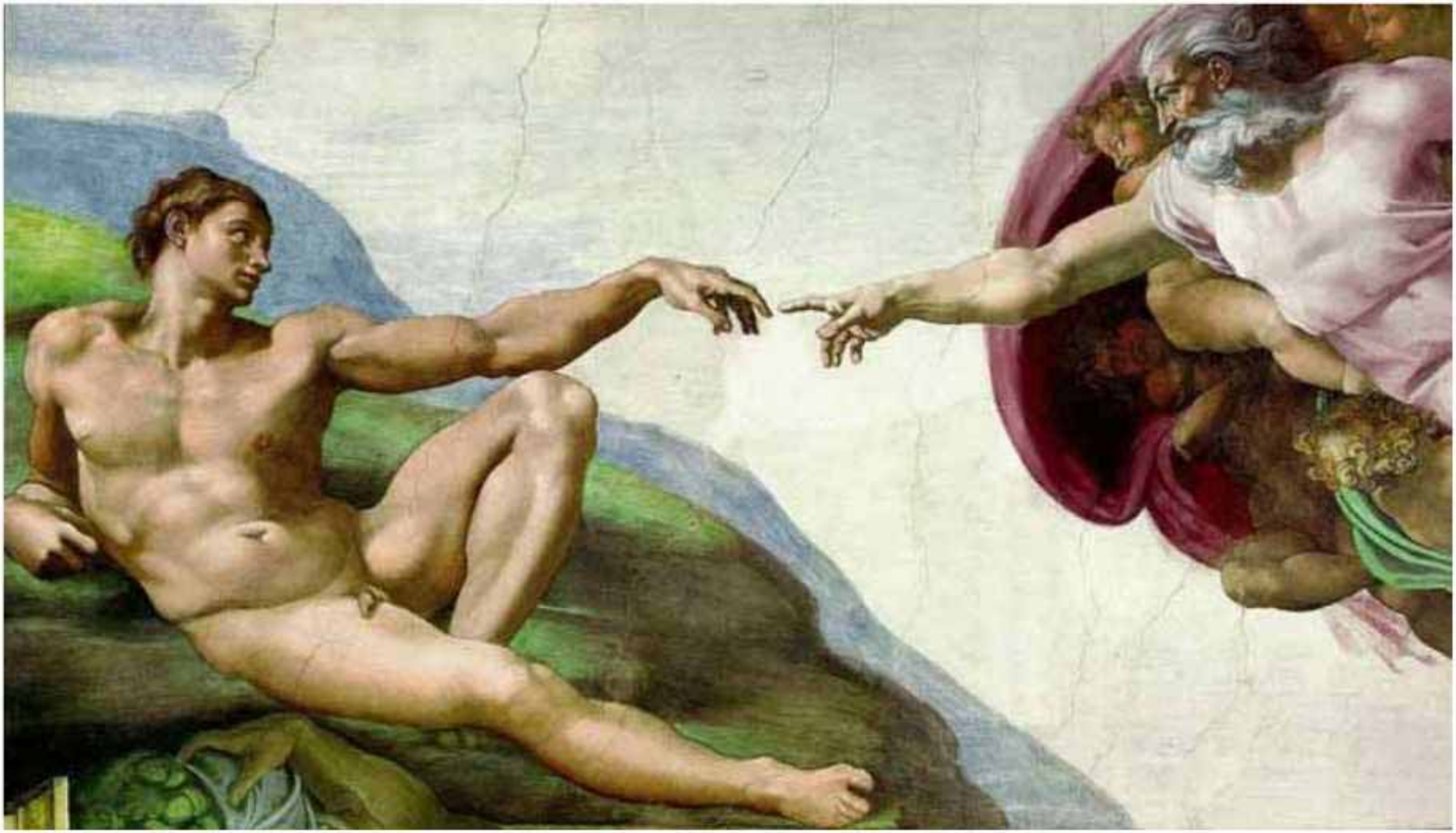
Creating new species:

the future of man and his dominion over other animals

Professor Keith Kendrick

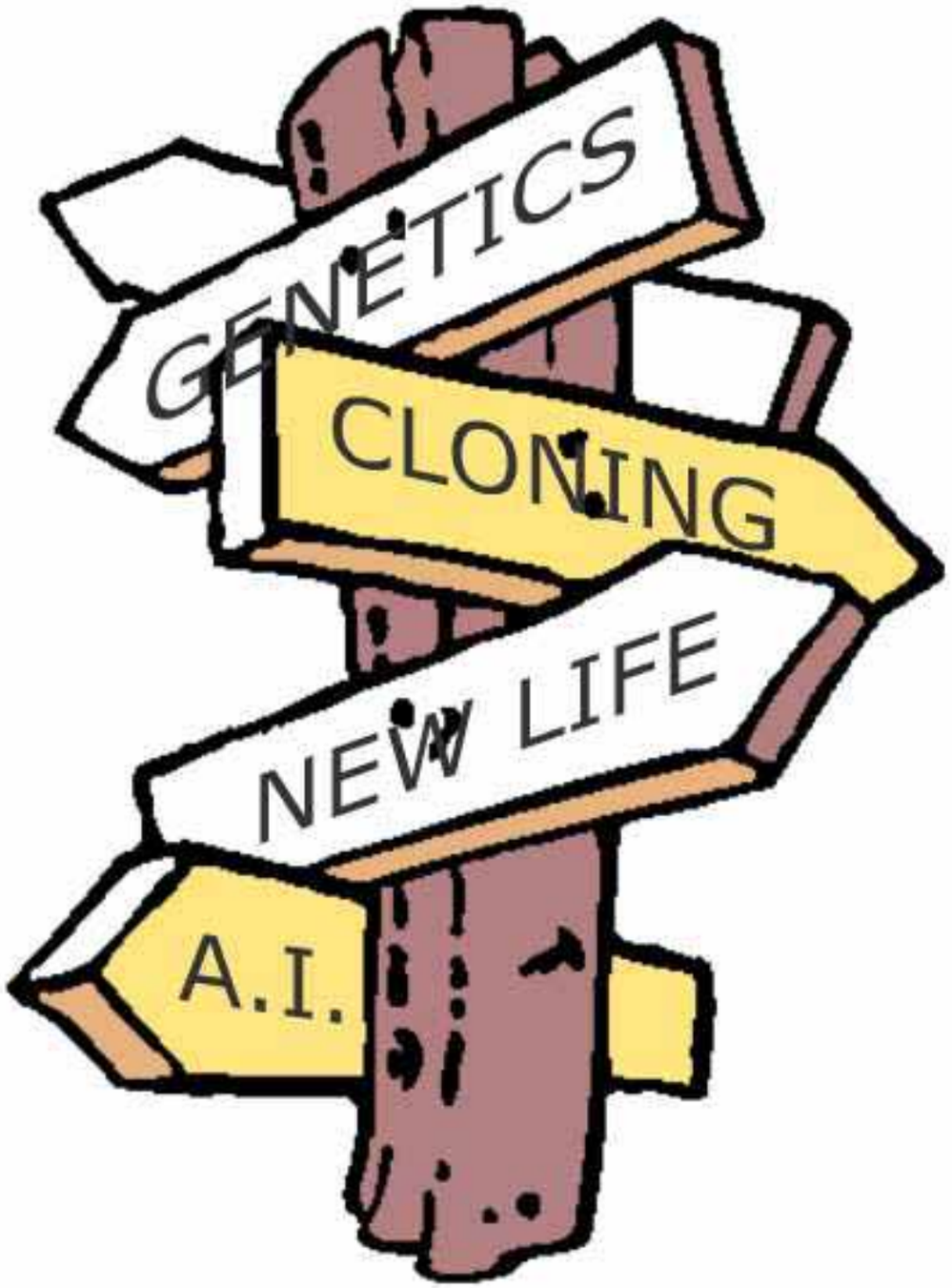
Babraham Institute

In the beginning.....



Creating new species

Where will modern biology lead us during this century?



Creating new species

Where will modern biology lead us during this century?

What science fiction will become science fact?

Creating new species

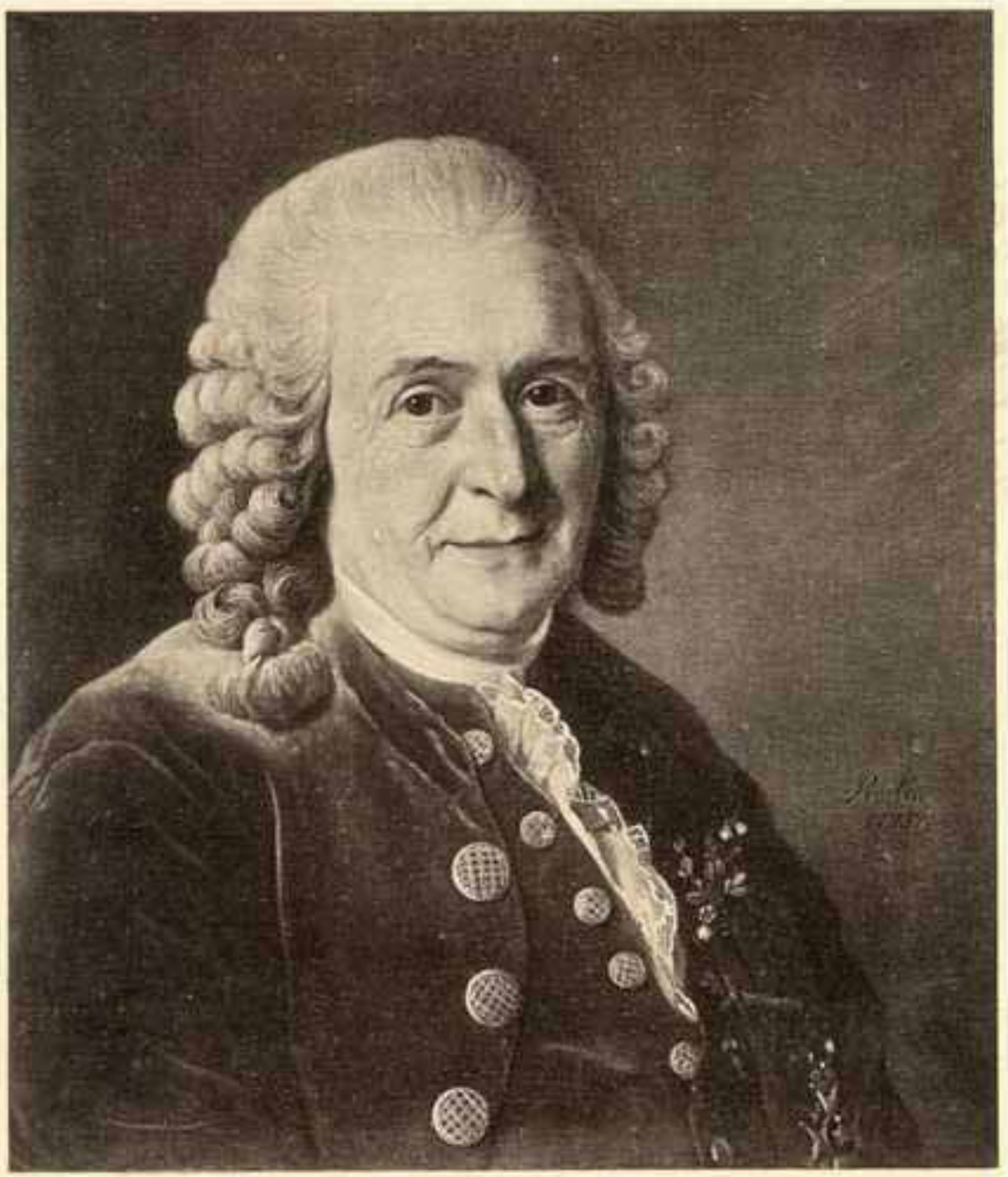
Where will modern biology lead us during this century?

What science fiction will become science fact?

Will we be able to design and create new life forms?

Plant and animal species

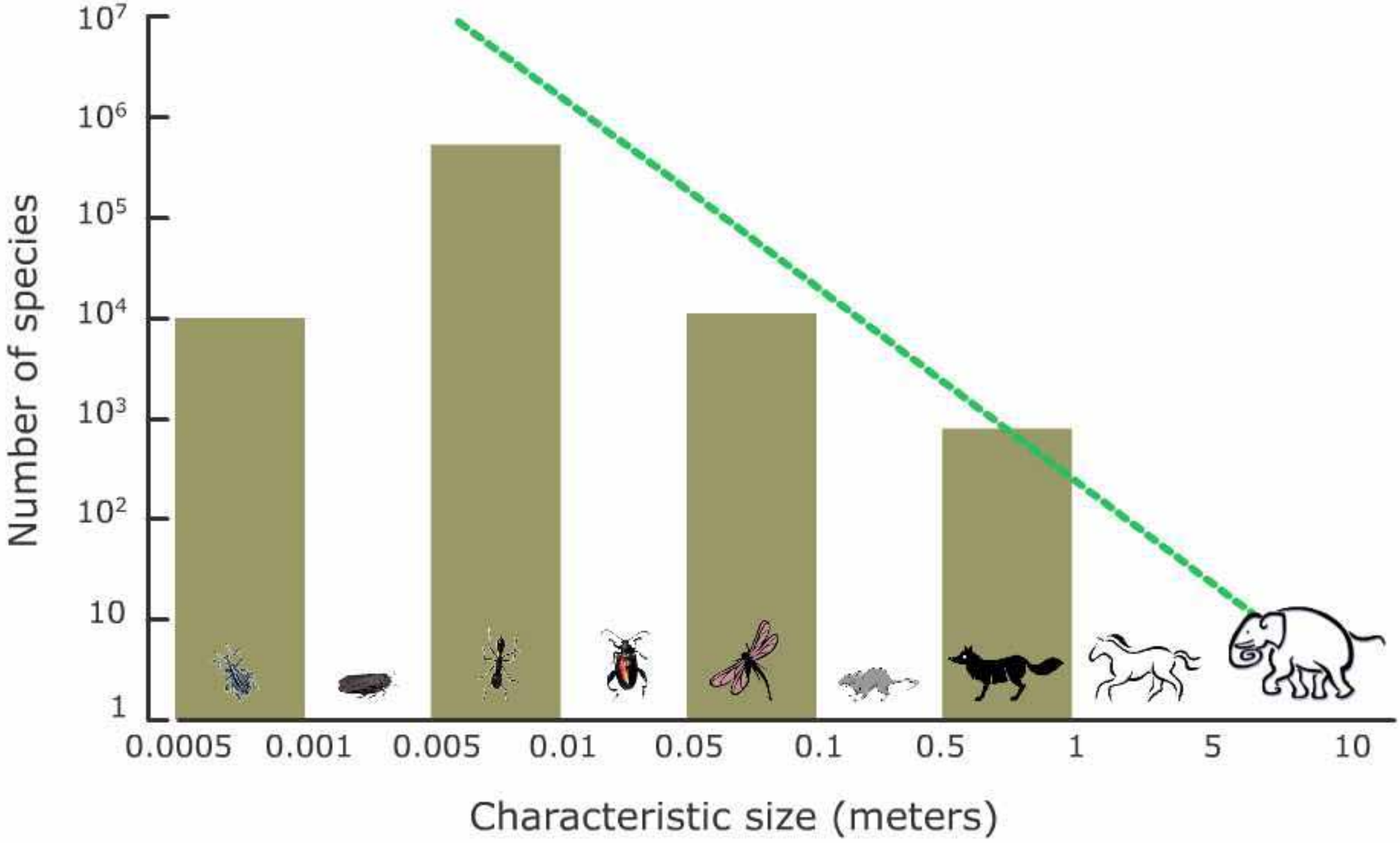
Biodiversity: How many living species are there?



Carl von Linné
Painting by A. Roslin, 1775

Plant and animal species

Actual predicted numbers are 10-50 million

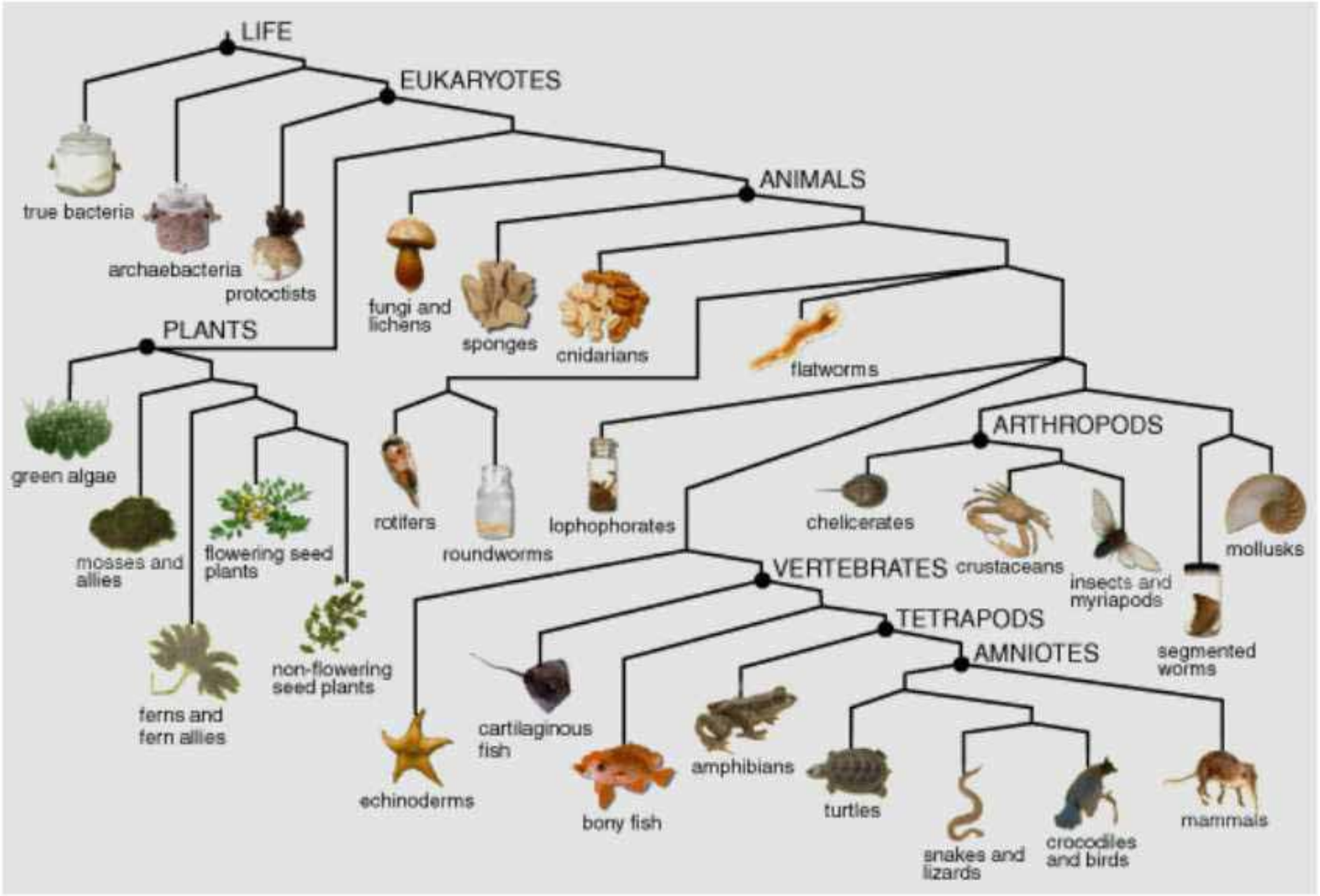


Plant and animal species

Of 300,000 plant species perhaps 90% are yet to be identified

Plant and animal species

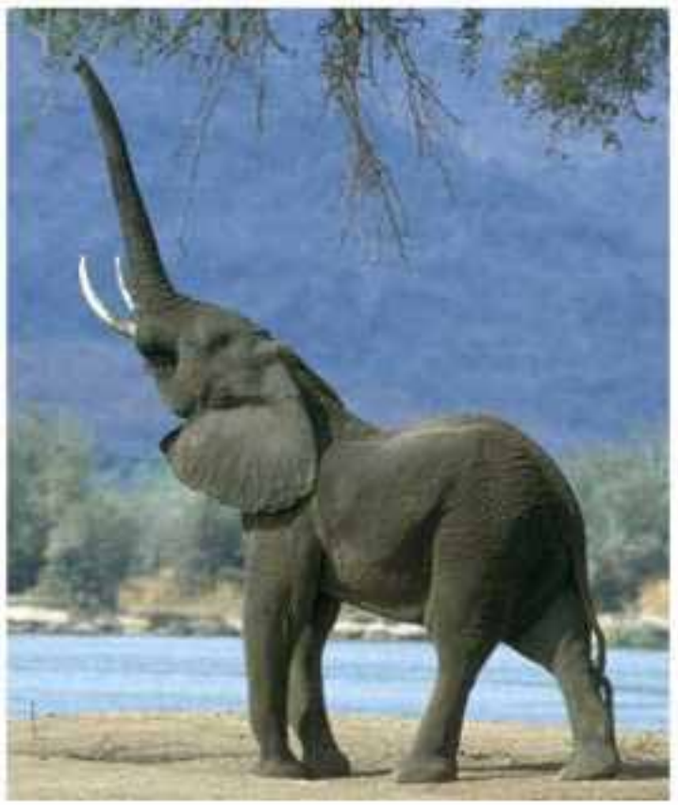
Animal numbers



Plant and animal species

Animal numbers

Mammals	5,416



Plant and animal species

Animal numbers

Mammals	5,416
Birds	9,917

Plant and animal species

Animal numbers

Mammals	5,416
Birds	9,917
Amphibians/Reptiles	13,906

Plant and animal species

Animal numbers

Mammals	5,416
Birds	9,917
Amphibians/Reptiles	13,906
Fish	28,500

Plant and animal species

Animal numbers

Mammals	5,416
Birds	9,917
Amphibians/Reptiles	13,906
Fish	28,500
Crustaceans	40,000

Plant and animal species

Animal numbers

Mammals	5,416
Birds	9,917
Amphibians/Reptiles	13,906
Fish	28,500
Crustaceans	40,000
Molluscs	70,000

Plant and animal species

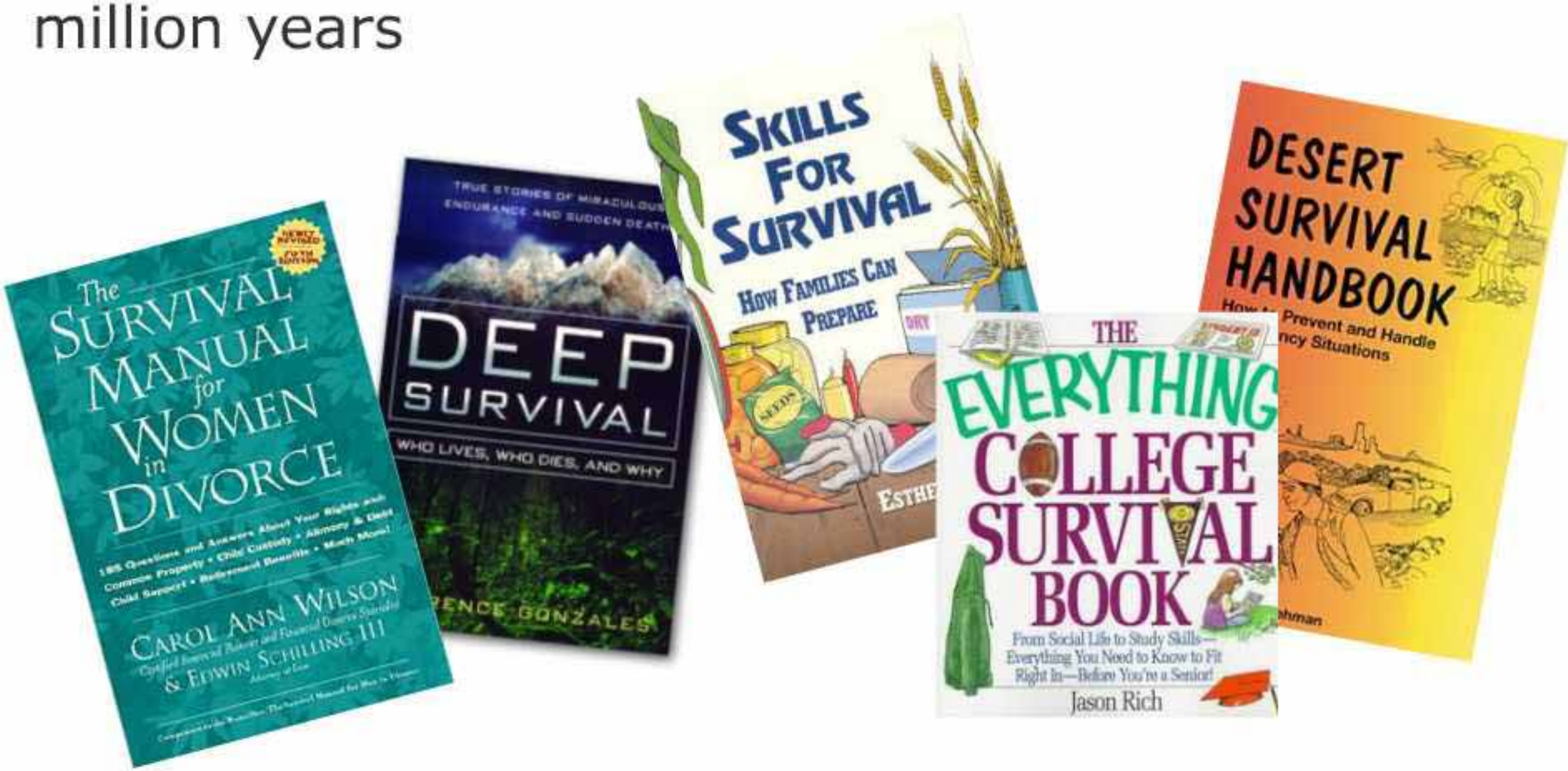
Animal numbers

Mammals	5,416
Birds	9,917
Amphibians/Reptiles	13,906
Fish	28,500
Crustaceans	40,000
Molluscs	70,000
Insects	950,000 (Actual number 10+ million)

