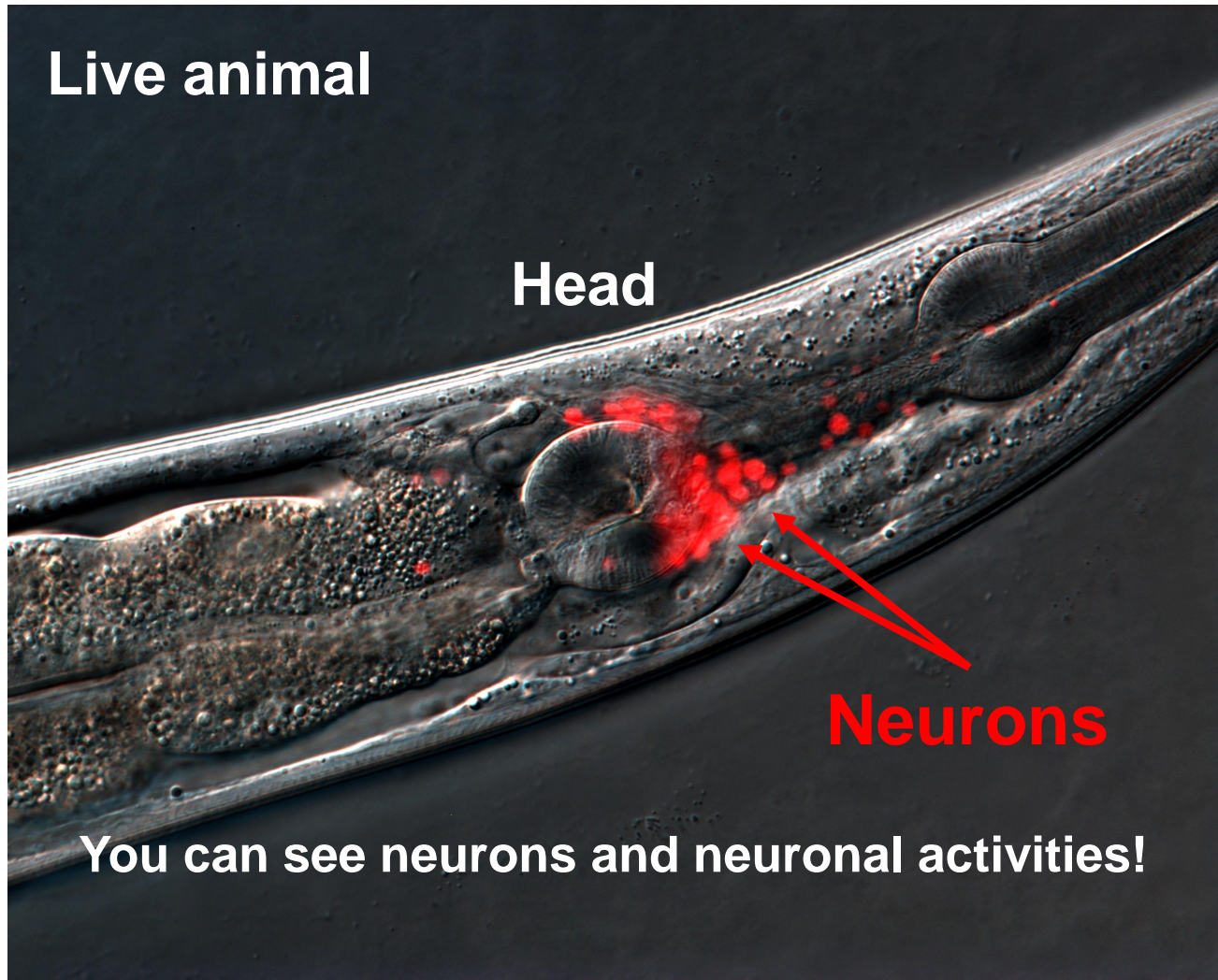
How do neurons process information?

How is the brain formed?

What is the consciousness?

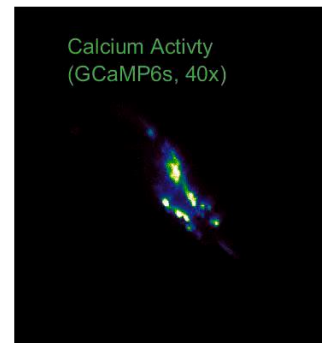
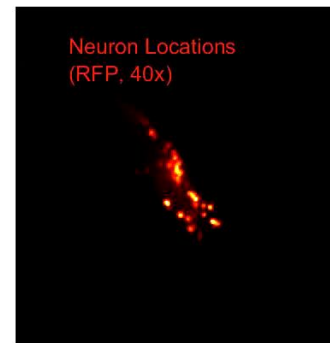
Elegance 6