Extinction rates

Extinction is a natural process:
99% of life forms have become extinct

The average survival time for each species is 10 million years



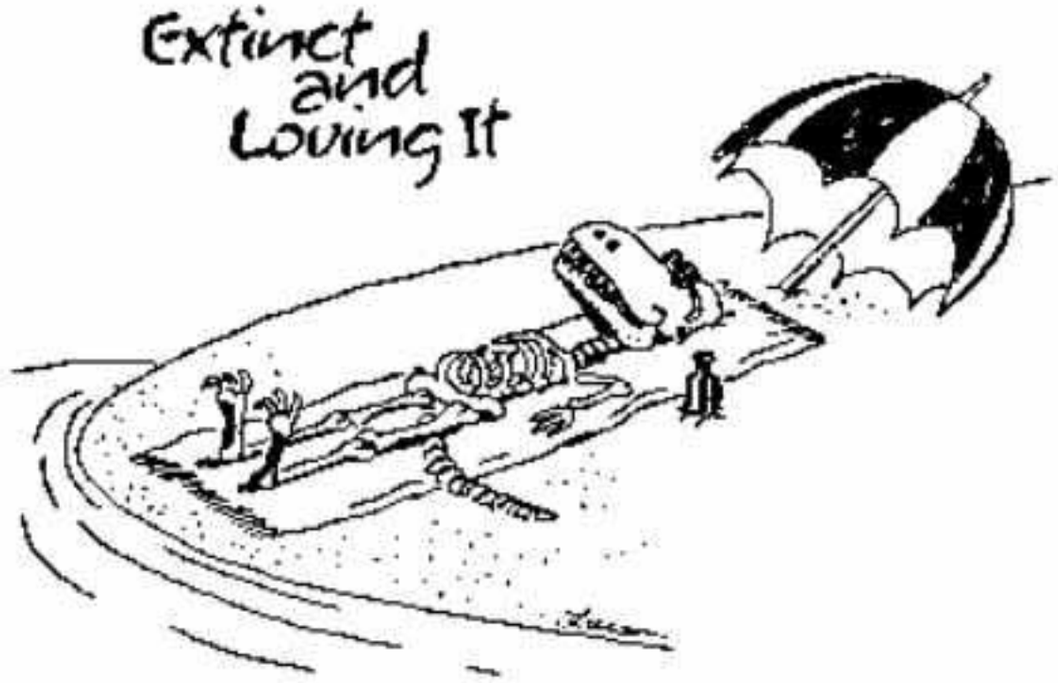
Extinction rates

Extinction is a natural process:
99% of life forms have become extinct

The average survival time for each species is 10 million years

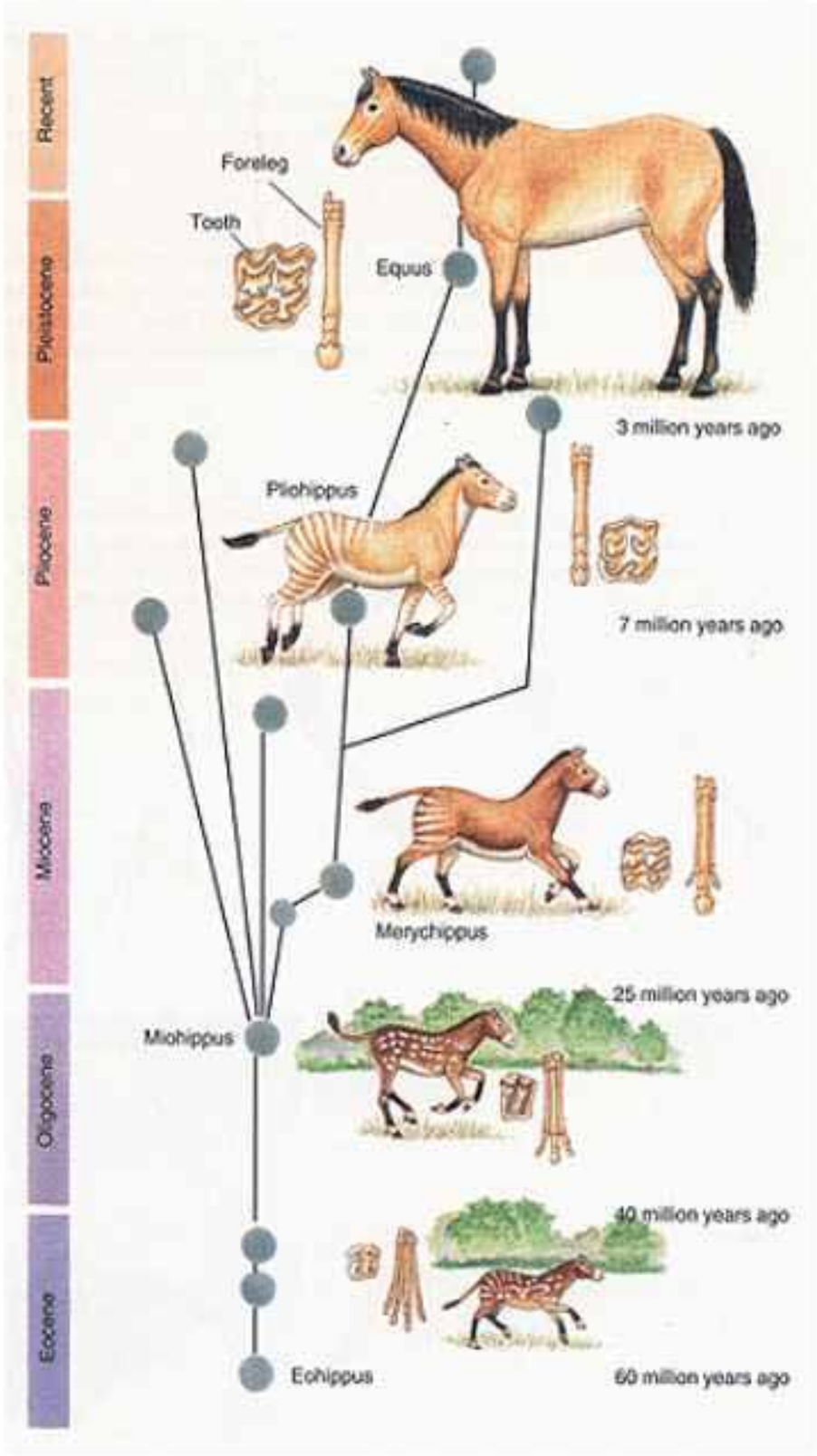
Natural extinction rate is
0.01 – 0.001% of species each century

Based on 10 million this equates to 100-1000 species



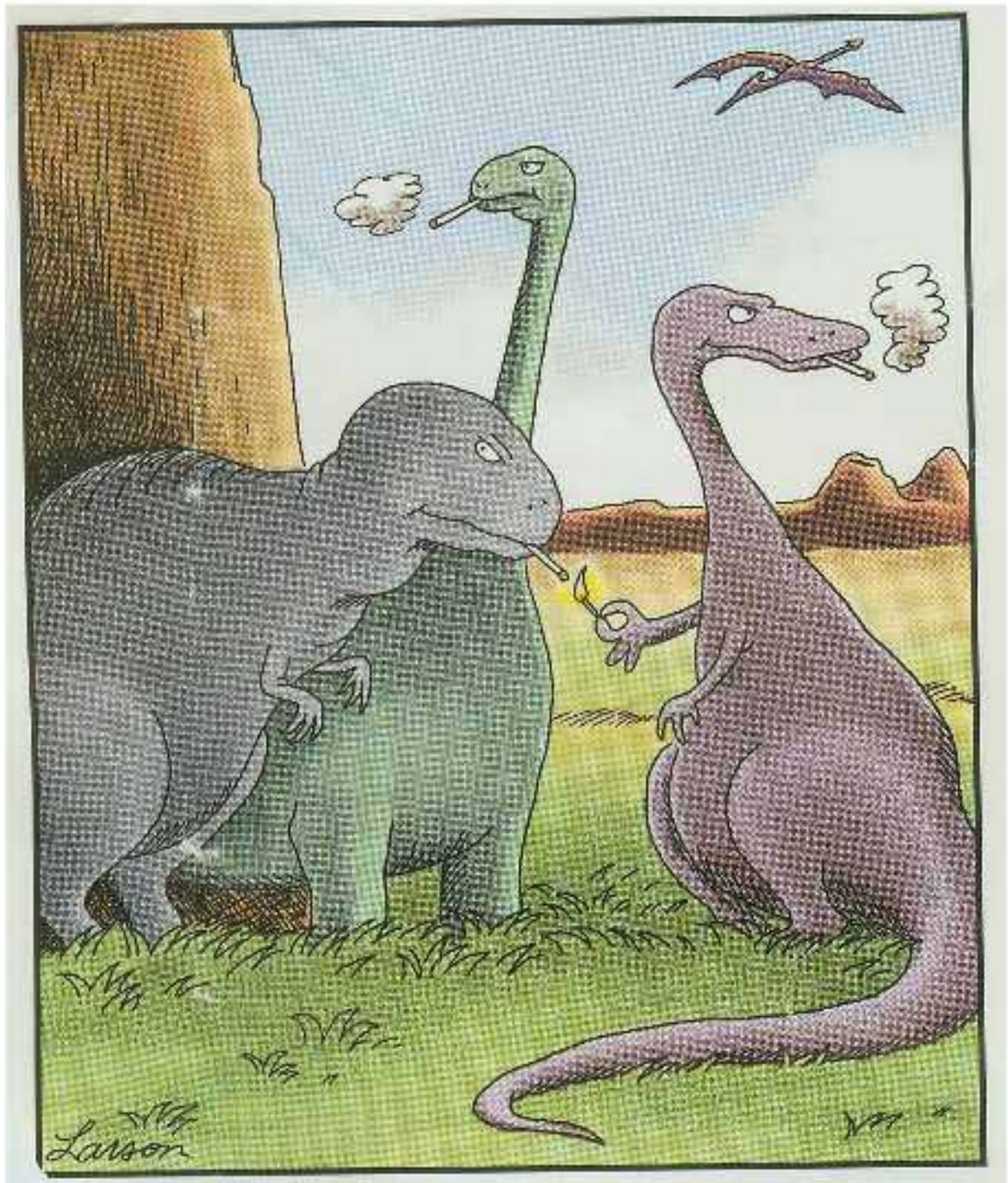
Extinction rates

Compensated for by the evolution of new species



Extinction rates

Mass extinctions are nothing new



The real reason dinosaurs became extinct

Extinction rates

Mass extinctions are nothing new

Current 6th mass extinction is caused by humans

'Now we know what it looked like, we just have to discover why it died out.'

Extinction rates

Average = 1% each century (100,000-500,000 species!)

	Number of species	% under threat		Number of species	% under threat
Mammals	5,416	20	Mosses	15,000	0.5
Birds	9,917	12	Ferns	13,025	1
Reptiles	8,163	4	Gymnosperms	980	31
Amphibians	5,743	31	Dicotyledons	199,350	4
Fishes	28,500	3	Monocotyledon	59,300	1
Insects	950,000	0.06	Lichens	10,000	0.02
Molluscs	70,000	1			
Crustaceans	40,000	1			
Others	130,200	0.02			

The IUCN Red List of
Threatened Species™

Database Search

Extinction rates

Average = 1% each century (100,000-500,000 species!)

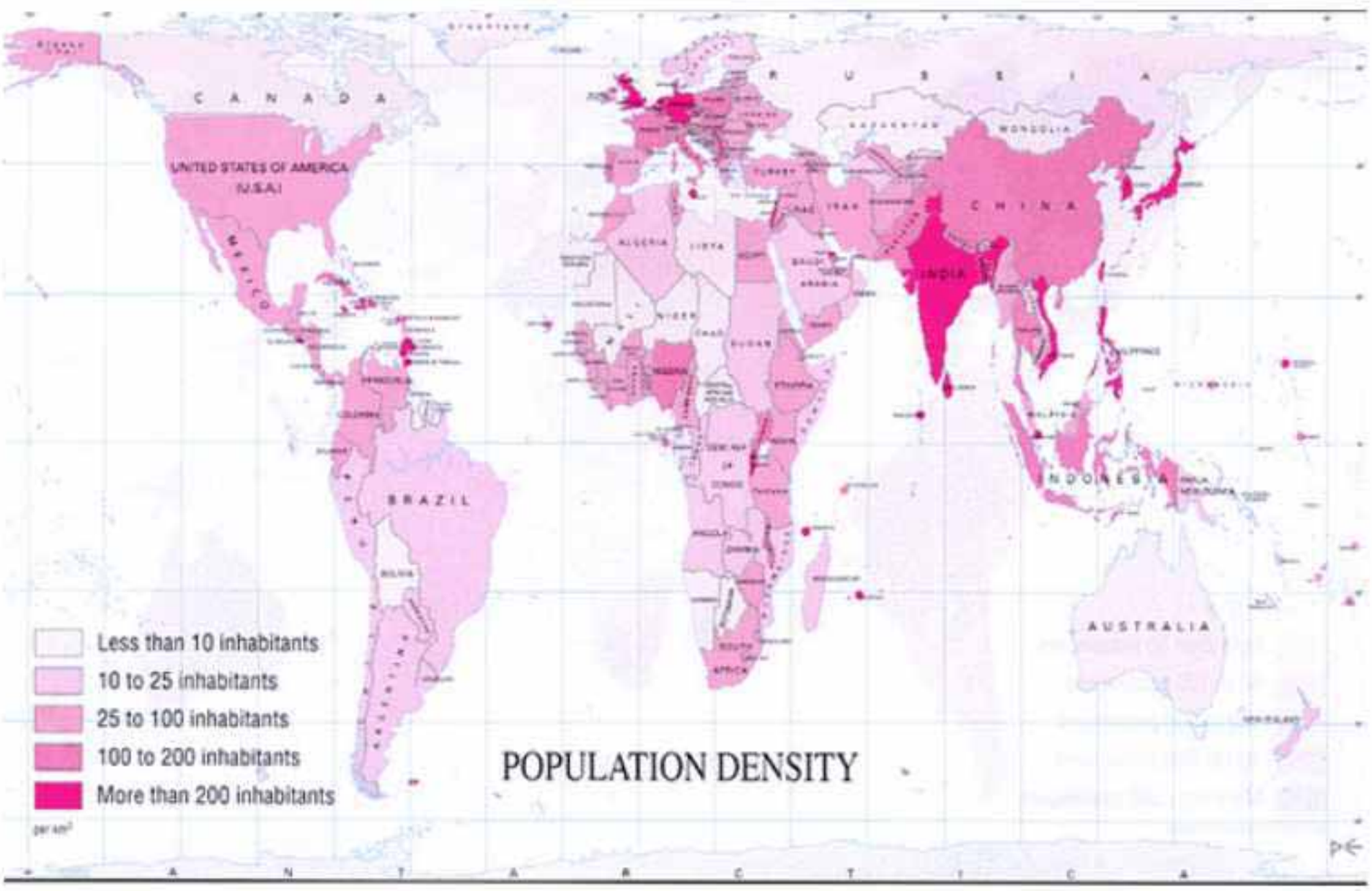
This is 100 - 1000 times above the natural level

Extinction rates

The planet's biodiversity is decreasing

The human impact

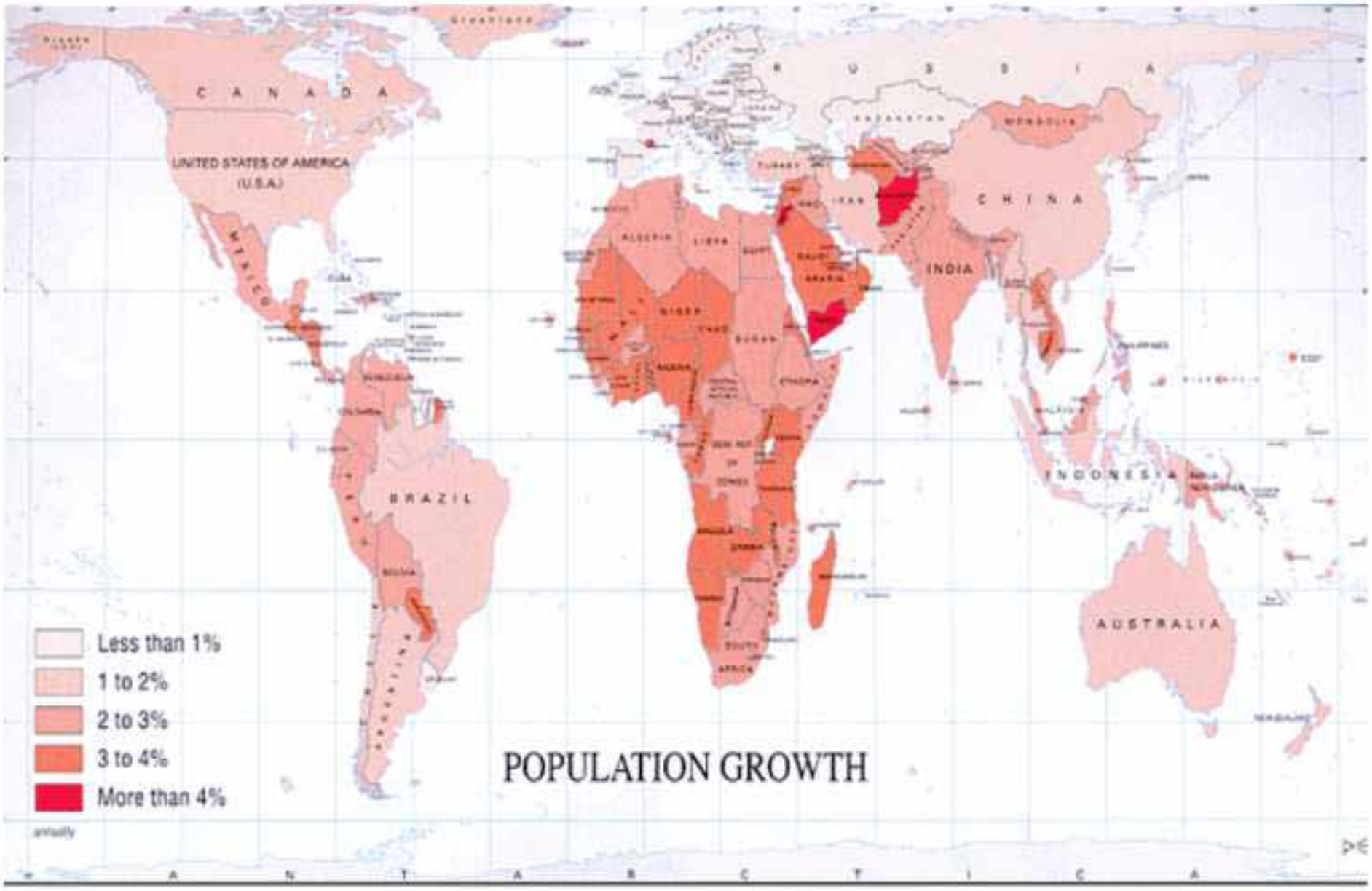
The world’s population exceeds 6 billion...



The human impact

The world's population exceeds 6 billion...

...and has increased 6-fold in the last 150 years



The human impact

The increase is slowing, but not in regions of highest biodiversity (shown below as ●)

The human impact

Agriculture has allowed our numbers to increase 30-fold

The human impact

Agriculture has allowed our numbers to increase 30-fold

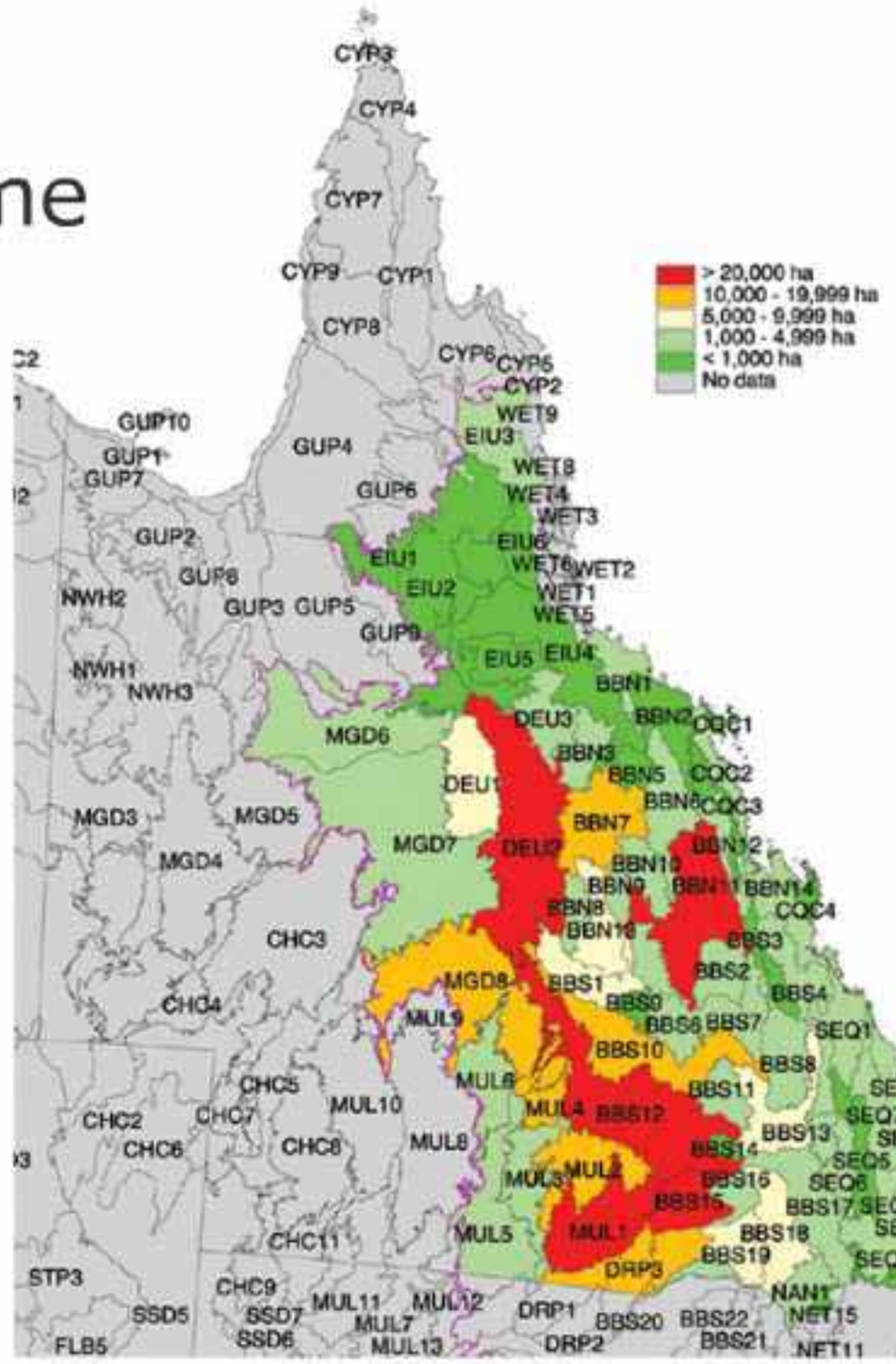
Hunting is responsible for some large mammals and birds

The human impact

Agriculture has allowed our numbers to increase 30-fold

Hunting is responsible for some large mammals and birds

The main cause is habitat loss and degradation



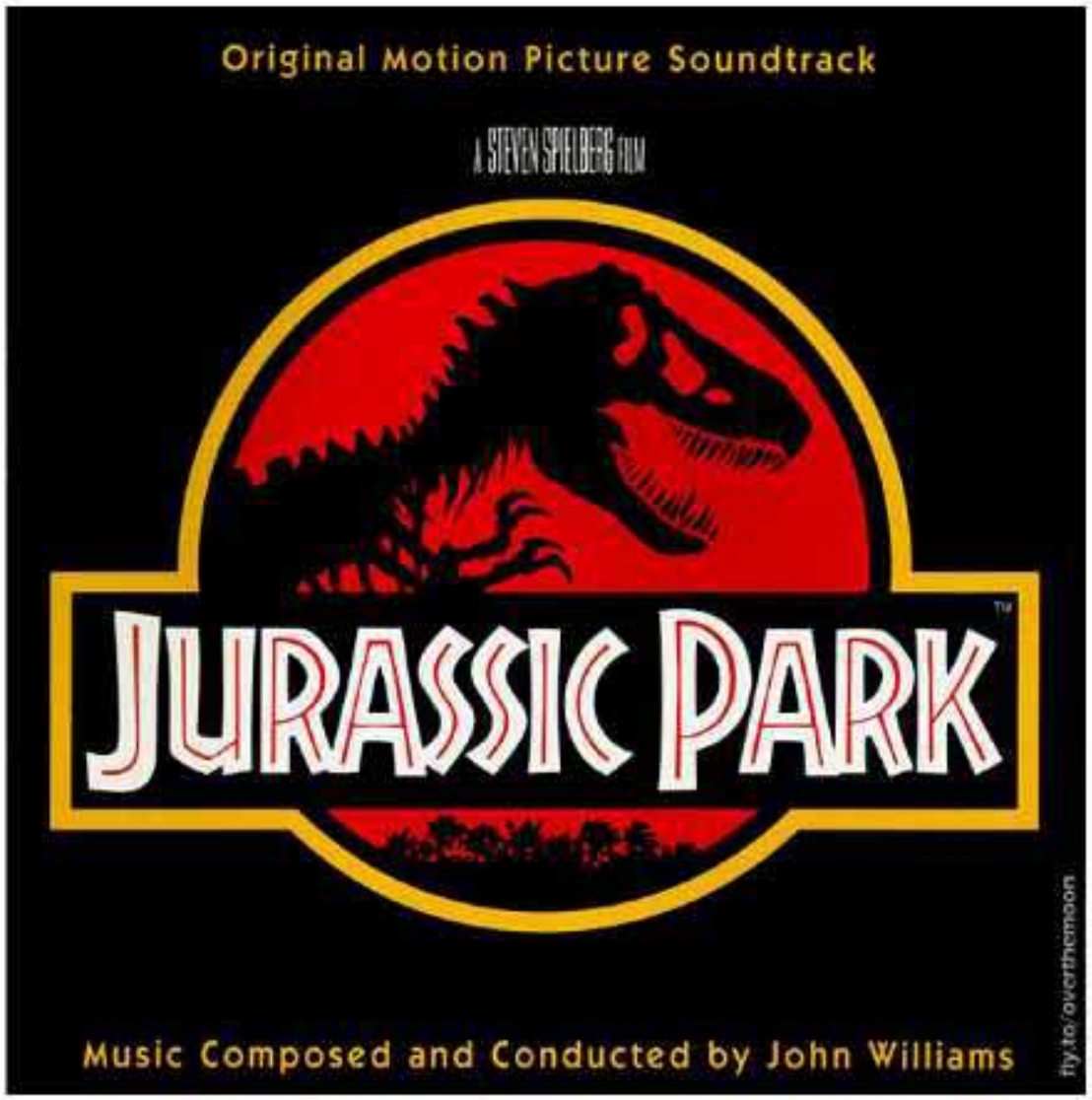
The human impact

50% of all plant and animal species are living in closed tropical forests

The human impact

50% of all plant and animal species are living in closed tropical forests

We could preserve their DNA and perhaps bring them back to life!



The human impact

There is no point if natural habitat is destroyed

The human impact

New species may be:

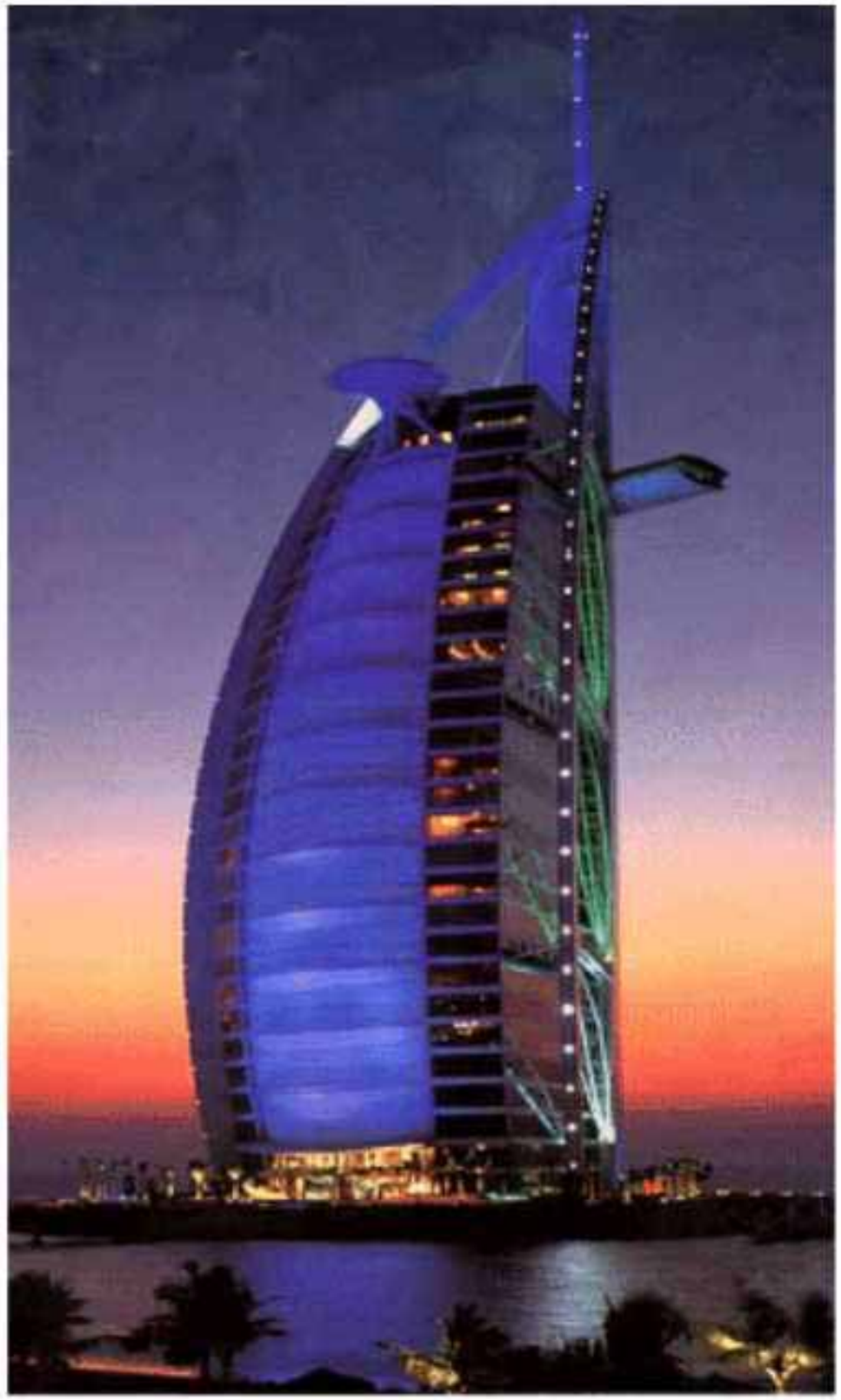
Useful to us

The human impact

New species may be:

Useful to us

Able to live in humanised habitats



What do we need other living species for?

Plants and/or other animals help to:

11-5-02

Plant would aid region

A new Dow facility in Midland would create hundreds of jobs.

JEAN SPEIGNER, PAUL WYCHE and CATHY HENG
■ THE SAGINAW NEWS

If Dow Chemical Co. builds a $230 million chemical plant in Midland, it would have an economic impact that could ripple through out the Saginaw Valley.

"Anytime you have an investment like that you create an opportunity for the entire region," said JoAnn Crary, president of Saginaw Future Inc., Saginaw County's economic development organization.

Along with 300 new jobs at the Dow plant, Saginaw Bay and Midland counties could benefit from an additional 648 plus spin-off jobs from services and suppliers that would move to the area, said Jesse Velasquez, executive director of the Midland Economic Development Council.

Velasquez helped explain the project to Midland City Council members Monday night and pitched the importance of creating a 12-year $69.5 million tax-break renais-sance zone for the plant.

"This is a new incentive program for the city for economic development," Velasquez said, "and approving it sends a message to global companies that Michigan and Midland can do what is needed for new jobs."

Midland is one of four or five sites in the running for the new facility, winnowed from a list of 23, said Ben Robertson, account manager for global business development for the Michigan Economic Development Corp., which has worked with Midland officials to use a renaissance zone to attract the Dow plant.

DOW – A2 ›

What do we need other living species for?

Plants and/or other animals help to:

Maintain our ecosystem

What do we need other living species for?

Plants and/or other animals help to:

Maintain our ecosystem

Provide food

What do we need other living species for?

Plants and/or other animals help to:

Maintain our ecosystem

Provide food

Act as labour-saving assistants

What do we need other living species for?

Plants and/or other animals help to:

Extend human biomedical advances

What do we need other living species for?

Plants and/or other animals help to:

Extend human biomedical advances

Provide pleasure and companionship

What do we need other living species for?

Plants and/or other animals help to:

Extend human biomedical advances

Provide pleasure and companionship

Provide psychological and emotional well-being

What do we need other living species for?

Humans only directly require <50 other animal species

Providing food

Agriculture and selective breeding of plants and animal species

Welcome to

IGER

Providing food

Agriculture and selective breeding of plants and animal species

Pressures for high productivity and low space utilisation

Providing food

Agriculture and selective breeding of plants and animal species

Pressures for high productivity and low space utilisation

High yield plants

Low intensity organic approaches could not provide for all

Wild Country Organics

Growing and delivering organic vegetables to your home

SOIL ASSOCIATION ORGANIC STANDARD

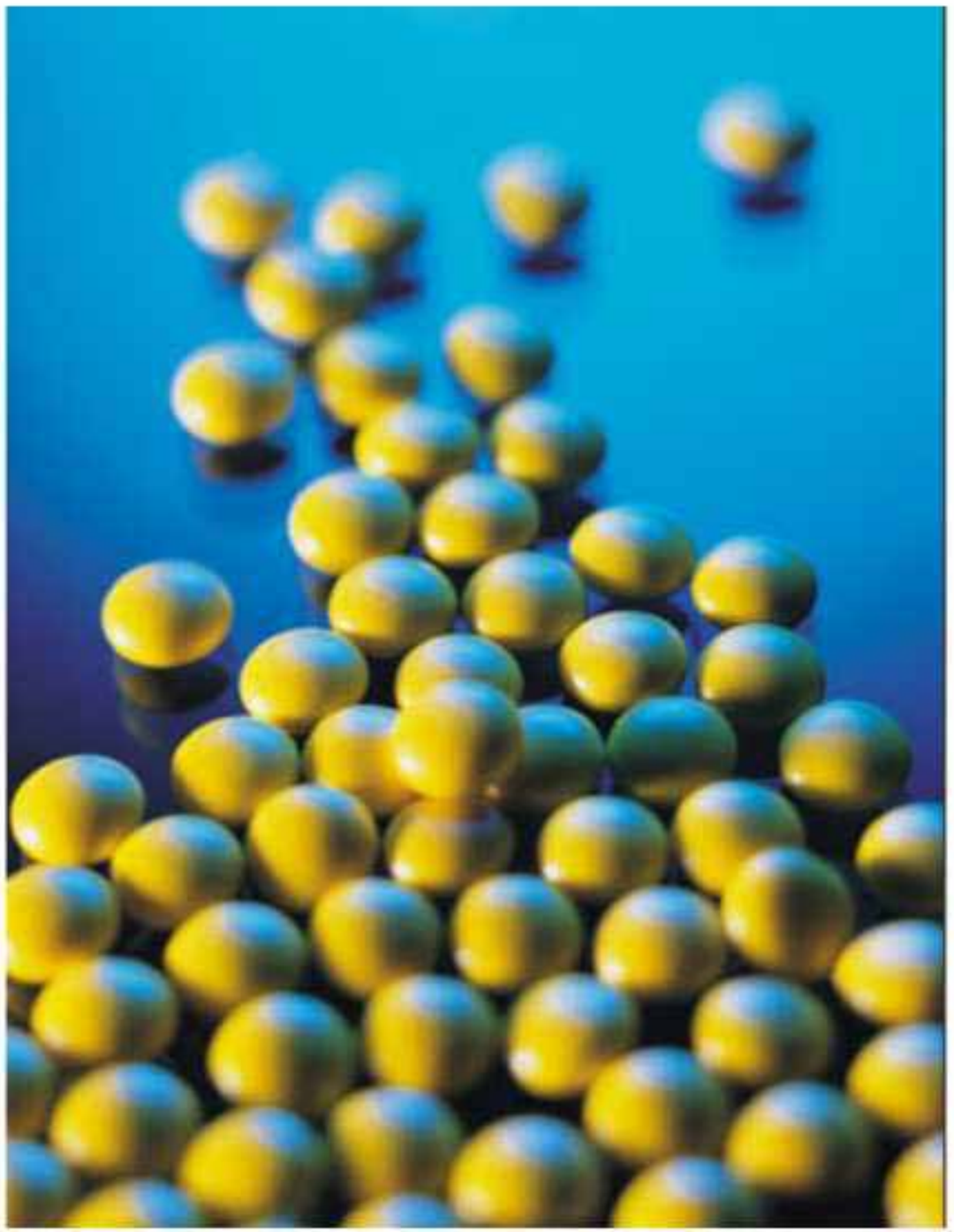
Order	Delivery info	Box Contents	Why Organic	Recipes	About Us	Wholesale	F.A.Q

Welcome to the Wild Country Organics website. Since 1998 we have been growing more than 60 varieties of organic vegetables on our small familly farm near Cambridge, certified by the Soil Association. Our box scheme offers fresh, tasty, organic fruit and vegetables delivered weekly.

Click **Order Form** to order on line or call us on **01223 560038** to place you order

Human biomedical advances

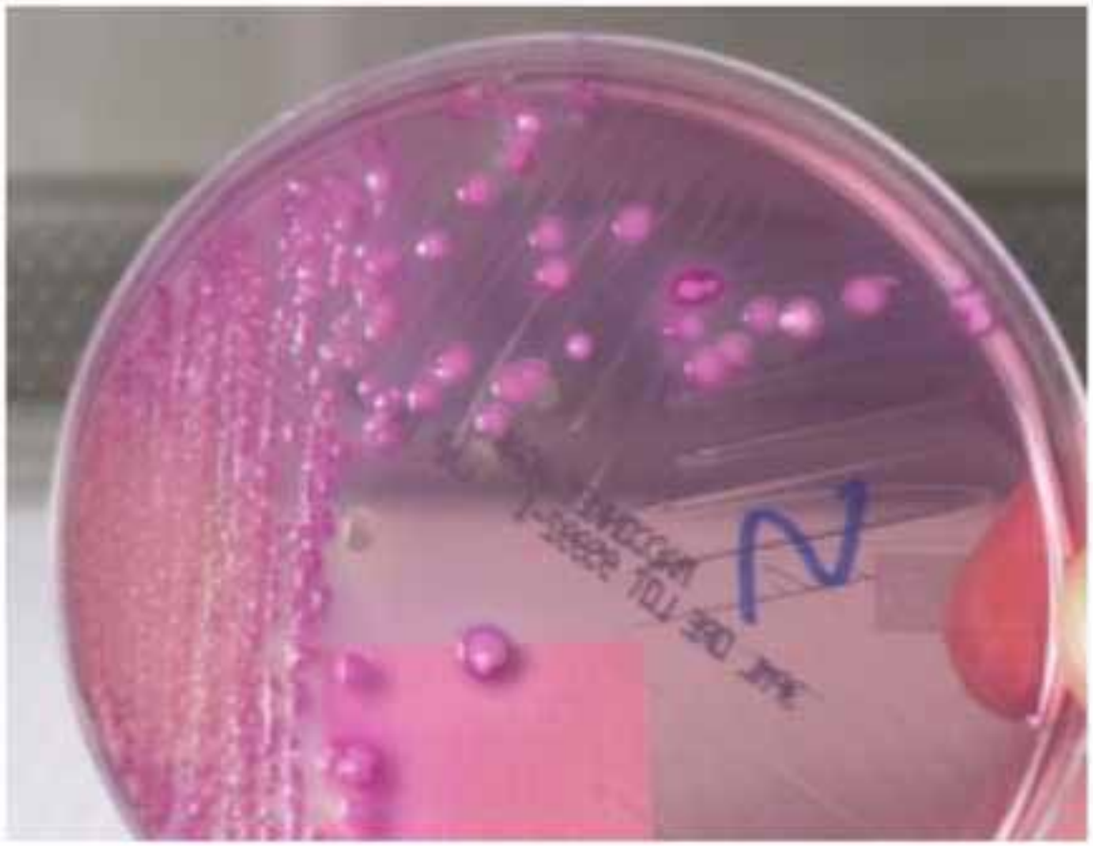
Medical advances and drug safety

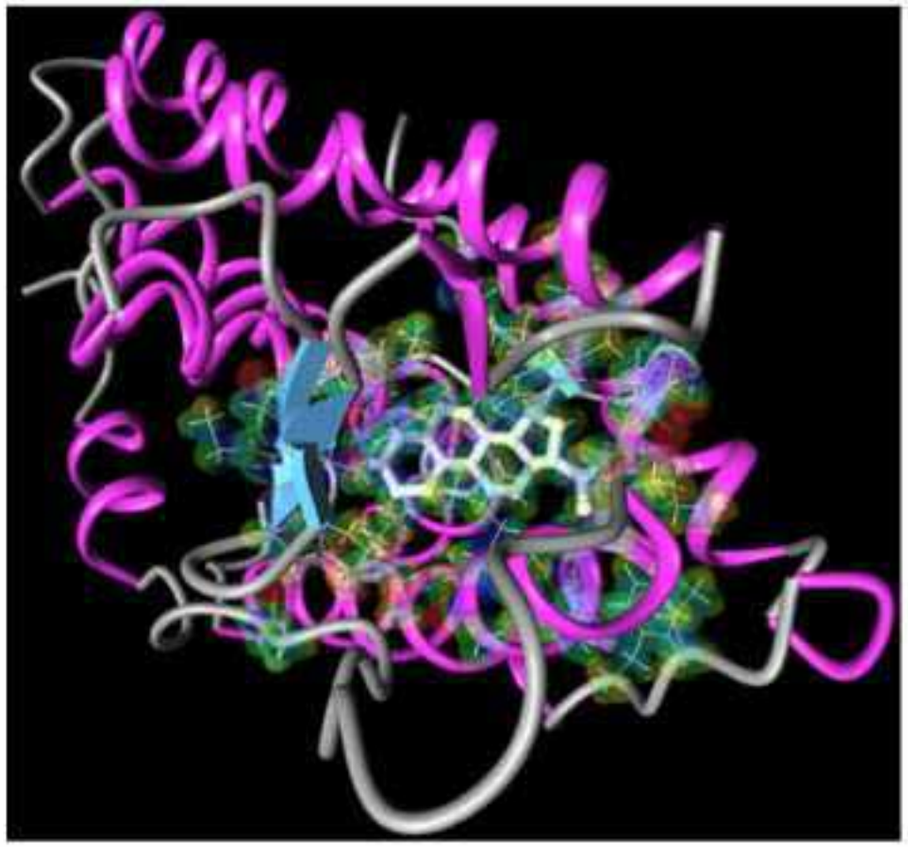


Human biomedical advances

Medical advances and drug safety

Culture-based and in silico systems are insufficient





Human biomedical advances

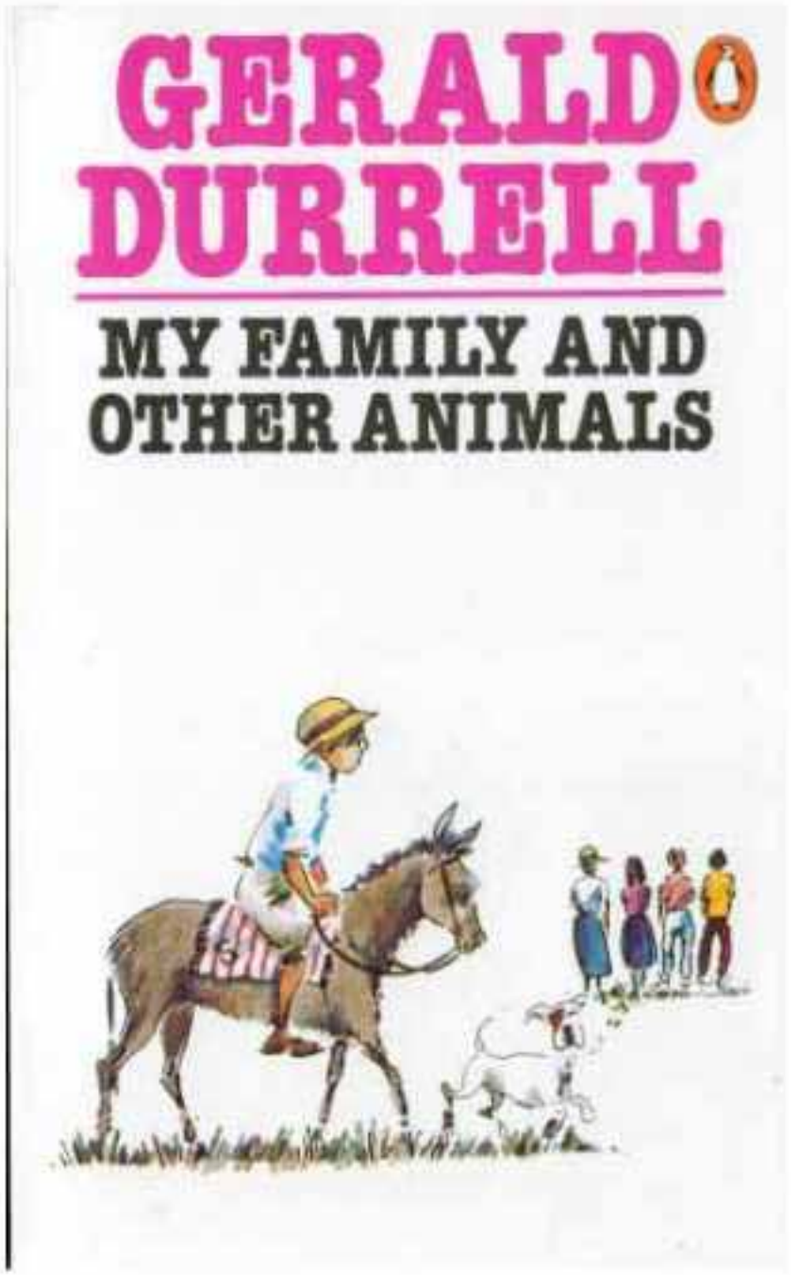
Medical advances and drug safety

Culture-based and in silico systems are insufficient

Ethical issues of animal use

Pleasure and companionship

Only humans routinely involve other species in their social groups



Pleasure and companionship

Only humans routinely involve other species in their social groups

Probably emerged from mutual exploitation

Pleasure and companionship

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Human relationships with companion animals may date back:

10,000 years for dogs

Pleasure and companionship

Only humans routinely involve other species in their social groups

Probably emerged from mutual exploitation

Human relationships with companion animals may date back:

10,000 years for dogs

4-5000 years for cats

Pleasure and companionship

Key characteristics:

Pleasure and companionship

Key characteristics:

Incorporated into our social groups

Pleasure and companionship

Key characteristics:

Incorporated into our social groups

Affectionate nature

Pleasure and companionship

Key characteristics:

Incorporated into our social groups

Affectionate nature

Playfulness

Pleasure and companionship

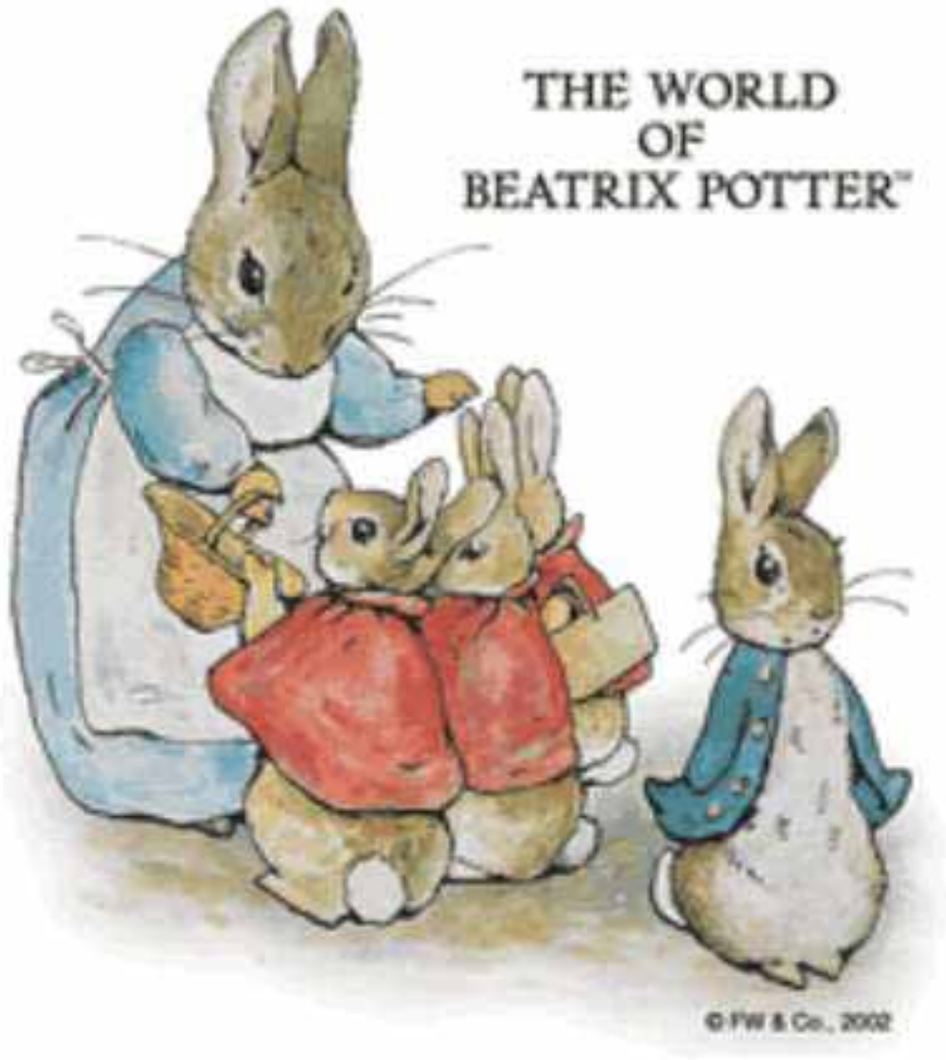
Key characteristics:

Incorporated into our social groups

Affectionate nature

Playfulness

Individuality and intelligence



Numbers of companion animals

In the UK there are: 7 million dogs

Numbers of companion animals

In the UK there are: 8 million cats

Numbers of companion animals

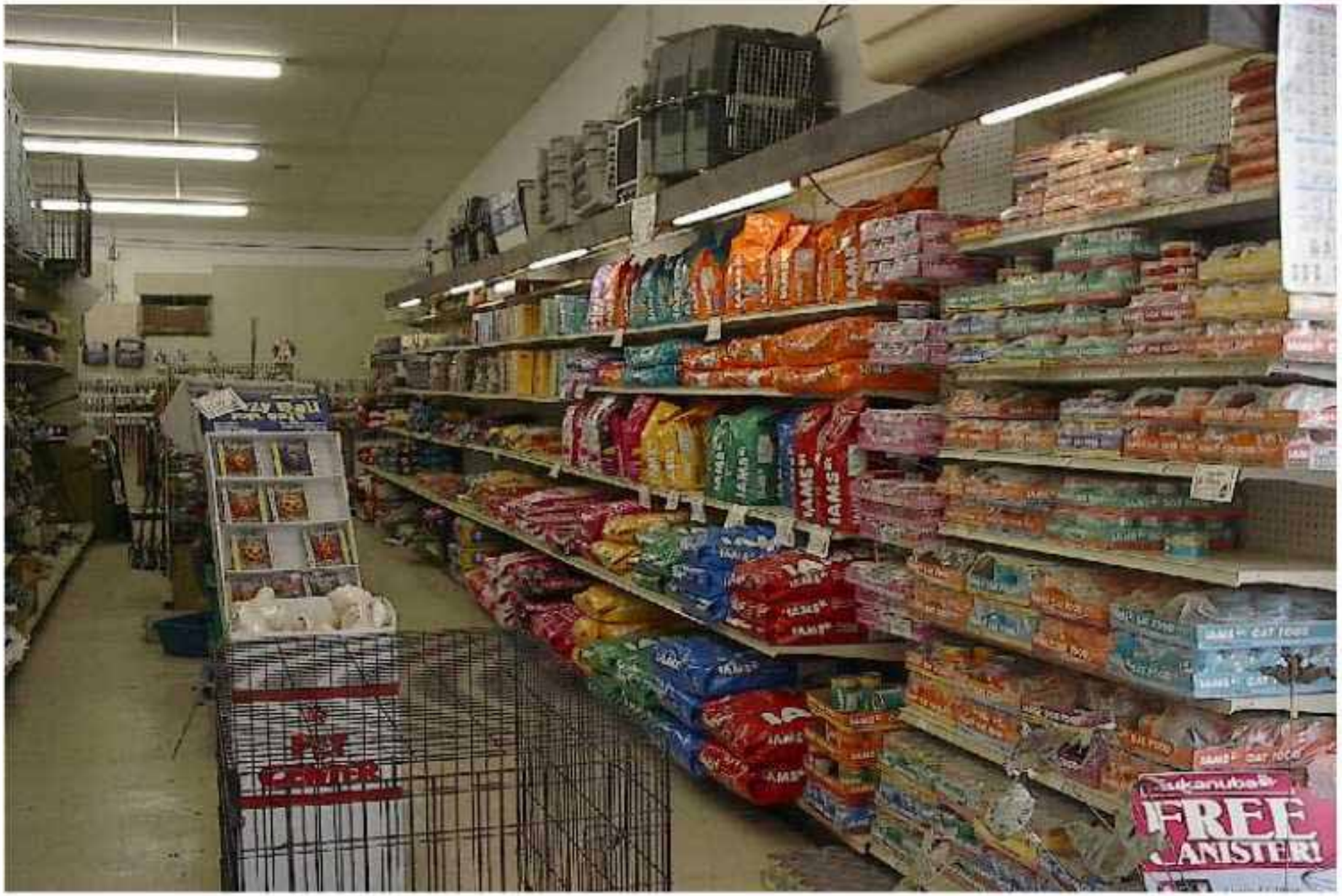
In the UK there are: 30 million others

Numbers of companion animals

45 million pets in a population of 60 million!

Numbers of companion animals

In 2002 the US pet food industry was worth $9.2 billion



Numbers of companion animals

In 2002 the US pet food industry was worth $9.2 billion

In the UK £200 million of medicine is produced for pets each year

Numbers of companion animals

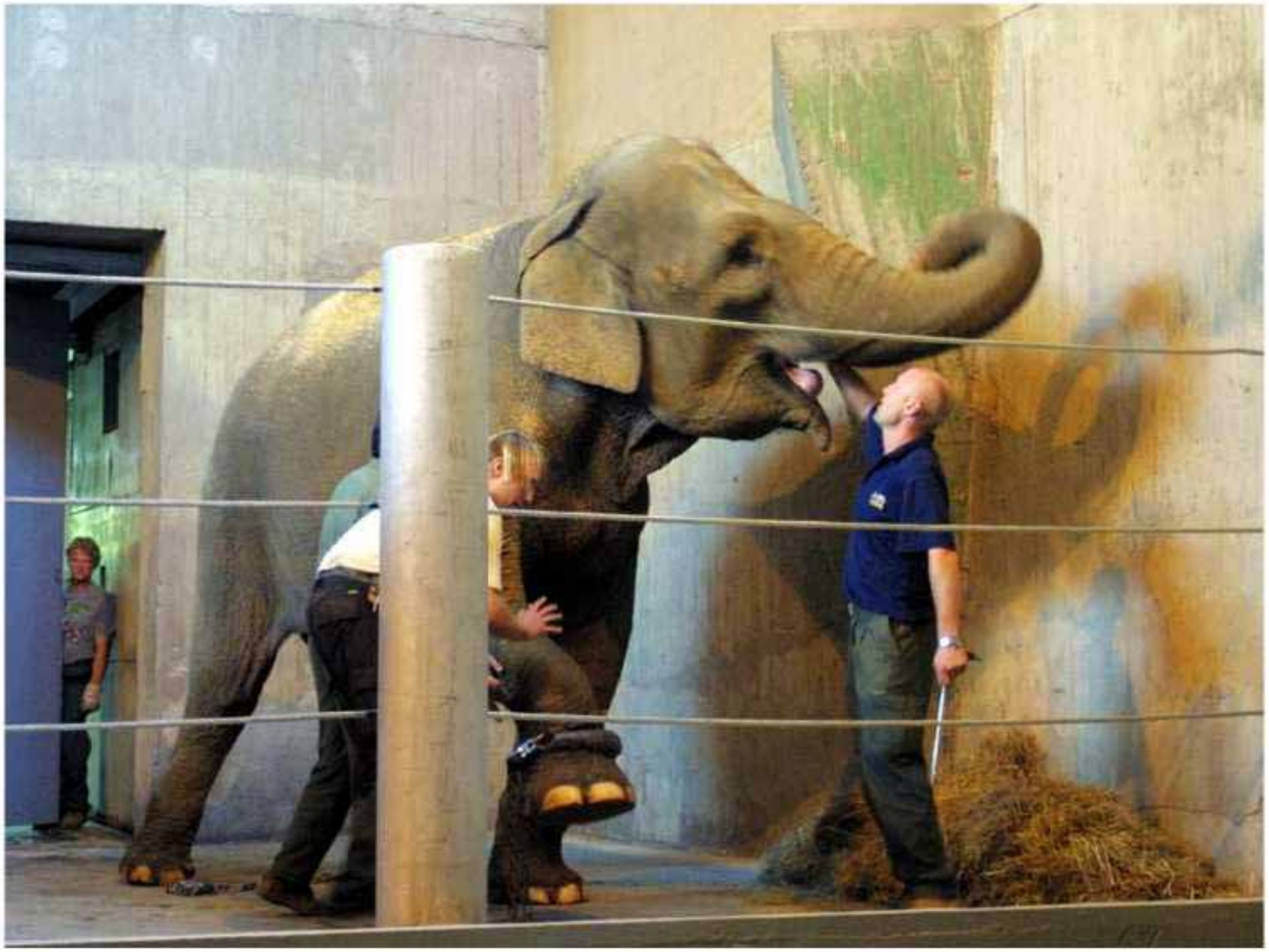
In 2002 the US pet food industry was worth $9.2 billion

In the UK £200 million of medicine is produced for pets each year

In the UK cats kill ~10 million birds each year

Numbers of companion animals

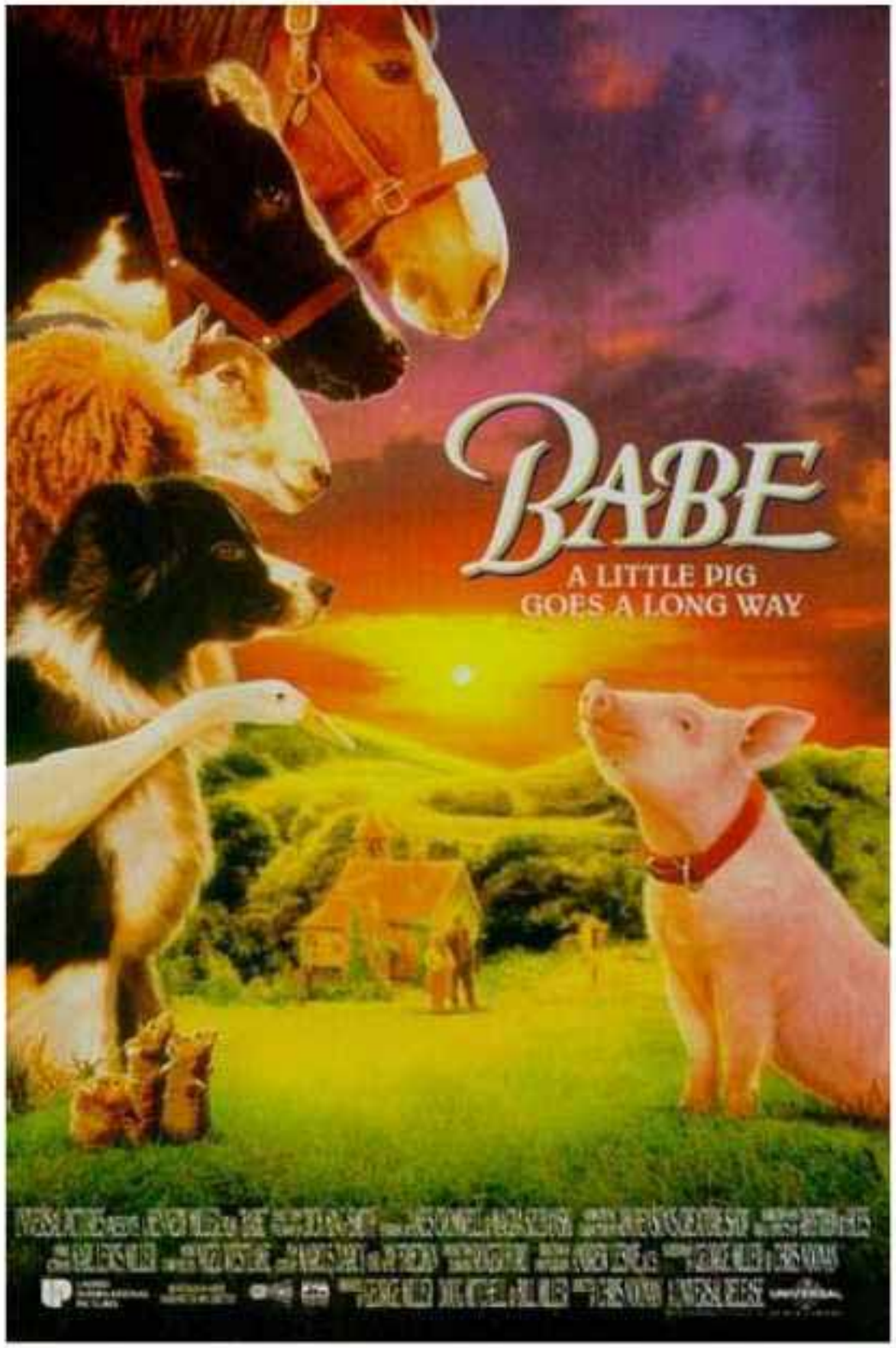
Other animals fascinate us



Numbers of companion animals

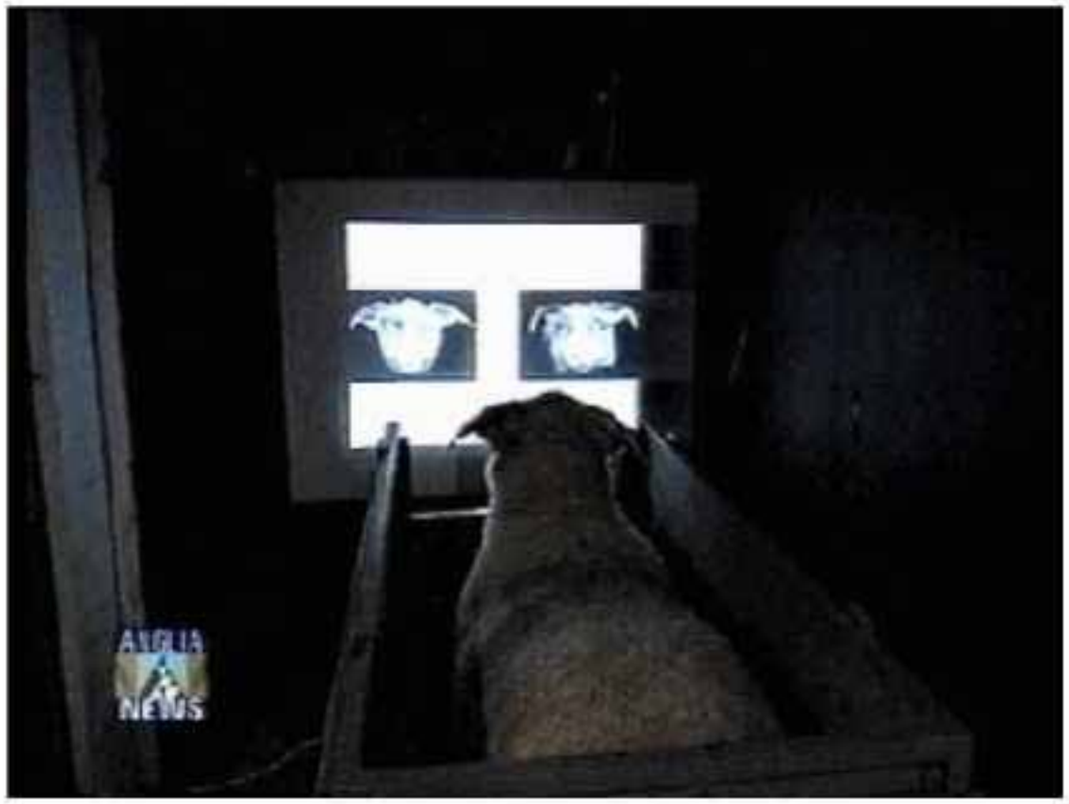
Other animals fascinate us

We find films of humanised animals entertaining



Numbers of companion animals

This makes the scientific discovery of real animal abilities seem mundane!



The first pictures.....

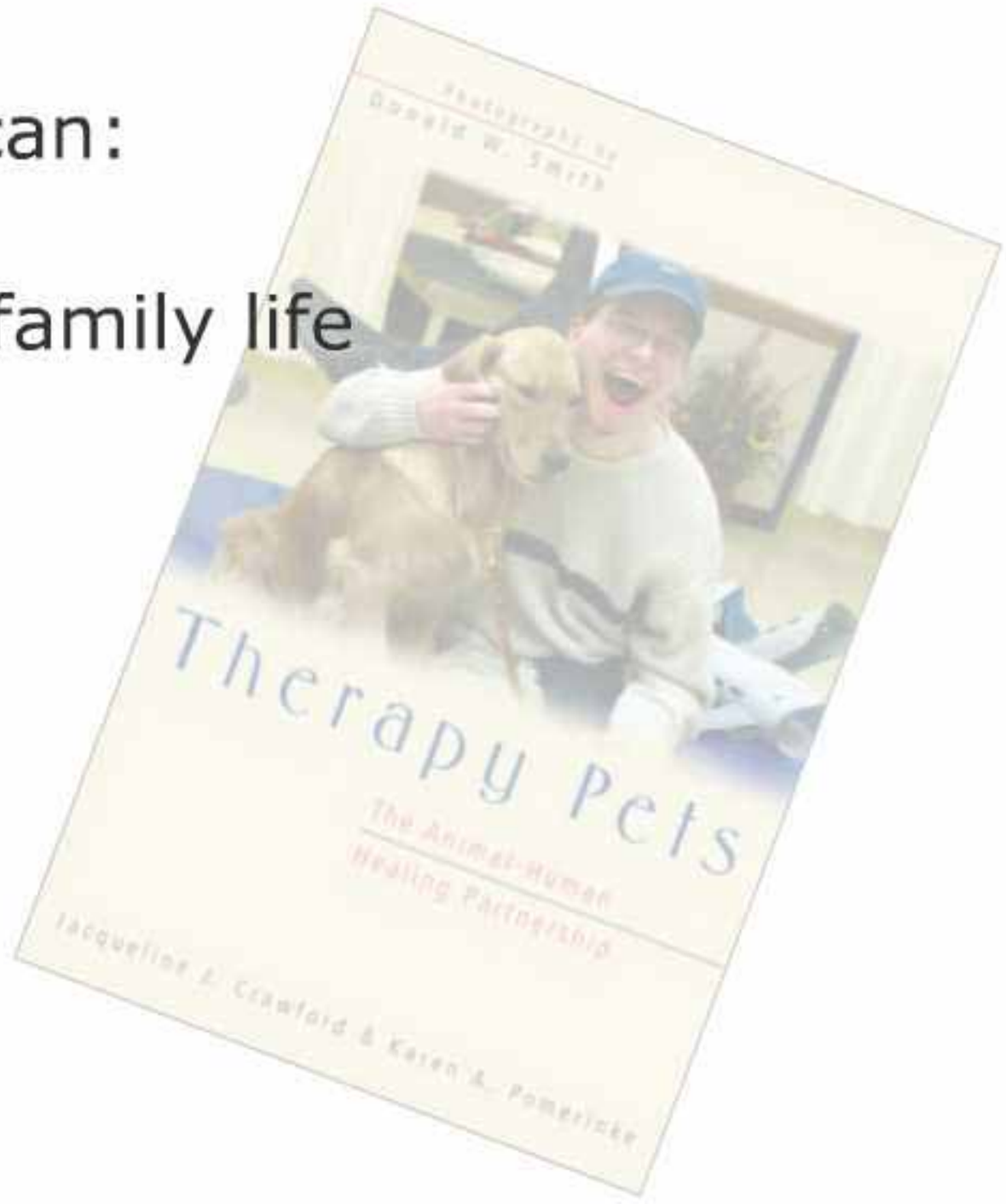
I'm looking at the faces

Physical, psychological or emotional well-being

Pets provide emotional and psychological support and even education

The human-animal bond can:

- Enhance the quality of family life



Physical, psychological or emotional well-being

Serious attempts at animal-assisted therapy have been tried for over 25 years

Health and pet ownership

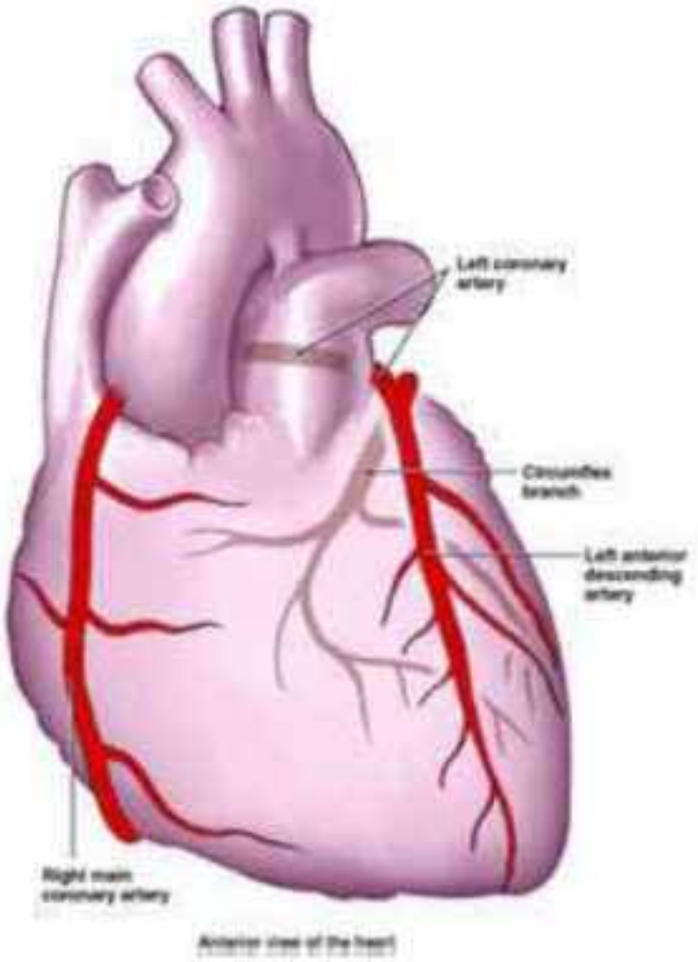
50% improvement in survival for >1 year following heart attack

Friedman 1980

Reduced risks of coronary heart disease

Lower blood pressure and cholesterol levels

Anderson *et al* 1992



Health and pet ownership

Minor health problems are reduced in individuals after they acquire pets
Serpell 1991

Dog ownership causes a 16% reduction in elderly seeking medical attention
Siegel 1990

Stress, anxiety and depression

Women show less stress in the presence of pet than with a best friend or husband

Allen 1991

Stress, anxiety and depression

Women show less stress in the presence of pet than with a best friend or husband

Allen 1991

Therapy dogs reduce anxiety in institutionalised psychiatric patients...

Barker and Dawson 1998

Stress, anxiety and depression

Women show less stress in the presence of pet than with a best friend or husband

Allen 1991

Therapy dogs reduce anxiety in institutionalised psychiatric patients...

Barker and Dawson 1998

...or individuals about to receive electroconvulsive shock

Stress, anxiety and depression

Visits to the dentist are less stressful...

Stress, anxiety and depression

Visits to the dentist are less stressful...

...if you can see tanks of tropical fish!

Stress, anxiety and depression

Interactions with therapy dogs reduce depression...

...enhance mood...

Stress, anxiety and depression

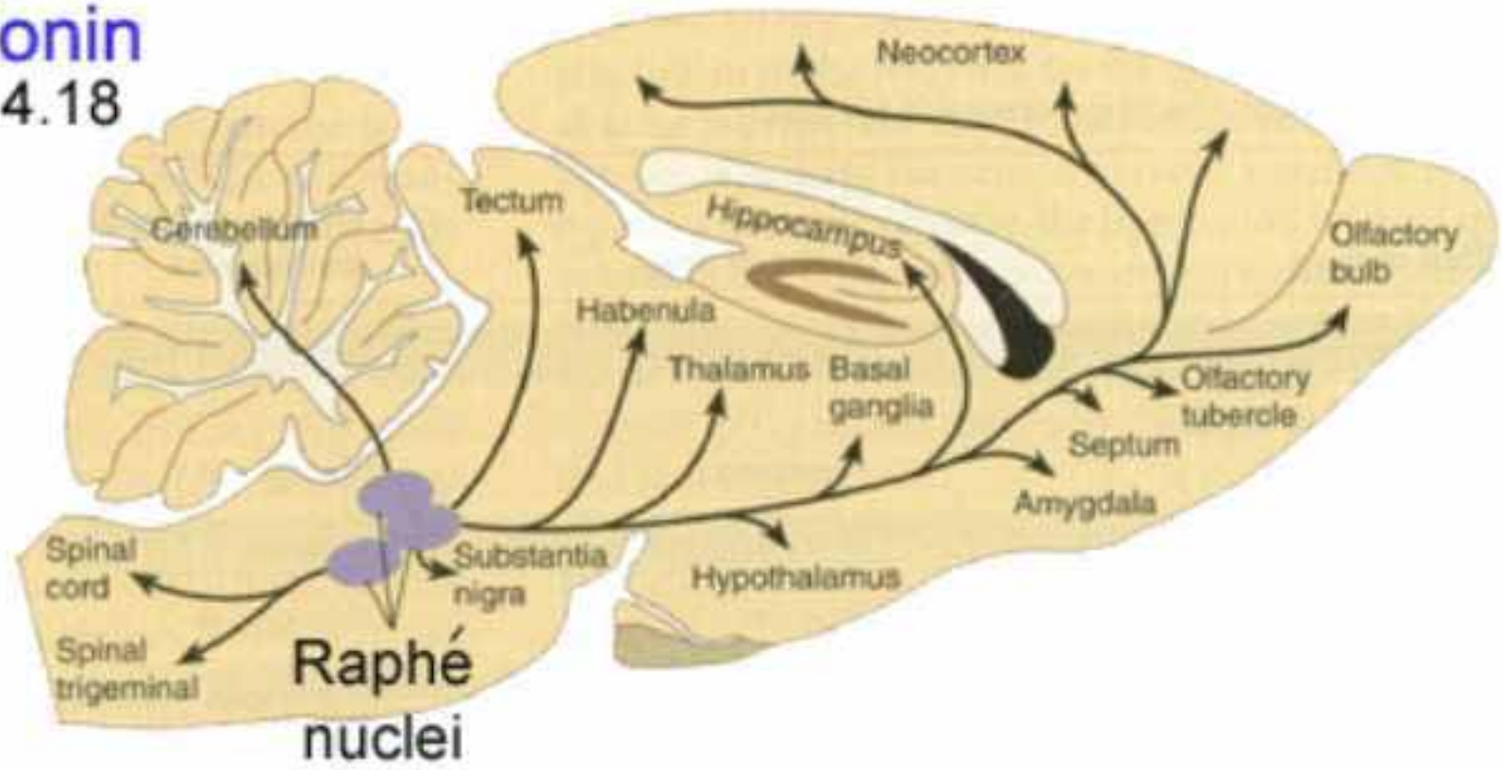
Interactions with therapy dogs reduce depression...