C. elegans is transparent

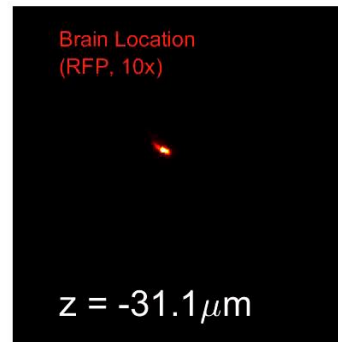
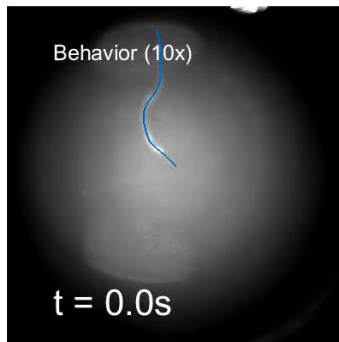


Elegance 6

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

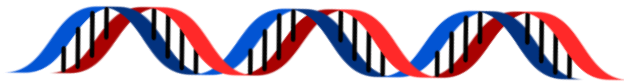
Exciting questions about the brain

How do neurons process information?

How is the brain formed?

What is the consciousness?

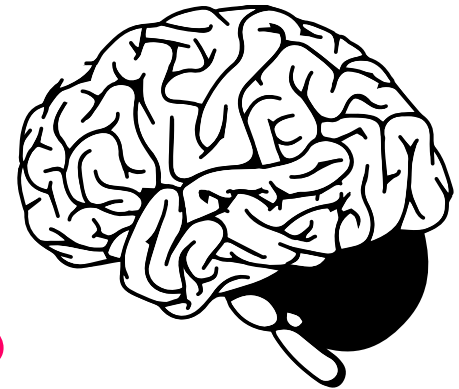
The brain is formed, based on the genome



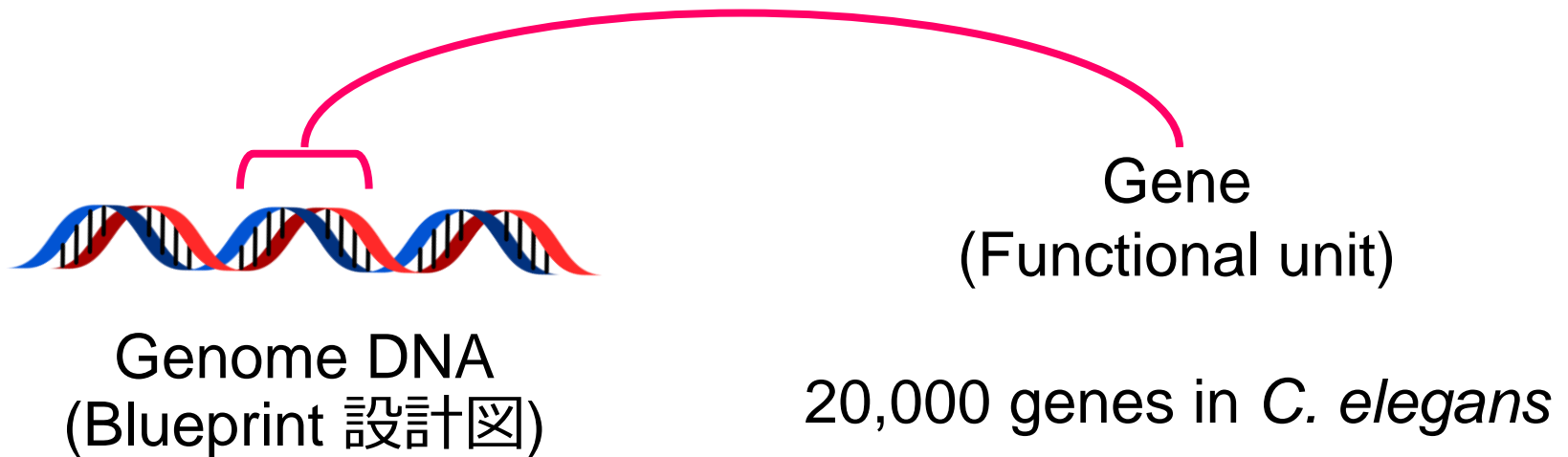
Genome DNA
(Blueprint 設計図)



HOW??



Genes are the functional units of the genome



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

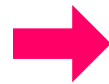


Gene B



Gene C

Forward genetic screen



Important for the brain!

Elegance 7

C. elegans is easily manipulated

Blueprint
設計図



Gene A



Gene B



Gene C

Forward genetic screen



Important for the brain!