...enhance mood...

...and increase levels of serotonin and dopamine precursors

Serotonin

Figure 4.18



Stress, anxiety and depression

So should we all try a pet rather than Prozac?

Stress, anxiety and depression

However, pet bereavement has the opposite effect

Stress, anxiety and depression

And pet cloning is not the answer!

Genetic Savings&Clone, Inc.
GENE BANKING & CLONING OF EXCEPTIONAL PETS

ABOUT US | OUR SERVICES | OUR CLIENTS & CLONES | ABOUT CLONING | NEWS

Register | Sign In | Orders | Co

- > Overview
- > PetBank
- > Emergencies
- > Cat Cloning
  - > Cat Cloning Process
  - > DNA Identification Results
- > Dog Cloning
- > International Service
- > Grief Resources

OUR SERVICES

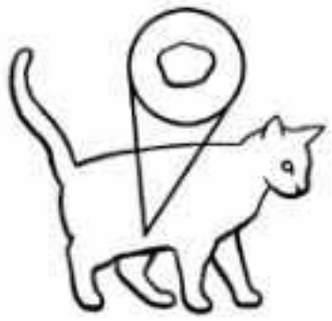
Cat Cloning Process

Pet cloning is very complex and involves many interconnected, species-specific processes. Dog cloning requires more steps than cat cloning, which is why our dog cloning service will be available later than our cat cloning service.

The following are the key steps used to clone an animal using the chromatin transfer process.

CC's birth was the result of research funded by GSC at Texas A&M University. CC was produced using the nuclear transfer process, whereas GSC now uses chromatin transfer.

1. Gene Banking: The cloning process begins with gene banking, in which a veterinarian takes a small tissue biopsy from the animal to be cloned, also known as the genetic donor.



2. Biopsy Sample Transport: The tissue biopsy is transported in a refrigerated container called a BioBox to our PetBank.

Recovery from trauma

Pets have significant supportive role for individuals with childhood sexual abuse

Barker et al - 1997

Recovery from trauma

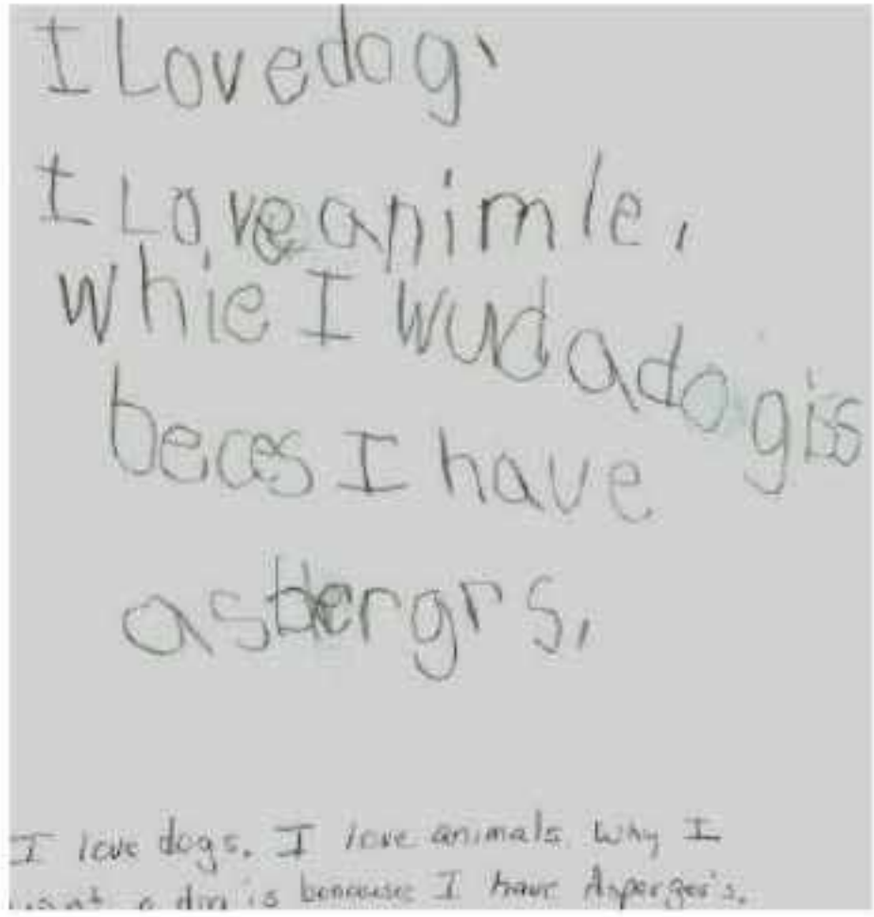
Pets have significant supportive role for individuals with childhood sexual abuse
Barker et al - 1997

Bonds with pets reduce abusive behaviour and anger in adults abused as children
Nebbe - 1998

Affective disorders

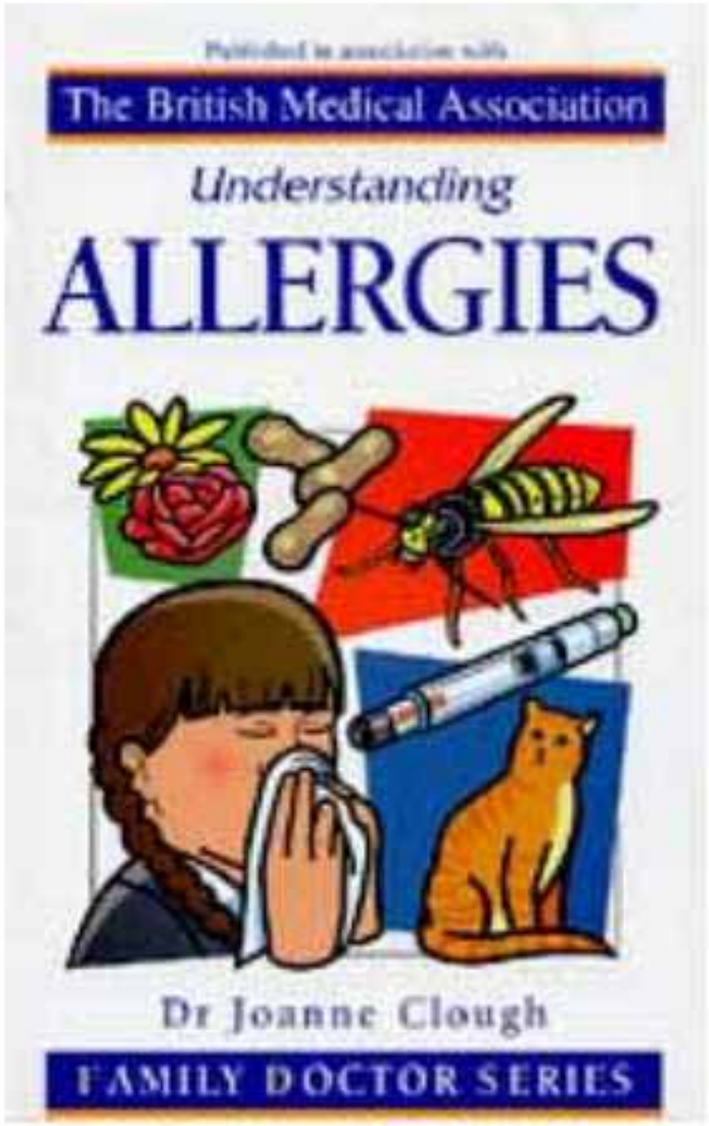
Improvements of social and communication skills in autistic and schizophrenic individuals have been reported

There have been no large scale studies however



Allergies

Children with pet dogs and cats are less likely to develop common allergies



Allergies

Children with pet dogs and cats are less likely to develop common allergies

Endotoxins formed from the breakdown of bacteria in the animal's mouths?

Cognitive enhancement

Learning is improved when rewarded by interaction with a companion animal

Cognitive enhancement

Learning is improved when rewarded by interaction with a companion animal

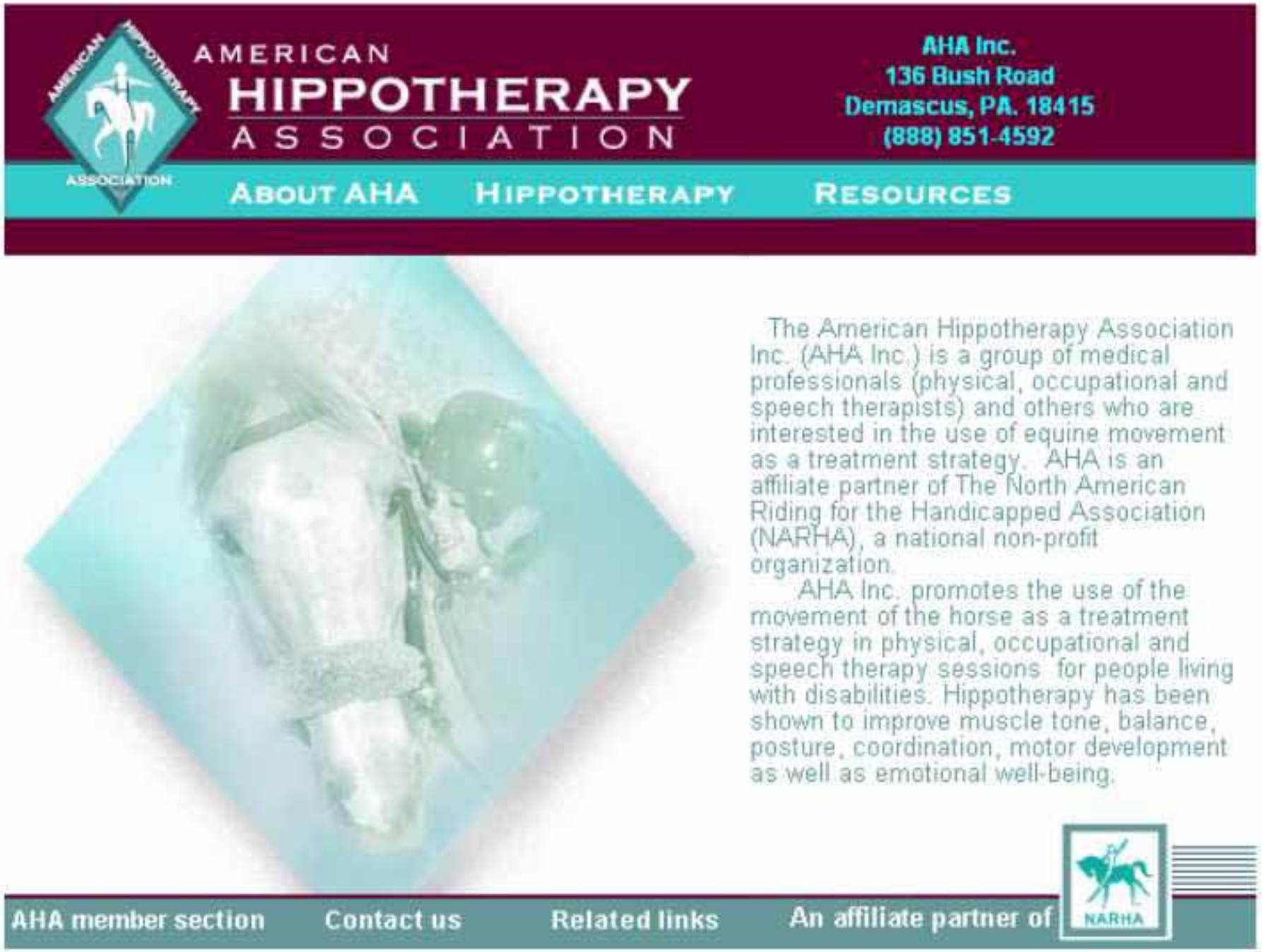
Enhanced cognitive and communication abilities have been reported in Alzheimer patients

Postural control, co-ordination and balance

Pet walking/play improves motor skills

Postural control, co-ordination and balance

Hippotherapy improves control of movement, co-ordination and balance...



Postural control, co-ordination and balance

Hippotherapy improves control of movement, co-ordination and balance...

...and also improves feelings of self-worth and power in individuals confined to wheel chairs

Horses used in psychotherapy to improve self-concept, self-confidence and social competence

Burgon 2003

Visual impairment

Guide dogs help the blind gain mobility and confidence

Visual impairment

Guide dogs help the blind gain mobility and confidence

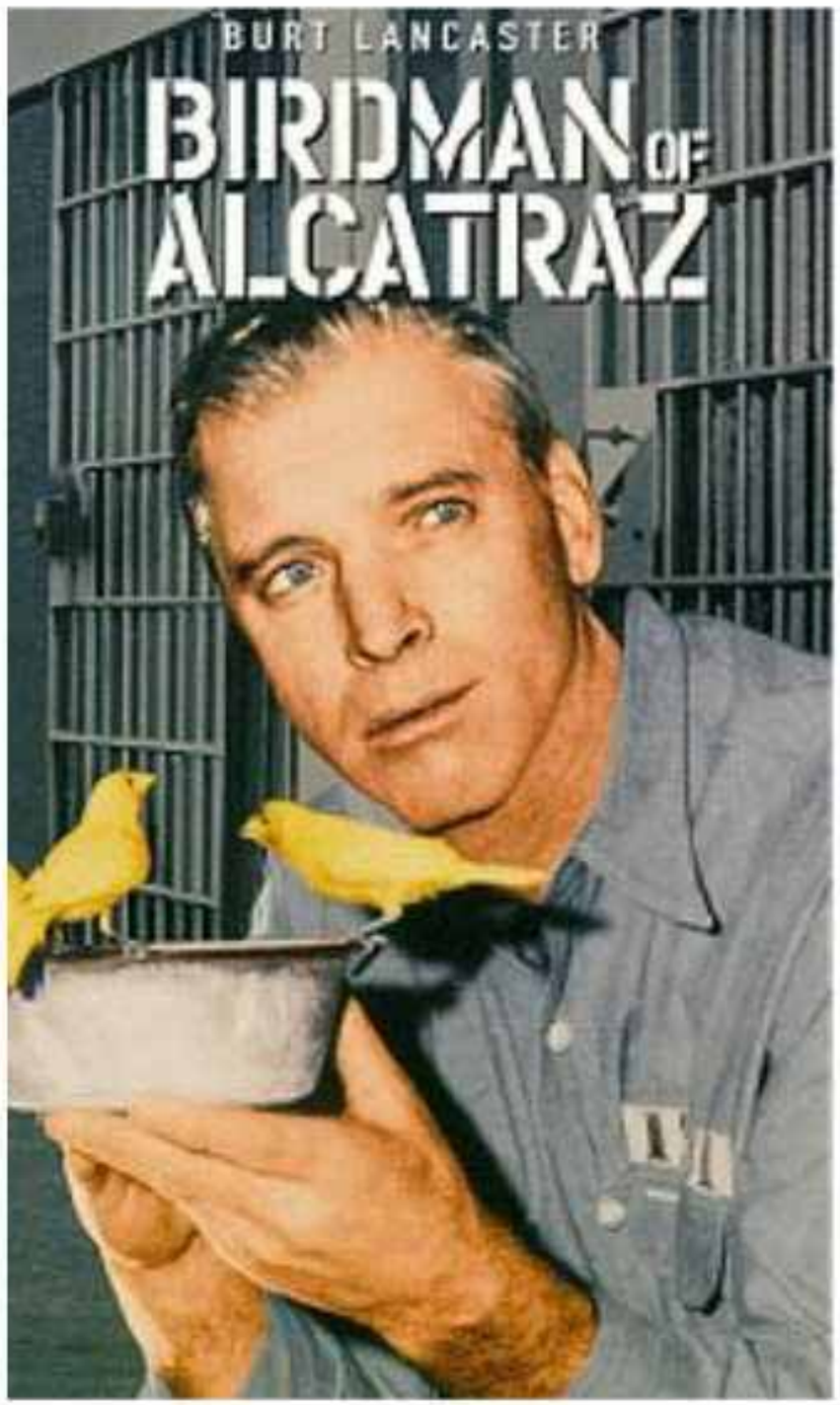
Close bonds help with psychological and emotional problems

Prisons

Access to pets reduced disciplinary problems with inmates in some US prisons

Washington State Correctional Center For Women

~~Prison Pet Partnership Program~~



How can pets have these effects on us?

Pets are a source of pleasure

Many are demonstrably affectionate and playful

Rarely hold grudges or become moody

Distract us from things that are stressing us

How can pets have these effects on us?

Bring us out of ourselves

Provide us with a source of social, emotional and tactile interactions

Need us to be there

Don’t answer back when we use them as sounding boards

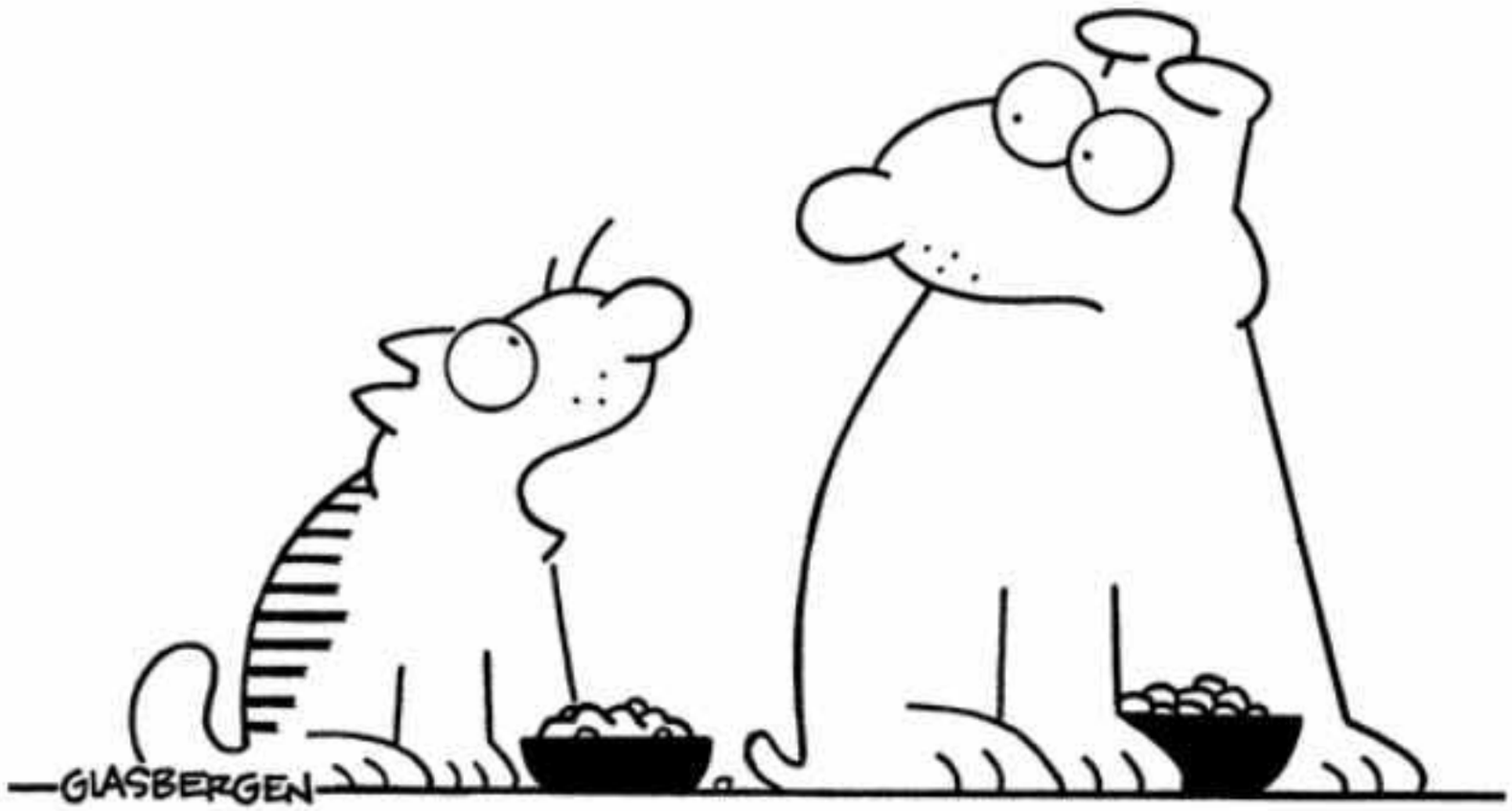
How can pets have these effects on us?

They are not substitutes for other humans

How can pets have these effects on us?

They are not substitutes for other humans

We would not want them to be as complex as us!



"The vet says i need a hobby. I thought eating and sleeping were my hobbies!"

How can pets have these effects on us?

They are not substitutes for other humans

We would not want them to be as complex as us!

They have simple qualities and disregard for physical or mental disabilities

Why can’t we get this from other humans?

We may need pets more as human society becomes increasingly demanding and complex!

Dolphin assisted therapy (DAT)

Dolphins are claimed to have profound therapeutic effects on children or adults with mental, emotional or social disorders

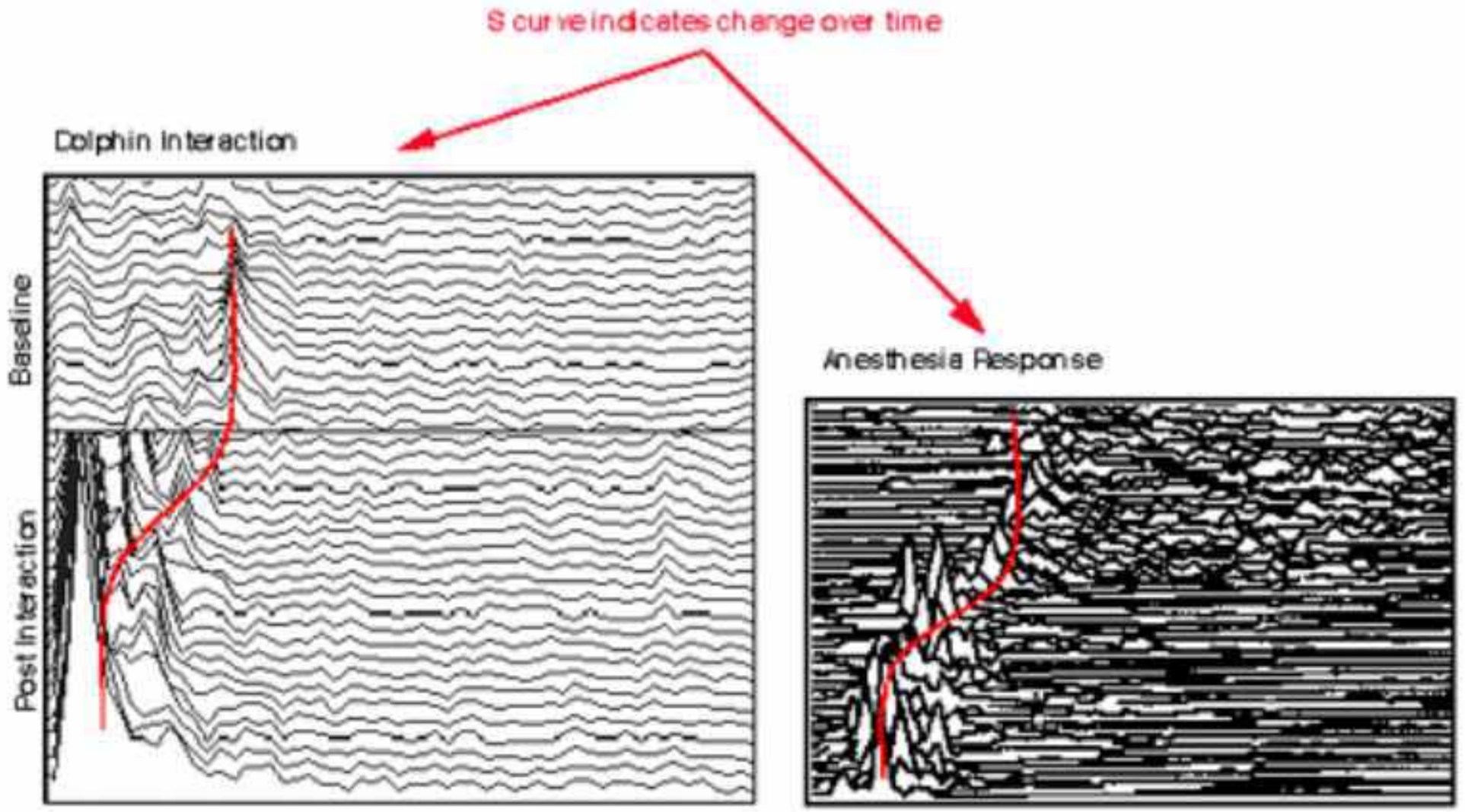
Dolphin assisted therapy (DAT)

Dolphins are claimed to have profound therapeutic effects on children or adults with mental, emotional or social disorders

Breeding large numbers in captivity for this purpose is unthinkable

Dolphin assisted therapy (DAT)

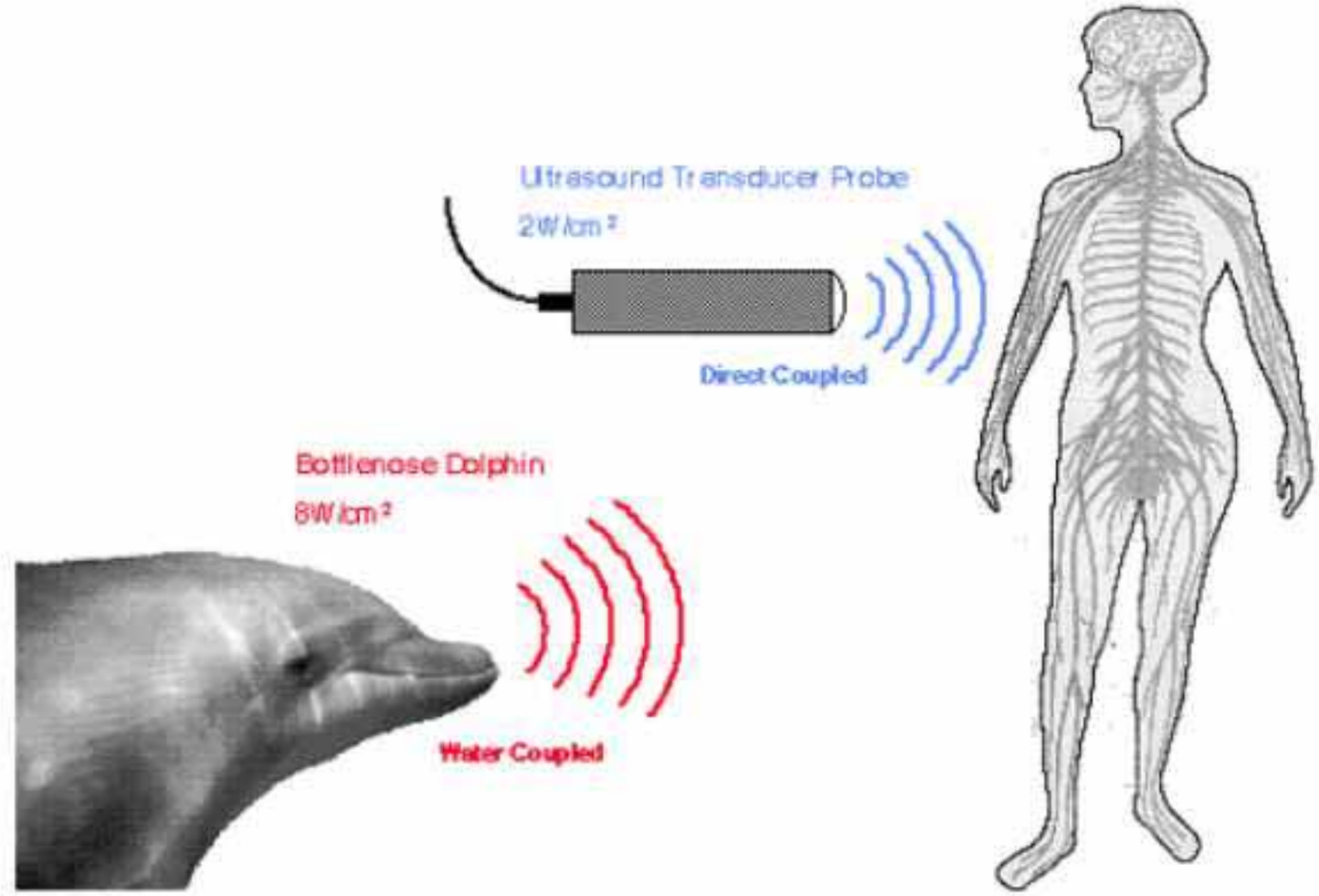
Is any scientific support for the beneficial claims that are made?



Dolphin assisted therapy (DAT)

Is any scientific support for the beneficial claims that are made?

If so, what is responsible and can we create it artificially?



Dolphin assisted therapy (DAT)

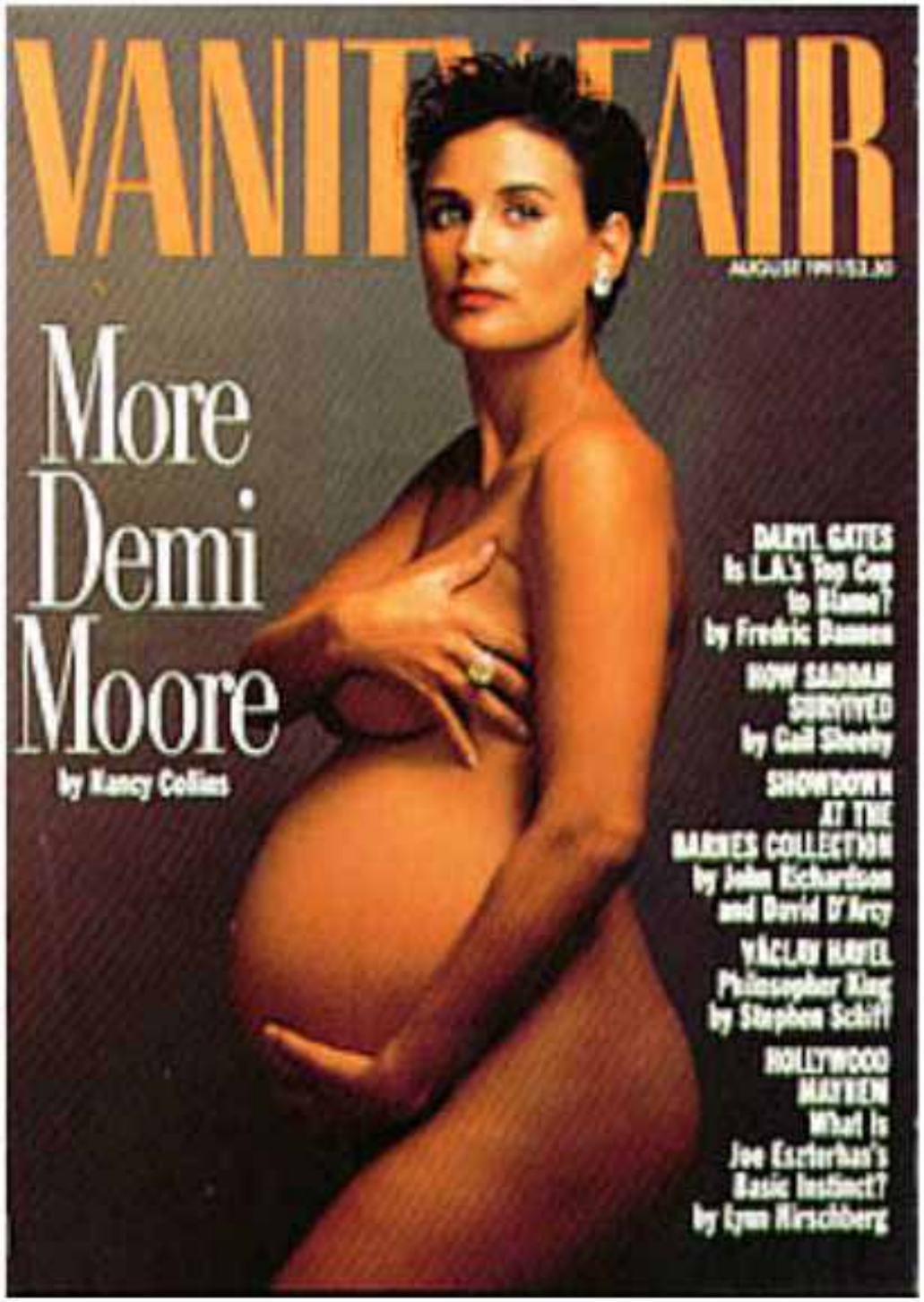
Is any scientific support for the beneficial claims that are made?

If so, what is responsible and can we create it artificially?

It’s not just about their attraction and swimming

Dolphin assisted therapy (DAT)

They are interested in pregnant women...



Dolphin assisted therapy (DAT)

They are interested in pregnant women...

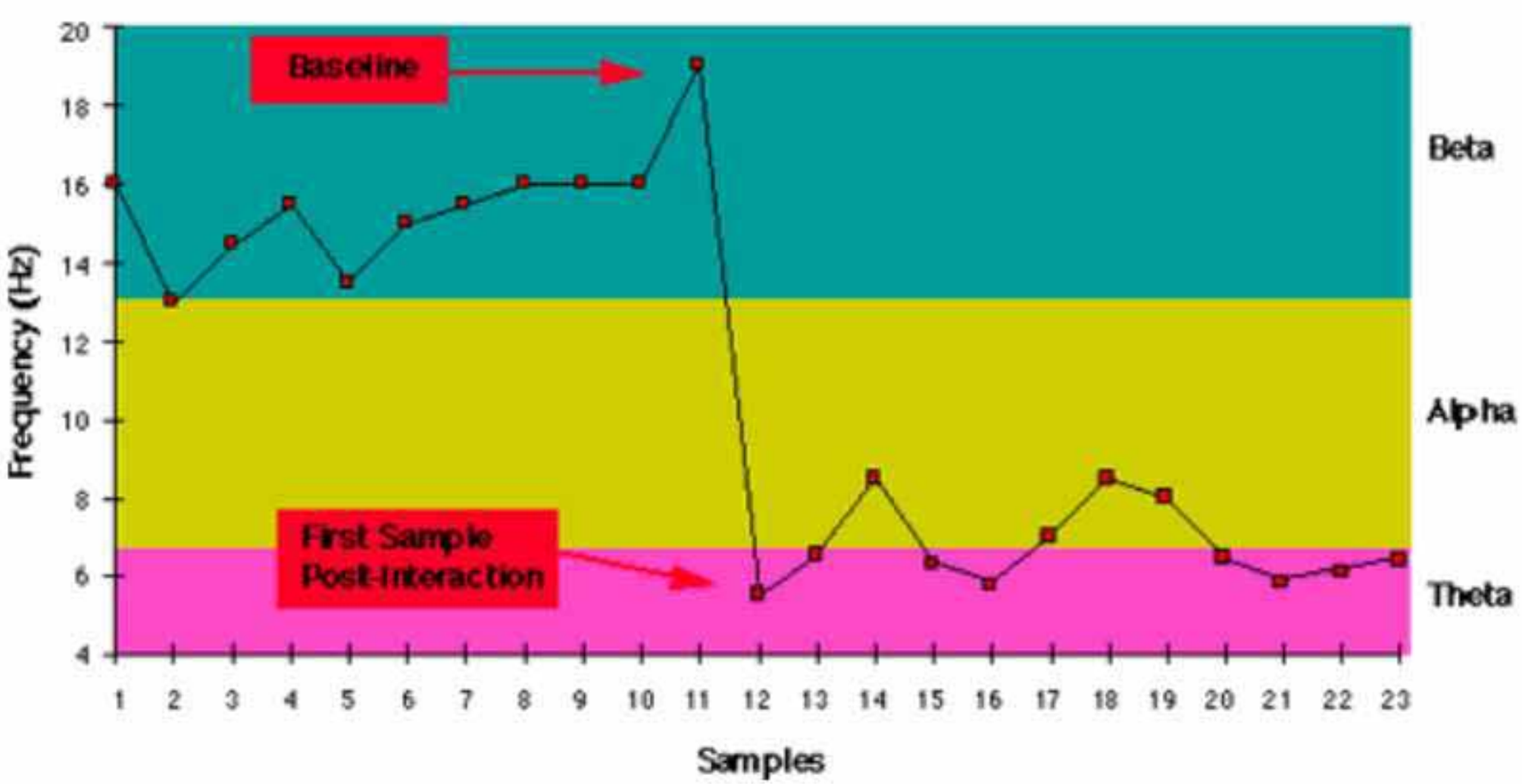
...can detect and focus on specific injuries...

Dolphin assisted therapy (DAT)

They are interested in pregnant women...

...can detect and focus on specific injuries...

...and may alter the electrical activity of our brains



Dolphin assisted therapy (DAT)

Dolphins can navigate and communicate using ultrasonic clicks at 120KHz

Dolphin assisted therapy (DAT)

Dolphins can navigate and communicate using ultrasonic clicks at 120KHz

Effects of different intensities of ultrasound

Diagnostic imaging	Therapeutic ultrasound	Dolphin sonar	Sonic welding
			
80mW/cm^2 Maximum	2W/cm^2 Typical	2W/cm^2 Maximum observed	2500W/cm^2 Typical

Dolphin assisted therapy (DAT)

Dolphins can navigate and communicate using ultrasonic clicks at 120KHz

Effects of different intensities of ultrasound

It seems unlikely that significant sonophoresis or piezoelectric effects are produced

Brensing et al, 2003

Results may be due to their gentle attentive behaviour and the aquatic environment

Robot therapists and virtual pets

Virtual pet software and simple talking electronic devices

Robot therapists and virtual pets

Virtual pet software and simple talking electronic devices

Won’t substitute for the feel of a contented cat or an affectionate dog

Robot therapists and virtual pets

Advances in robotic pets are unlikely to replace the real thing

Out with the old and in with the new?

How could humans design new living species to suit our needs?

Out with the old and in with the new?

The present:

Selective breeding strategies

Transgenesis

news@nature.com
The best in science journalism

Published online: 3 April 2005; | doi:10.1038/news050328-14

Transgenic cows have udder success

Roxanne Khamsi

Dairy herds with bacterial gene could cream mastitis.

Each year, the dairy industry loses billions of dollars to mastitis, an infection of cows' milk glands. Now researchers have succeeded in genetically engineering cows to resist this disease.

Out with the old and in with the new?

The future:

Mixing species

Out with the old and in with the new?

The future:

Mixing species

Evolve new life from a chemical soup

Out with the old and in with the new?

The future:

Mixing species

Evolve new life from a chemical soup

Recreate existing life and modify it

Out with the old and in with the new?

The future:

Mixing species

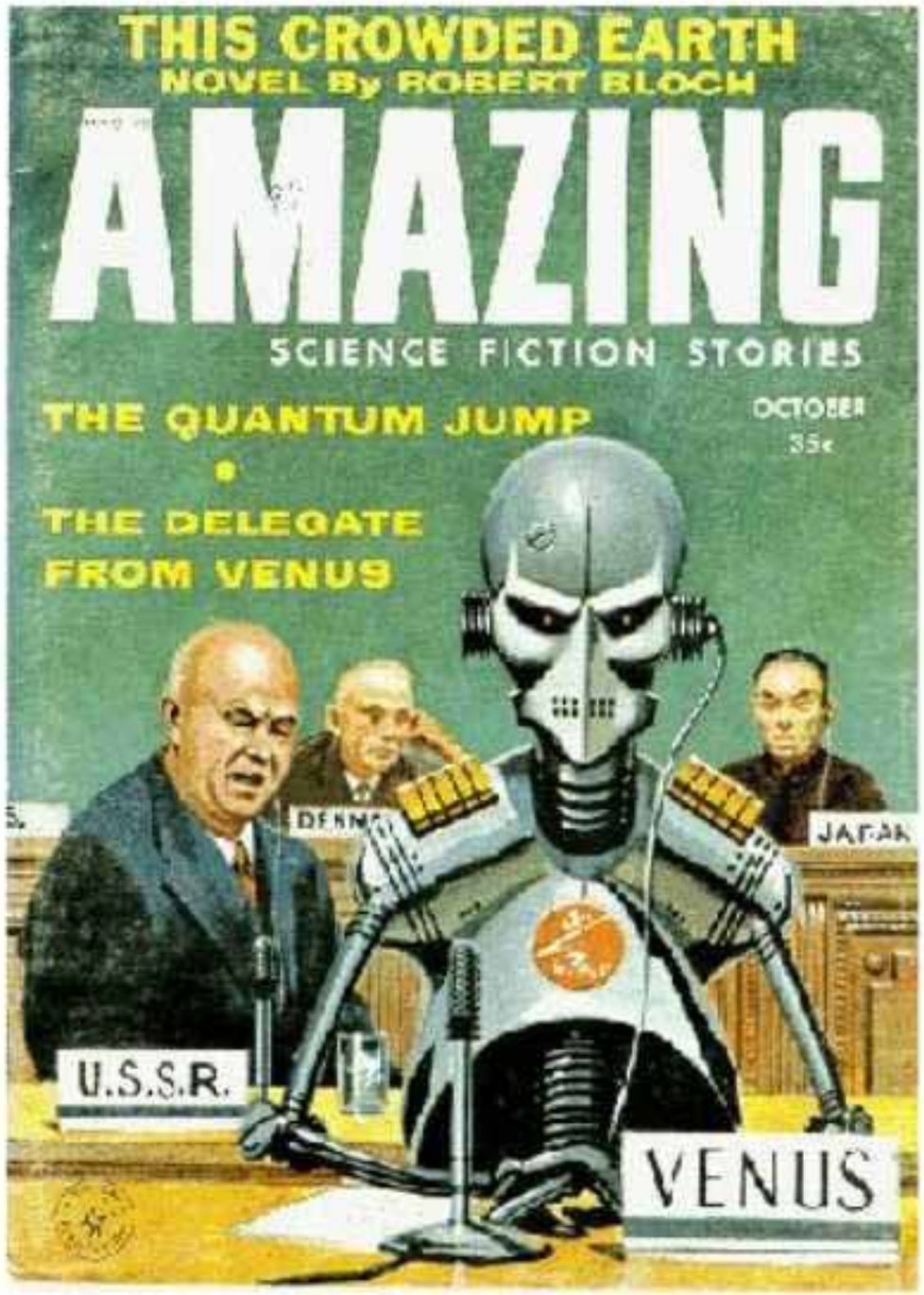
Evolve new life from a chemical soup

Recreate existing life and modify it

Build new life artificially

Out with the old and in with the new?

Isn’t this just science fiction?



BBC NEWS WORLD EDITION

Last Updated: Saturday, 18 December, 2004, 07:43 GMT

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'Artificial life' comes step closer

San Francisco Chronicle

BIOTECH & CREATIVITY
Venter's goal is creating life in the laboratory

Creation Magazine

Creation Archive > Volume 25 Issue 4

Genetic engineers unwind species barrier
But have they 'reversed evolution'?