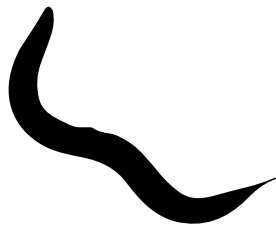
Example: a gene, *unc-13* important for neuronal communication



Elegance 8

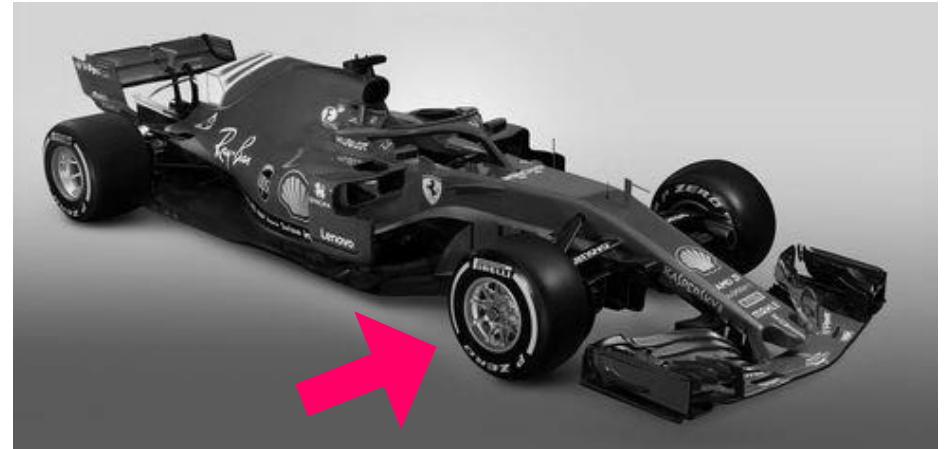
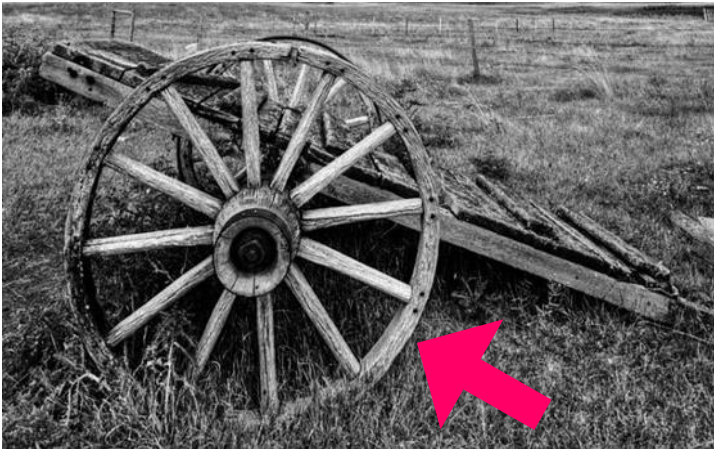
Important genes are conserved

保存されている



The blueprint

unc-13



https://books.google.co.jp/books/about/Twist_of_Gold.html?id=JKbQis8-xEC&source=kp_cover&redir_esc=y
2018/10/18

<https://response.jp/article/img/2018/02/23/306453/1279152.html?from=arrow-next> 2018/10/18

Take-home message

“Model organisms” are powerful!!