Health and Behavior

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Posted 1/26/2003 10:58 PM

Blueprint for life

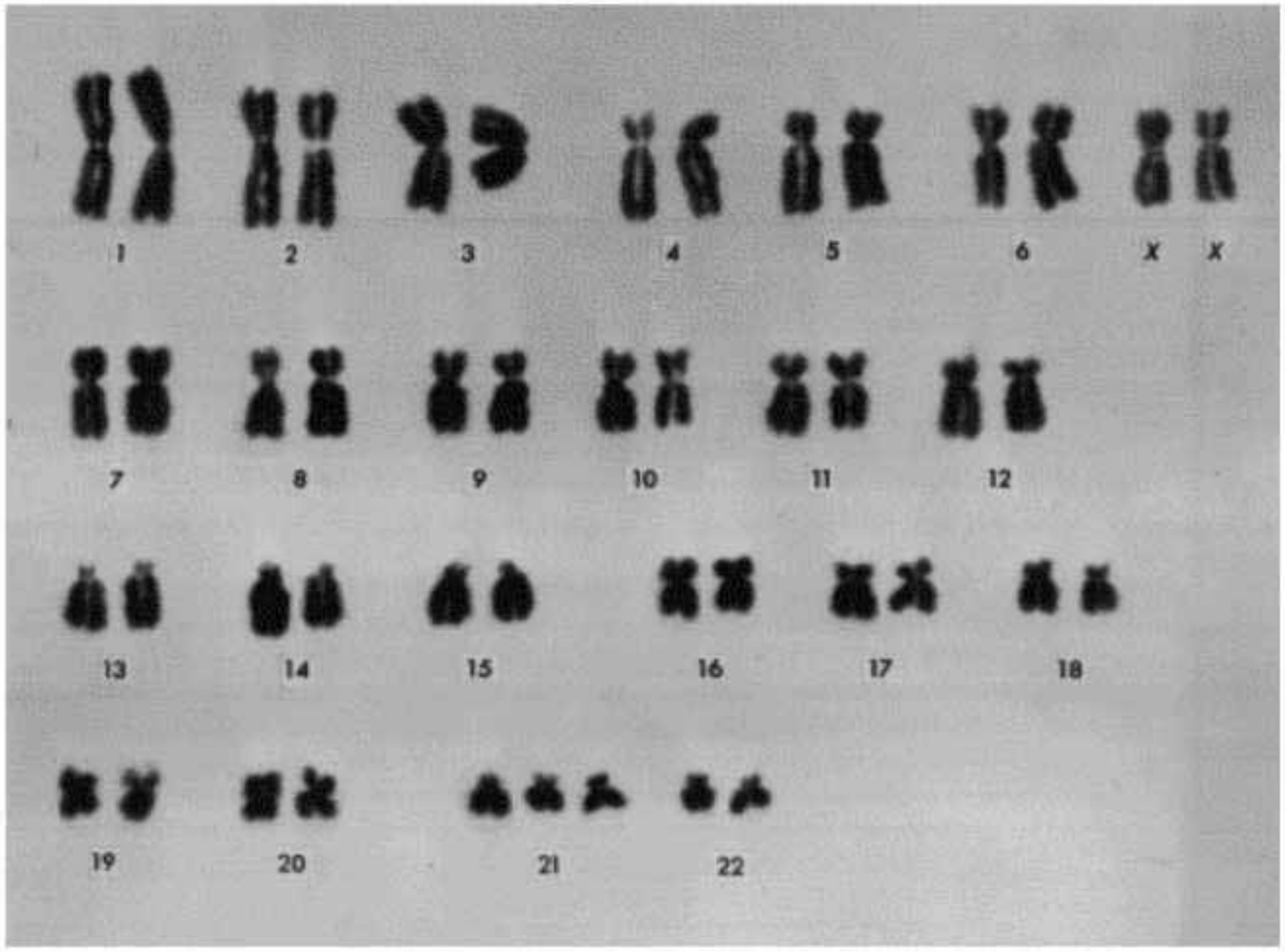
Mixing species

Reproductive isolation

Mixing species

Reproductive isolation

Chromosomal rearrangements

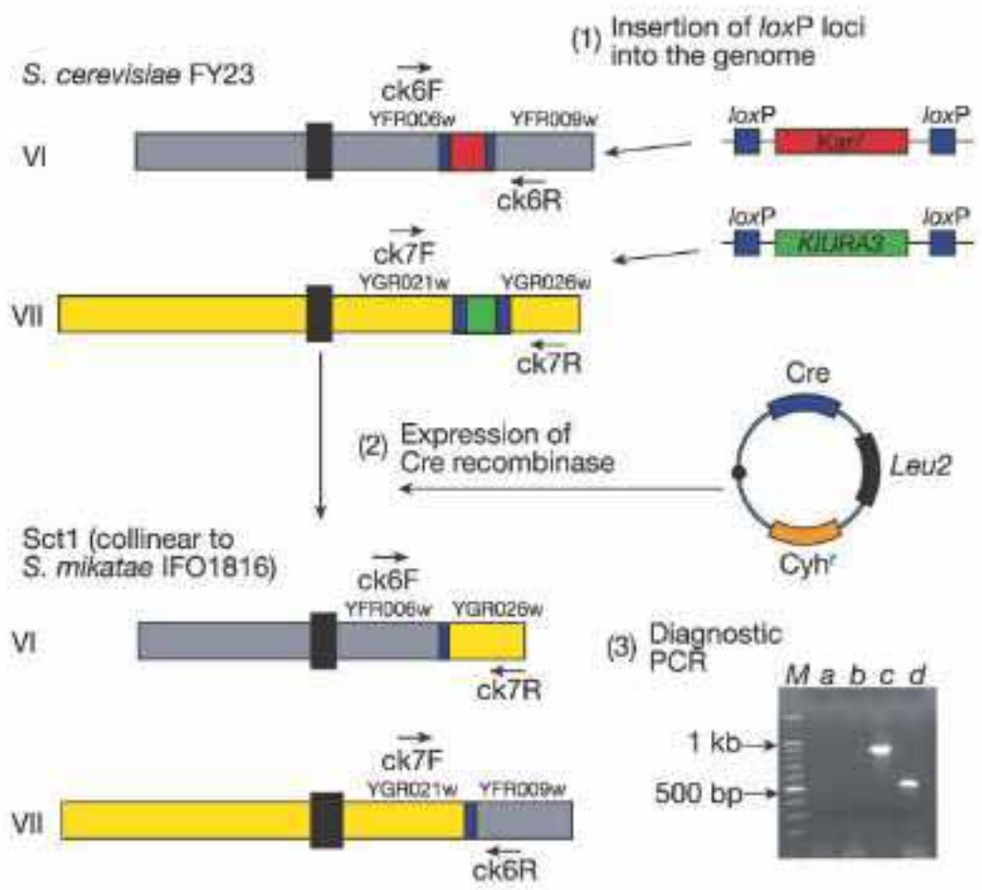


Mixing species

Reproductive isolation

Chromosomal rearrangements

Realignment of chromosomes in different species of yeast

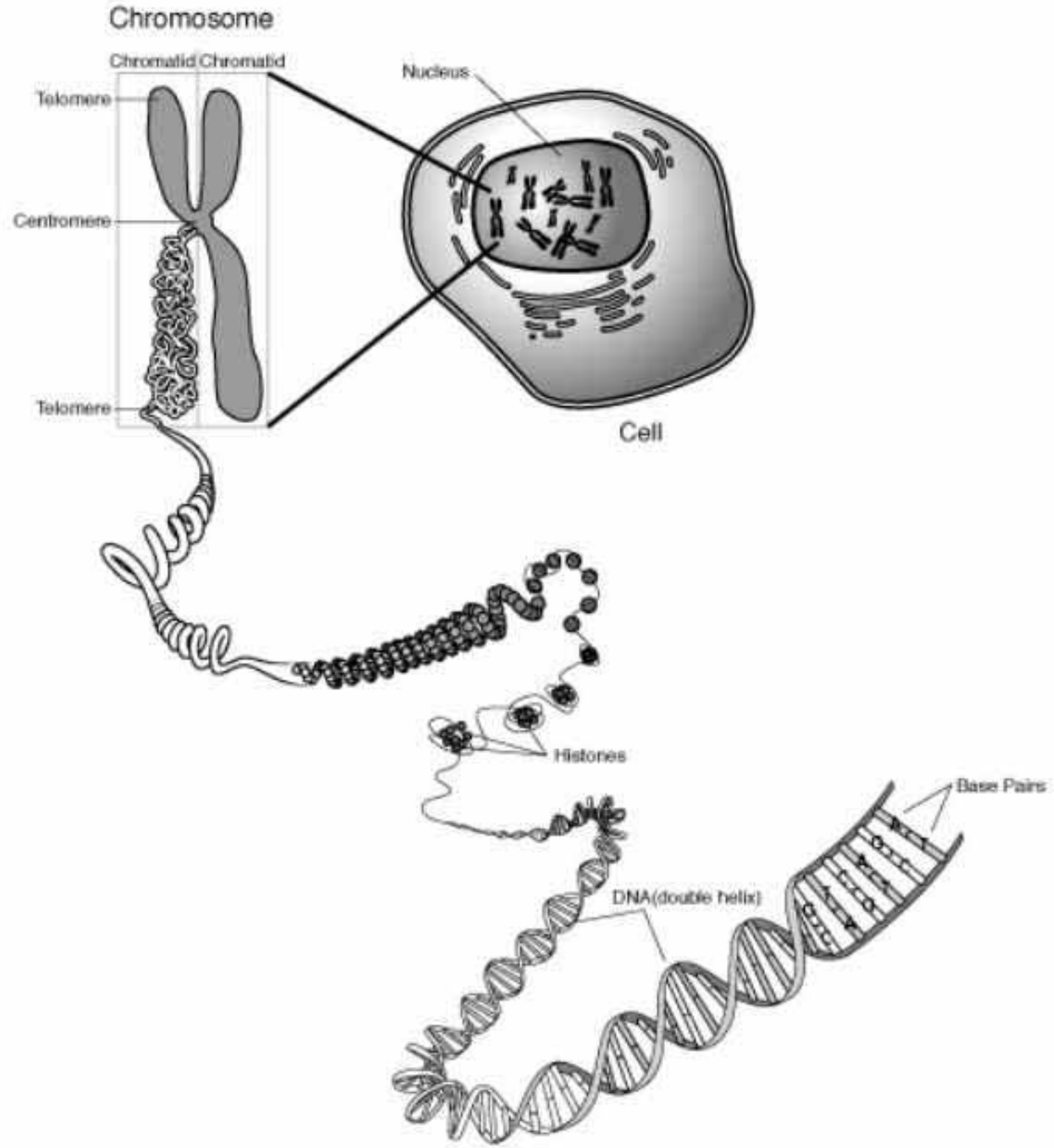


Containment

Defining life

Containment

Heredity

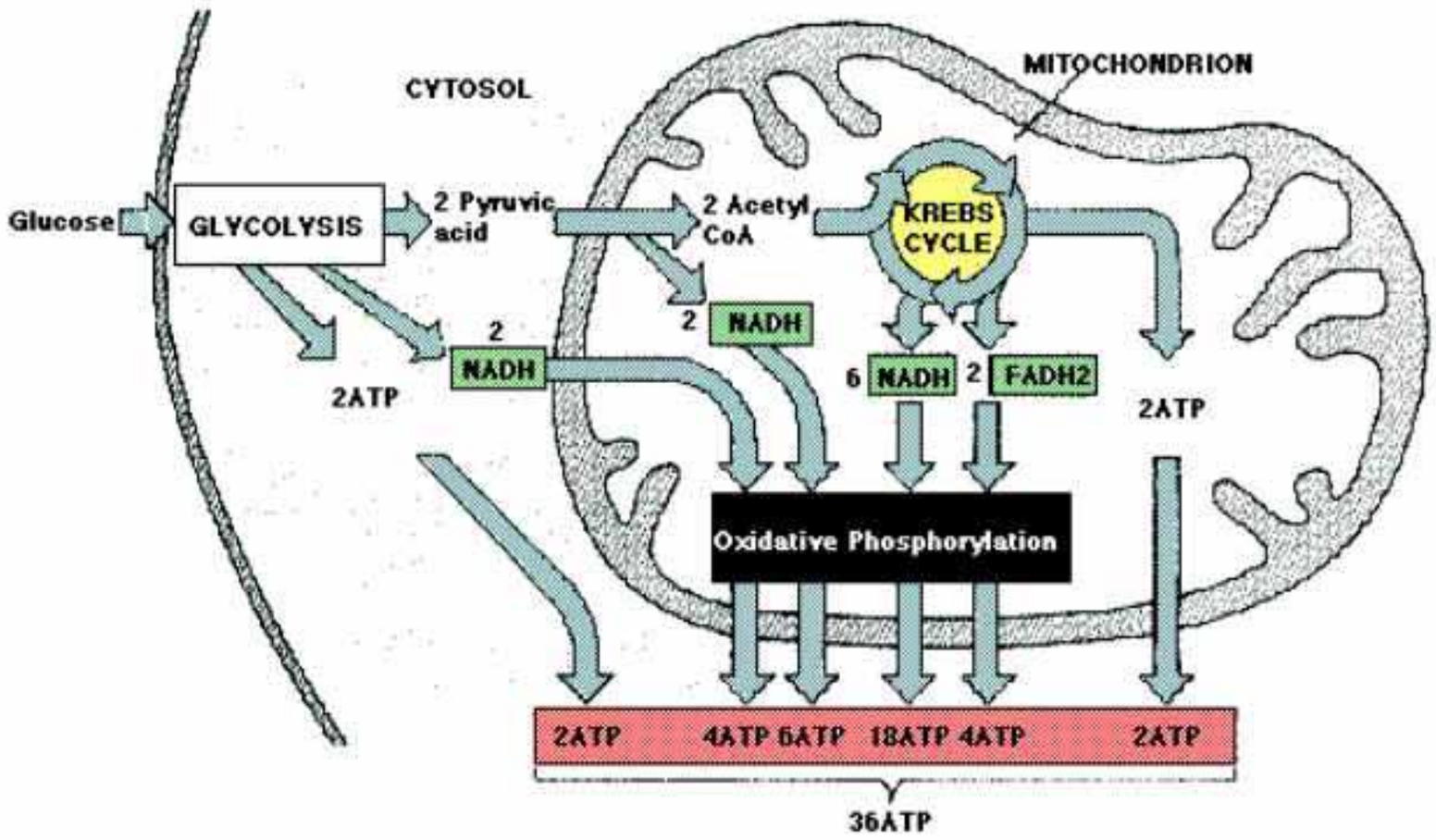


Defining life

Containment

Heredity

Metabolism



Defining life

Containment

Heredity

Metabolism

Evolution

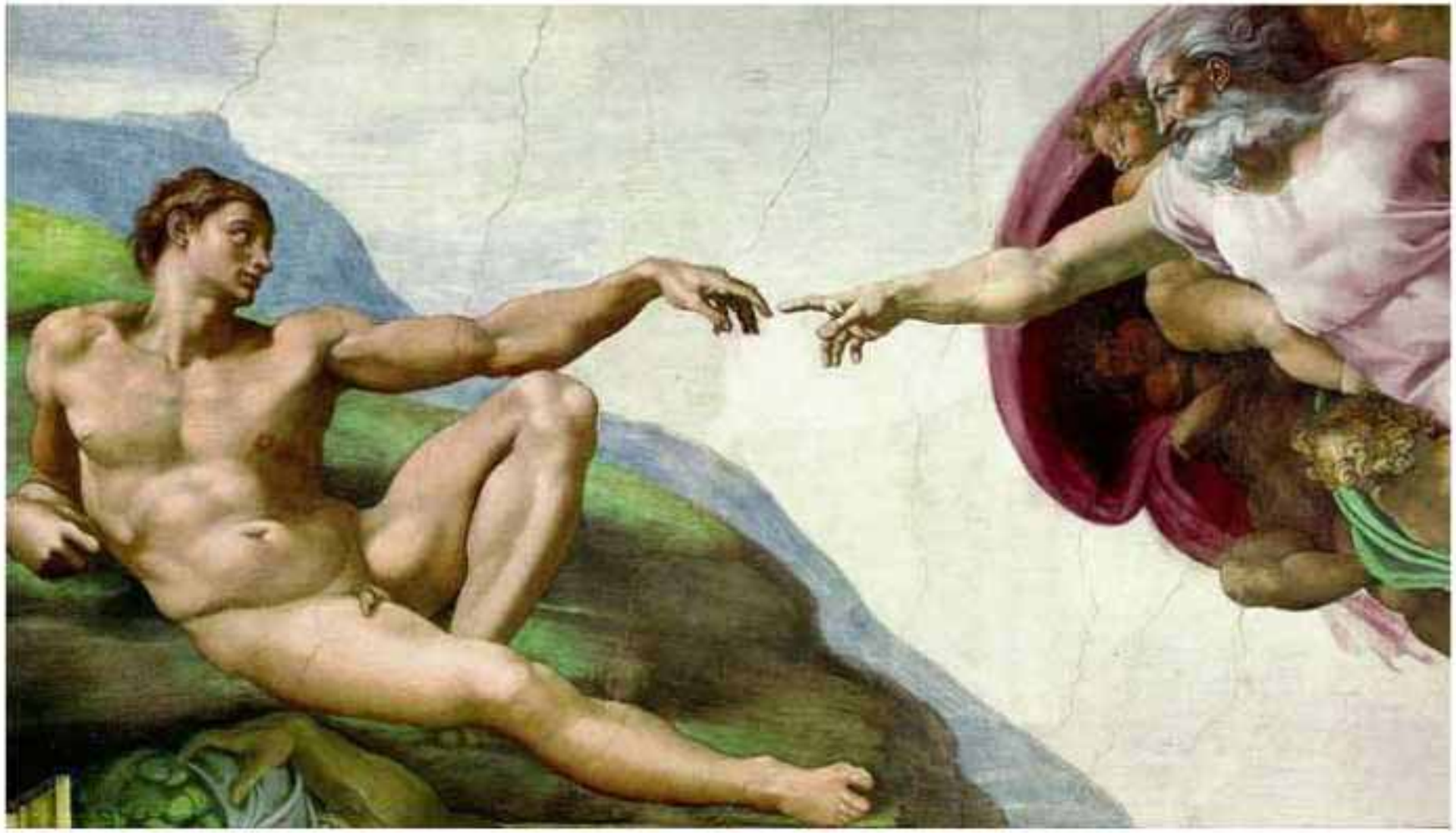
Chemical soup

It is easy to create environmental conditions for forming physiological amino acids

Chemical soup

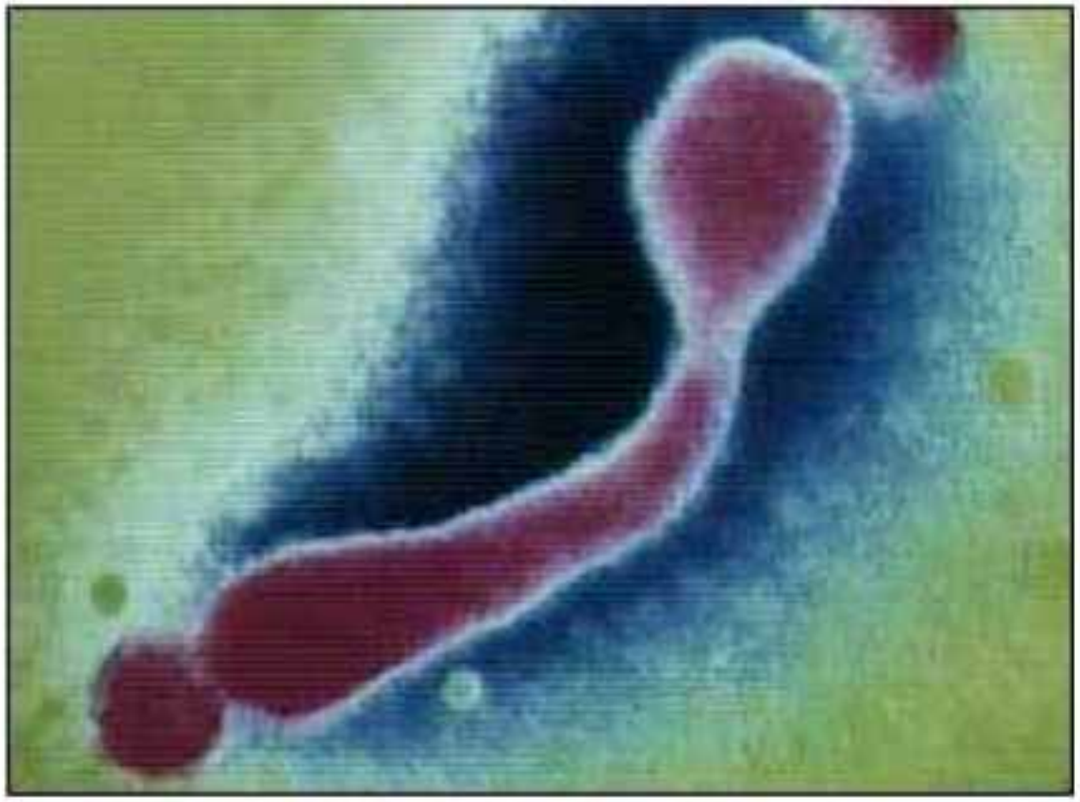
It is easy to create environmental conditions for forming physiological amino acids

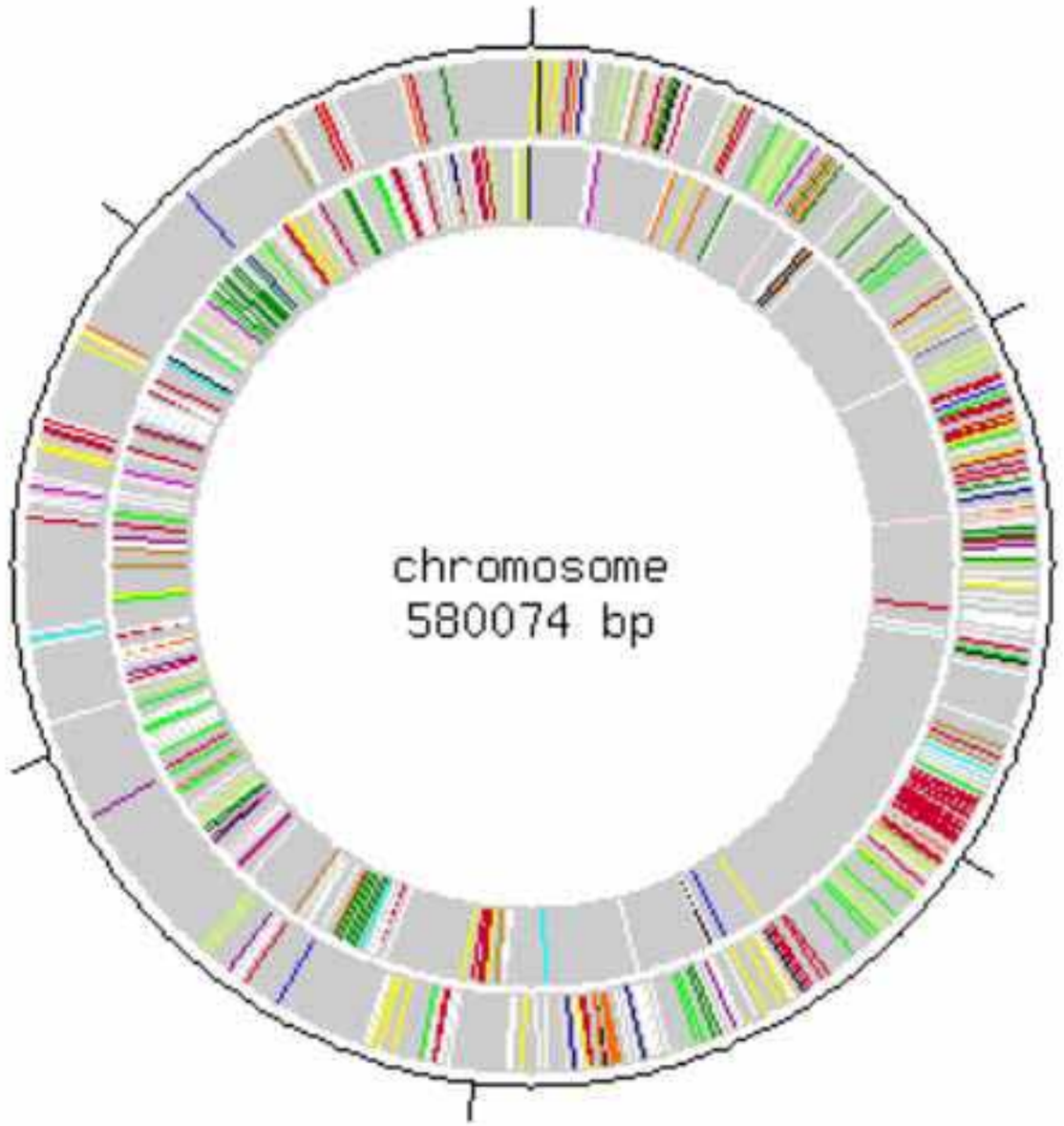
Not easy to accelerate or control the process for creating a life form



Building from a blueprint for life

Mycoplasma genitalium (517 genes)





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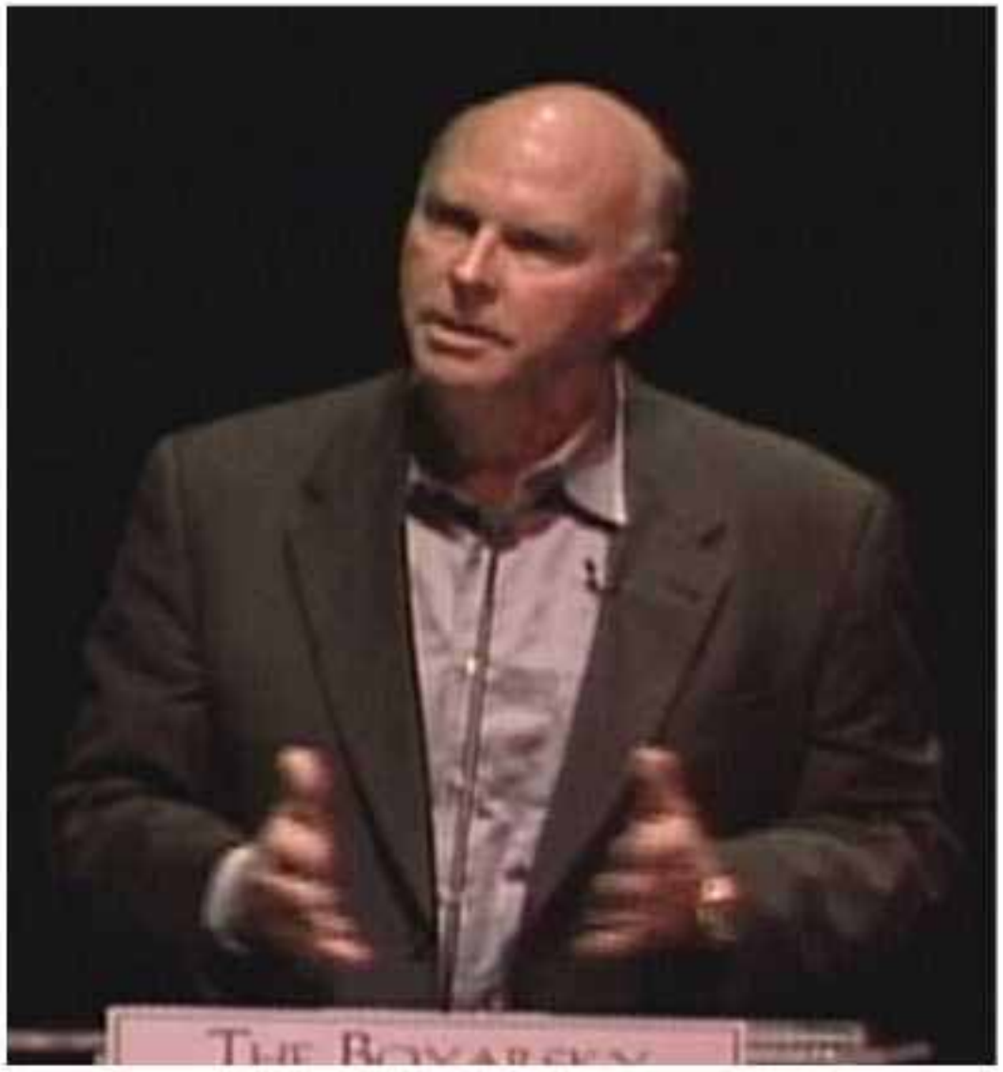
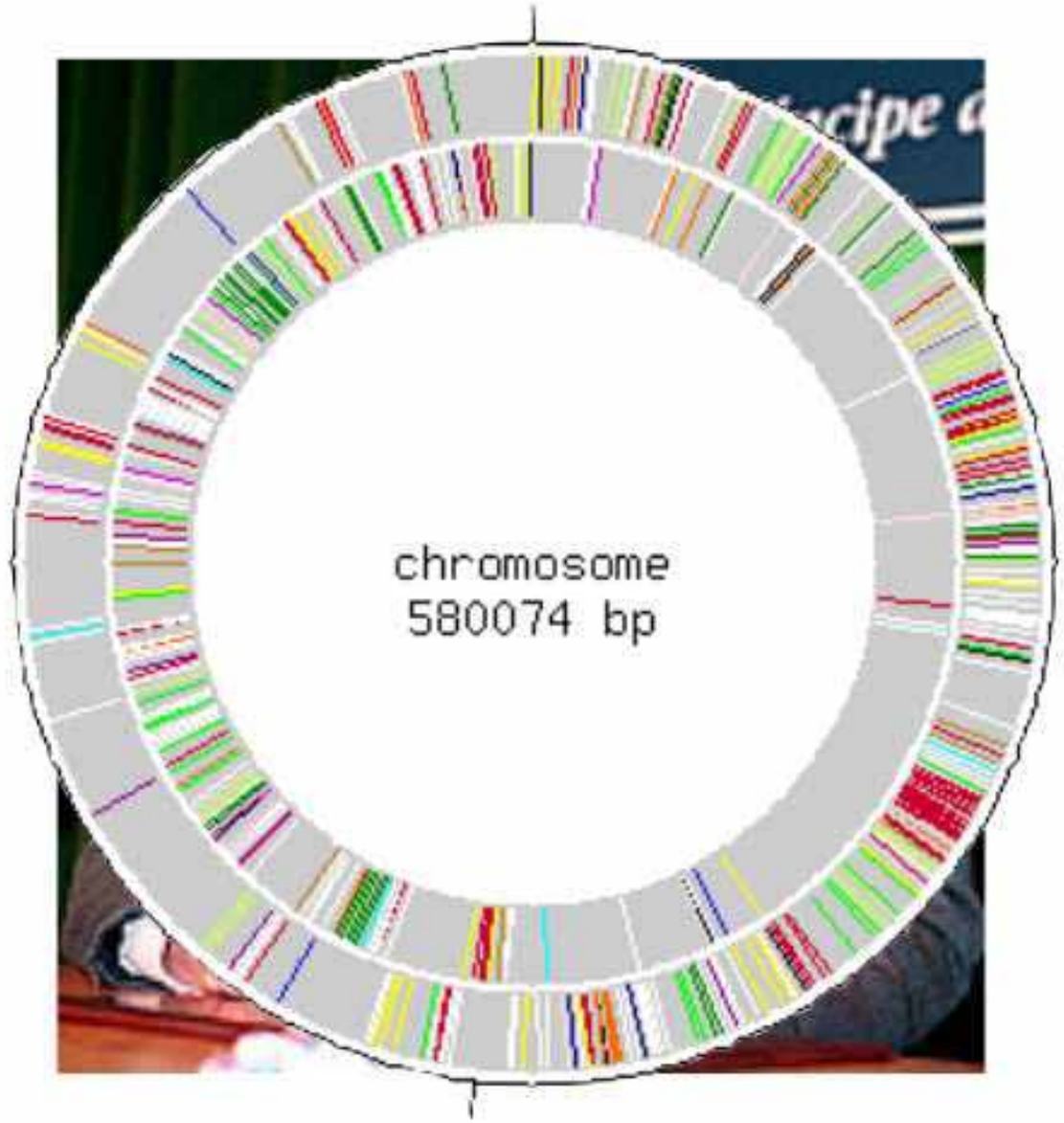