**Choose a
right tool!!**

Today's menu

- *Appetizer* -

Brain



- *Main dish* -

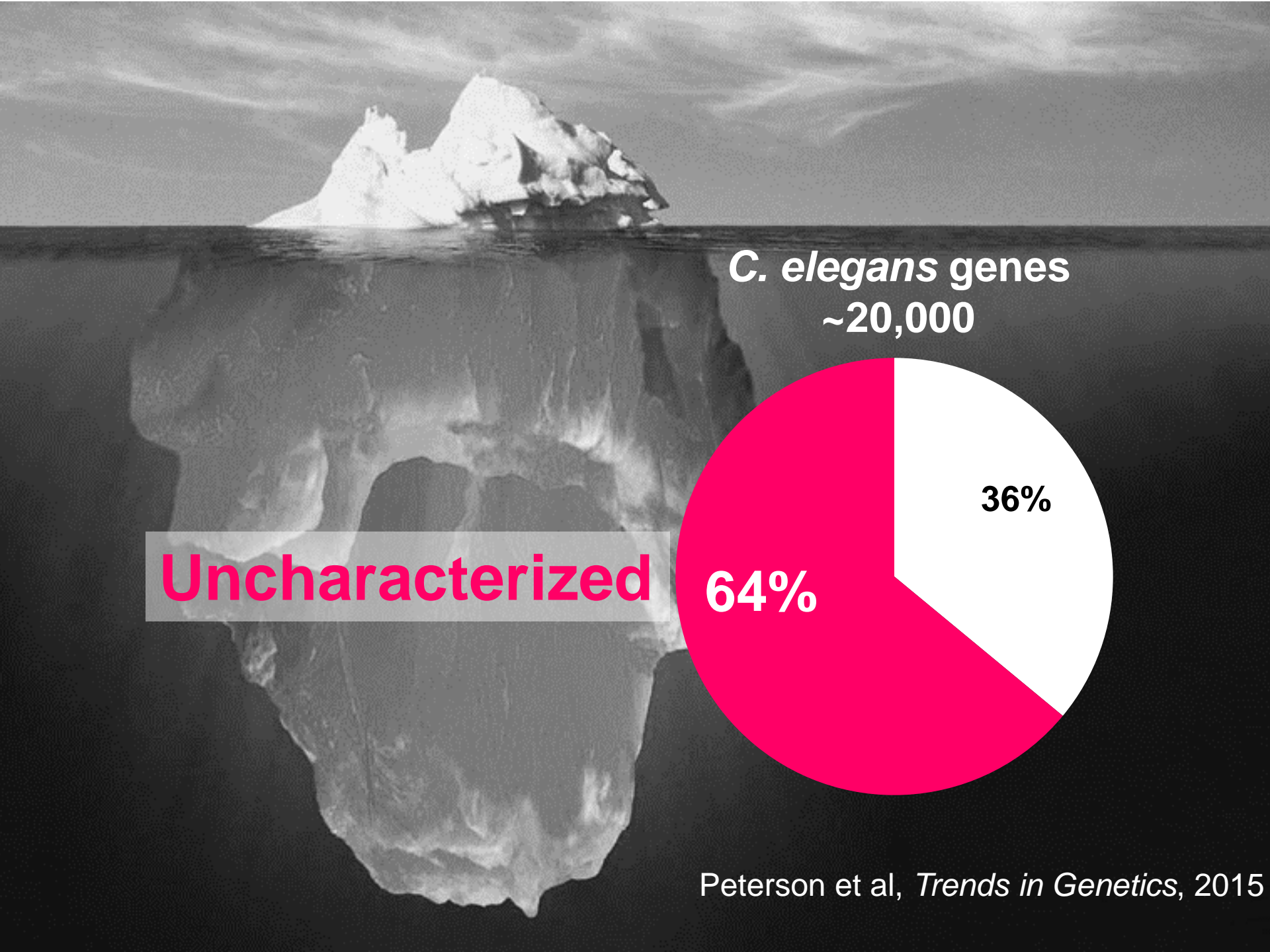
Worm



- *Dessert* -

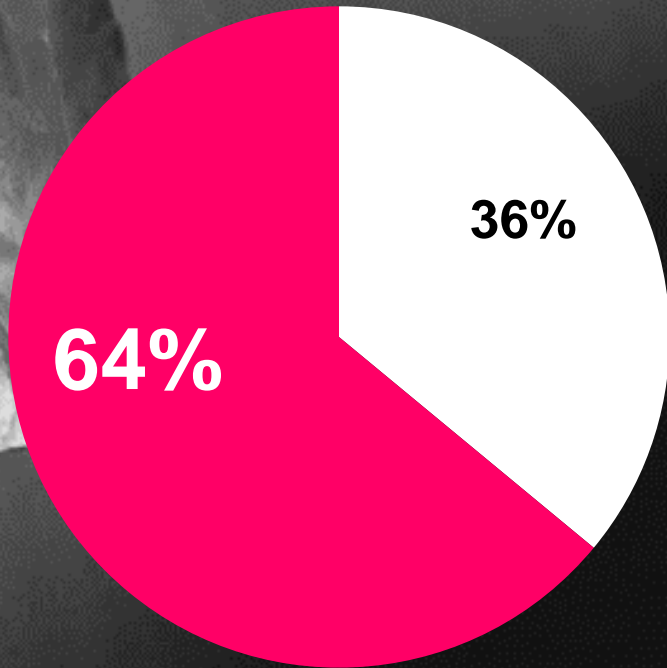
Me





C. elegans genes
~20,000

Uncharacterized



**I want to find and
characterize new
genes!!**



Forward genetic screen

$$0 + 0 = 1$$

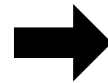
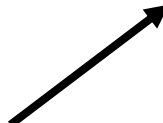
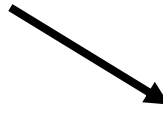
Blueprint
設計図



~~Gene A~~

~~Gene B~~

~~Gene C~~



~~Gene A~~

+

~~Gene B~~



Well characterized

Combination is challenging

Combination of two genes

$$20,000C_2 = 199,990,000$$



NEW
Forward genetic screen

I can do it with *C. elegans*!



8 elegant things

1. Maintenance

2. Sensation

3. Memory

4. Brain

5. Stereotype

6. Transparency

7. Manipulation

8. Conservation

I hope

you see elegance
in the *C. elegans* brain



Thanks!

Contact

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2012.10.31 @San Diego, USA