Craig Venter and Hamilton Smith

Building from a blueprint for life

The problem may be in getting everything properly organised

copy each image to a new page to define brush (51 images altogether

The Los Alamos Bug

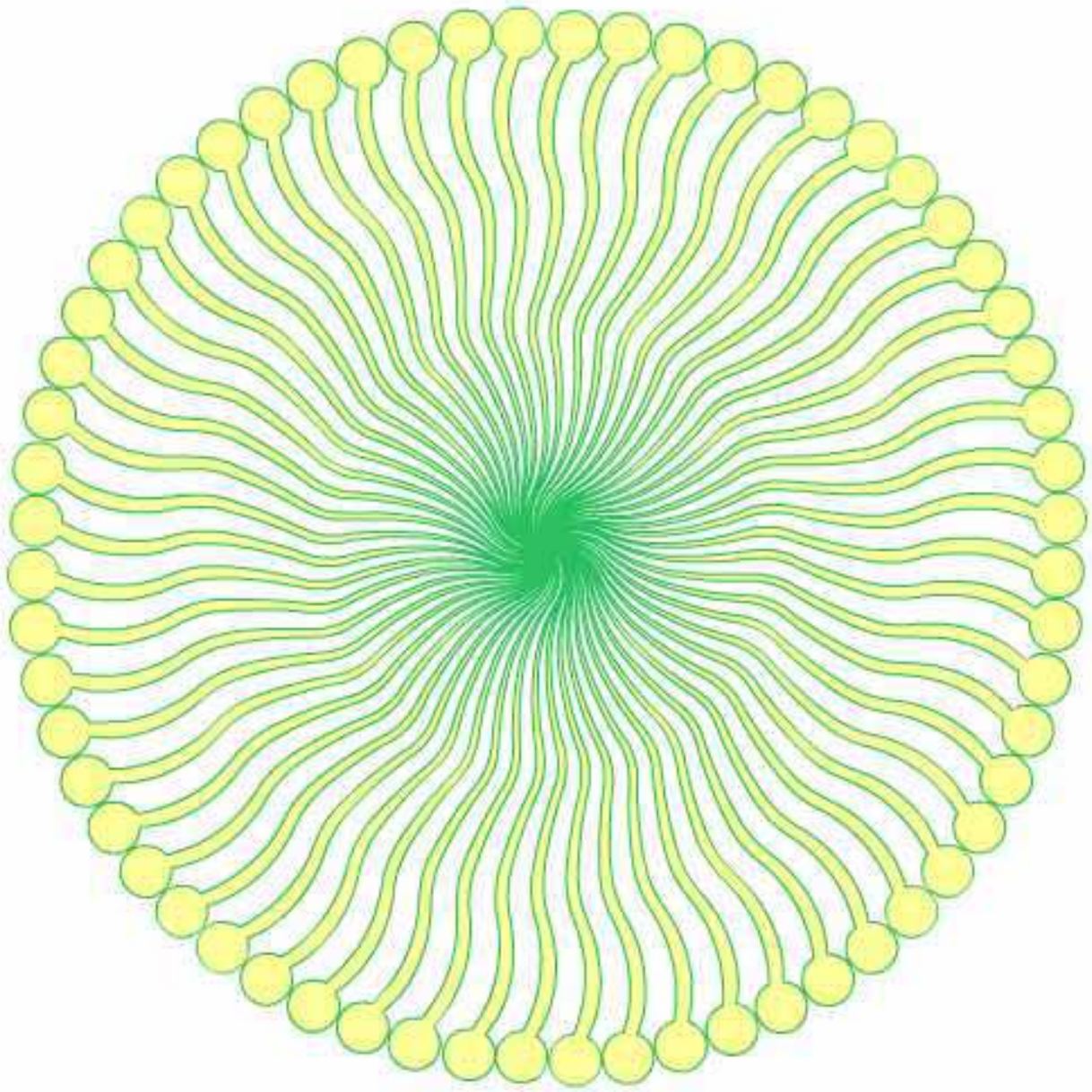
The Los Alamos Bug

Designing new life using an artificial approach

Steen Rasmussen and Norman Packard

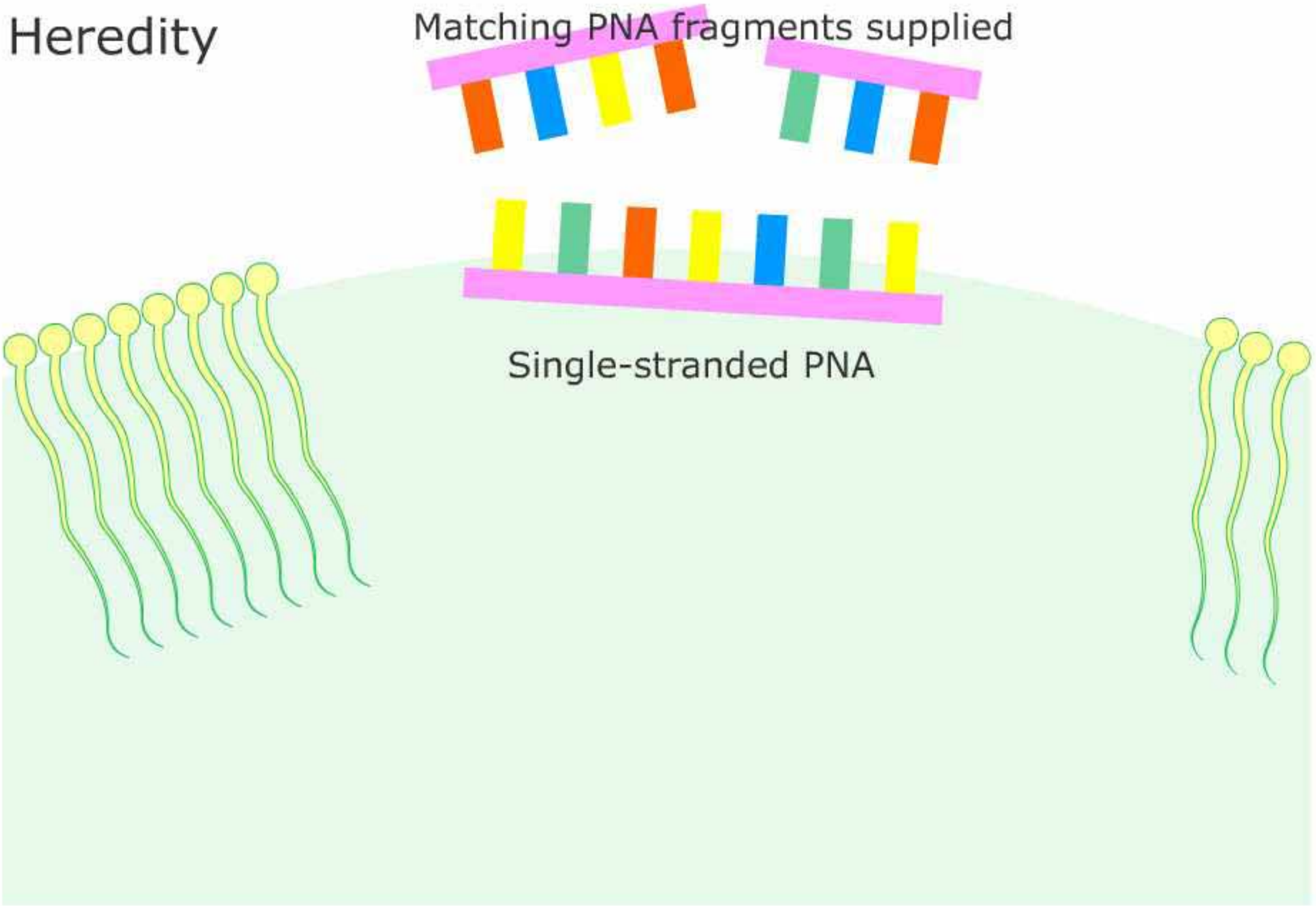
The Los Alamos Bug

Containment

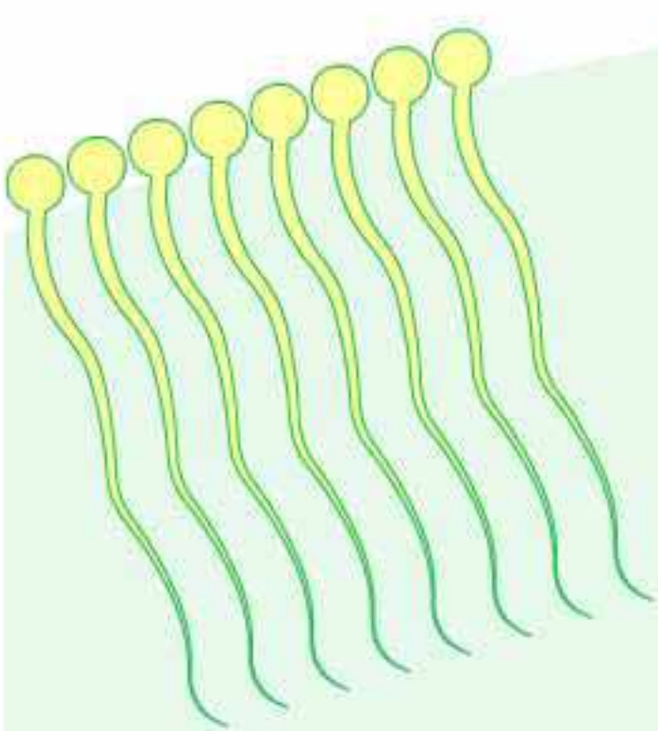


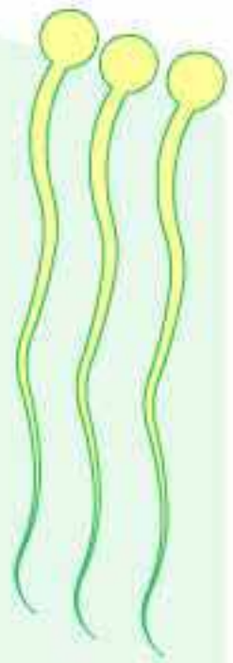
The Los Alamos Bug

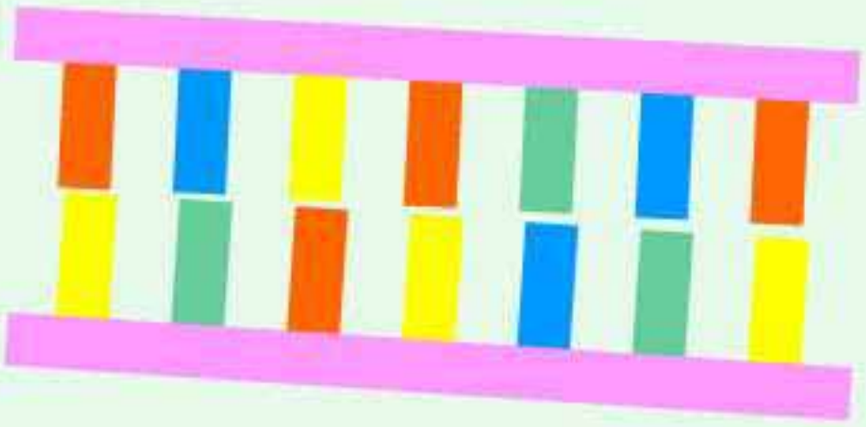
Heredity



Heredity



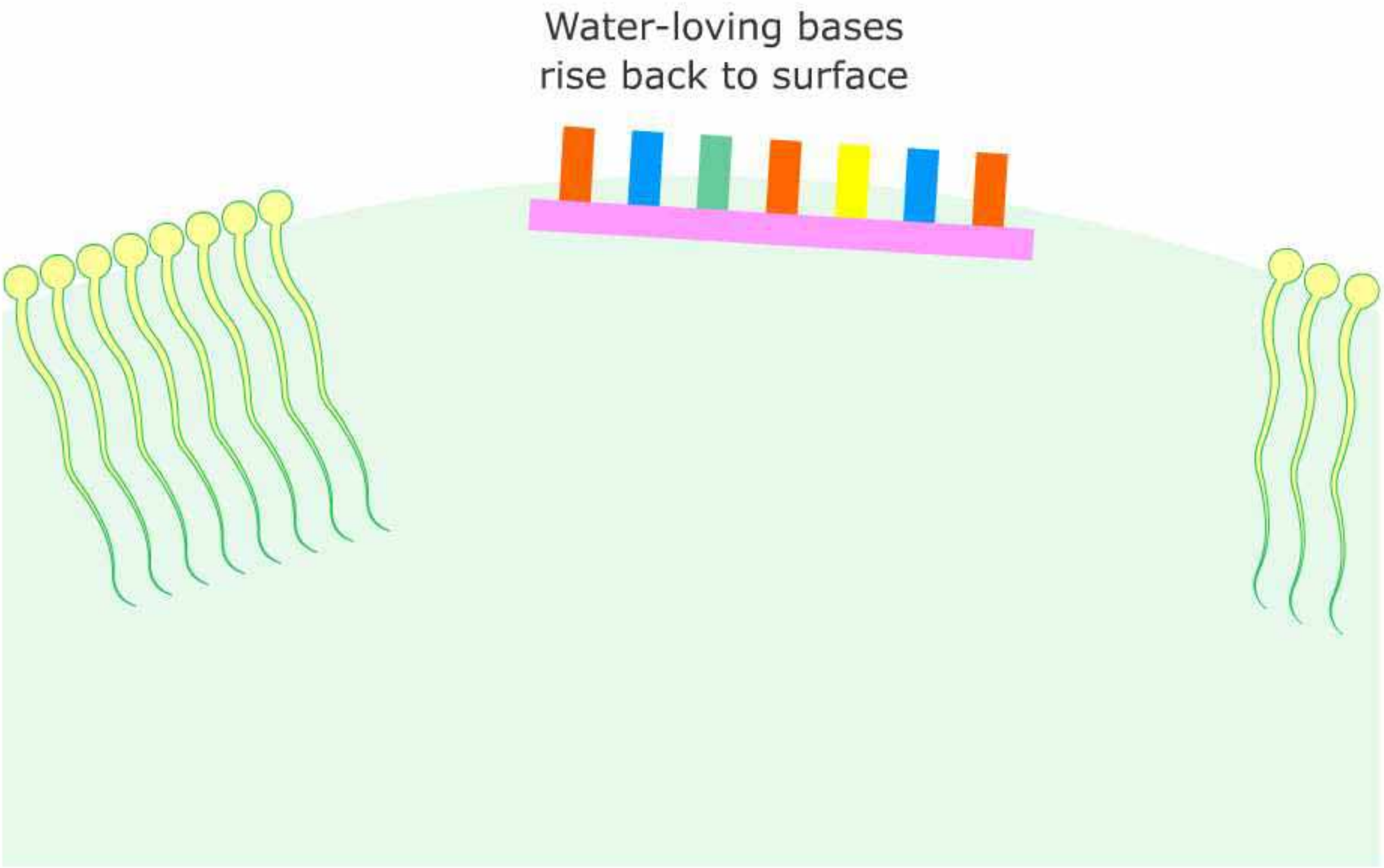




Double-strand PNA is soluble in the centre of the droplet and unzips

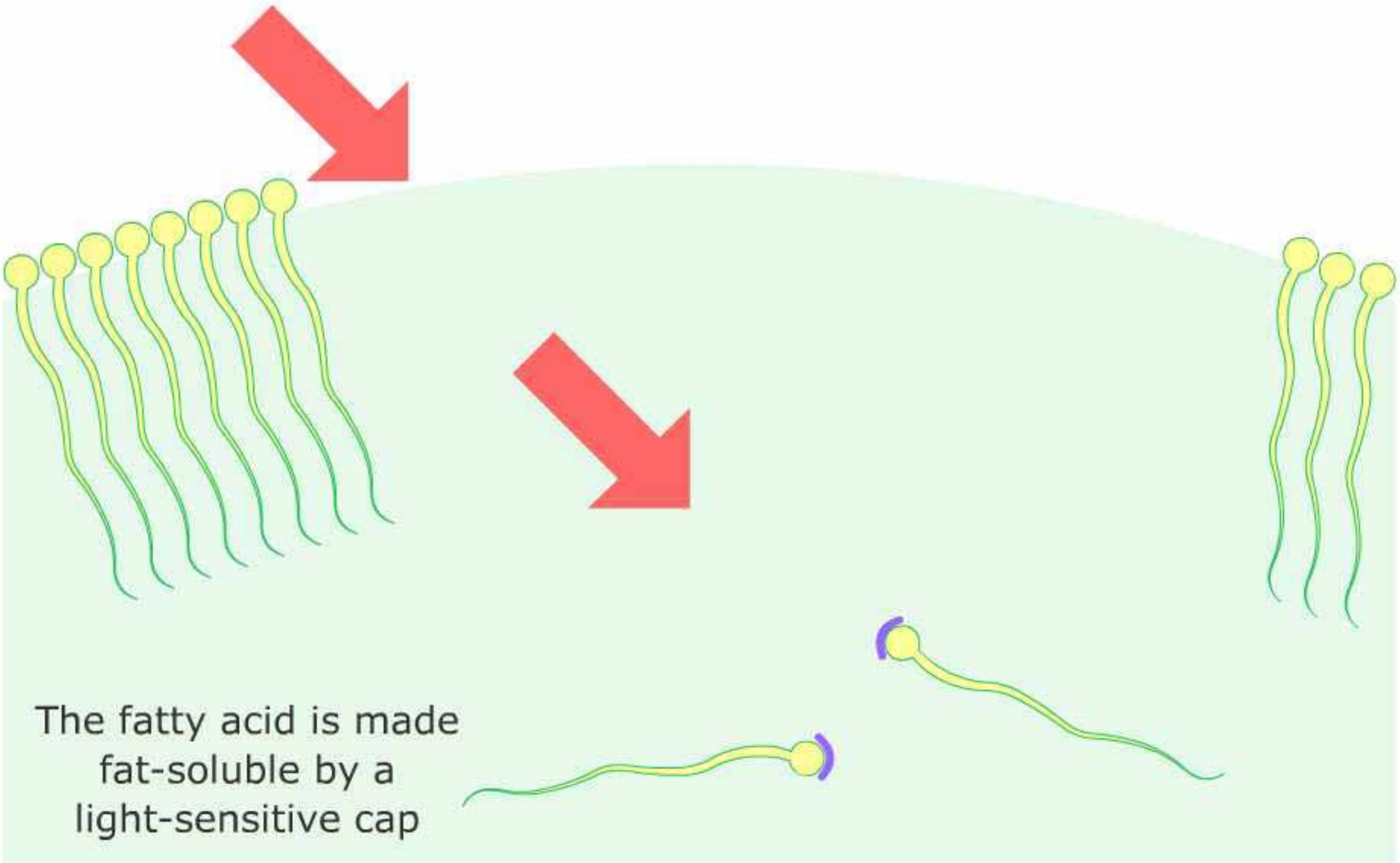
The Los Alamos Bug

Heredity

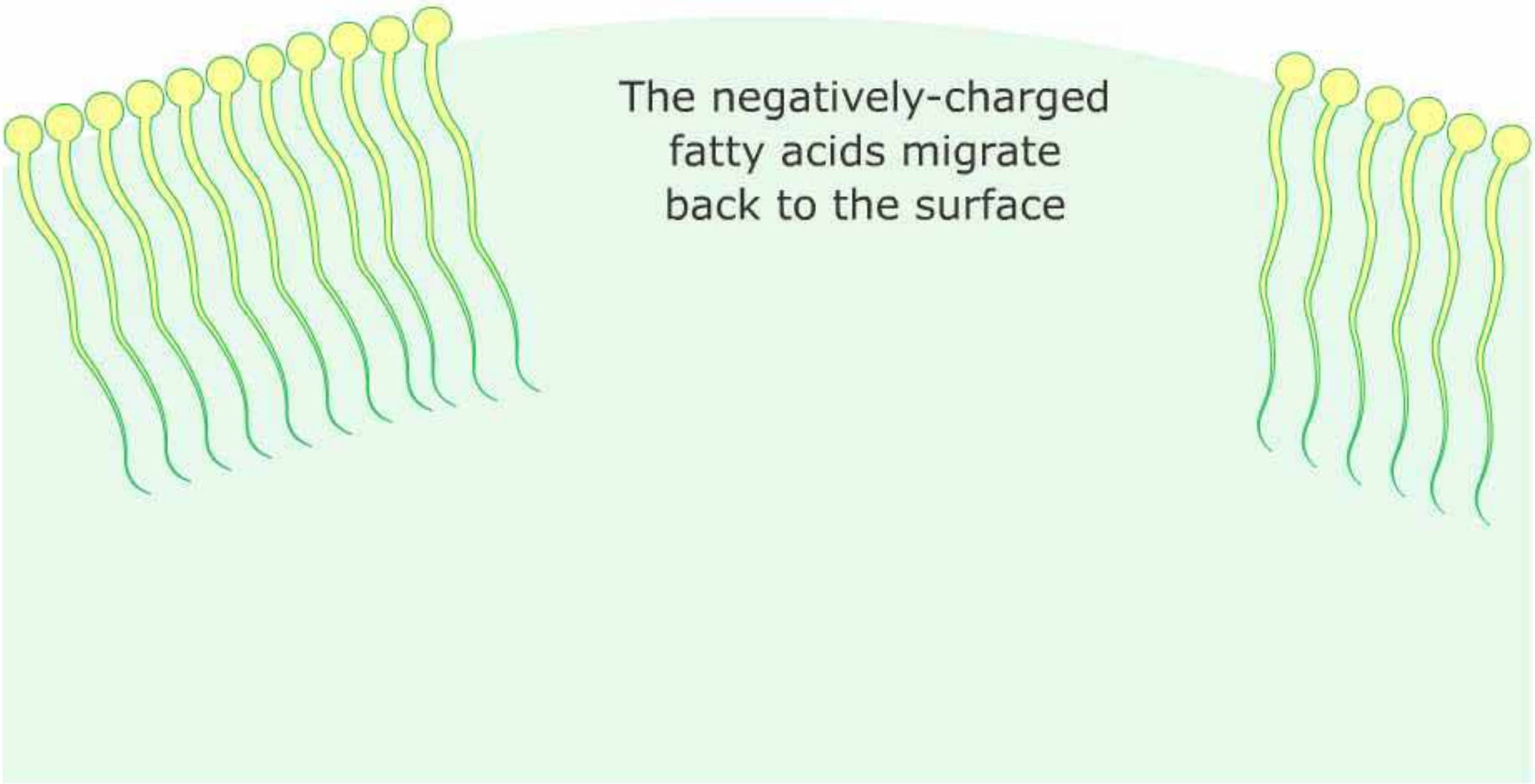


The Los Alamos Bug

Metabolism



Metabolism


The negatively-charged
fatty acids migrate
back to the surface

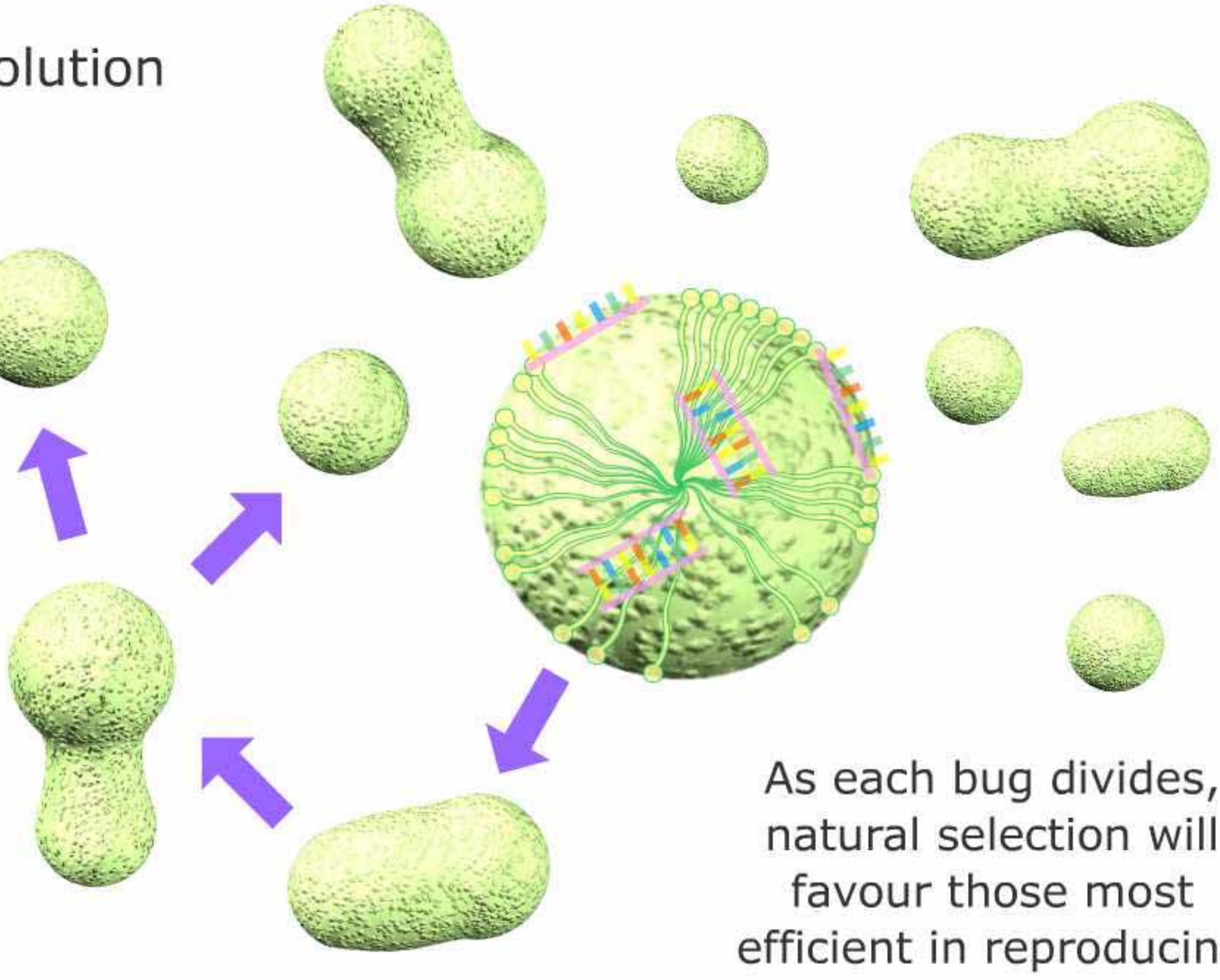
The Los Alamos Bug

Metabolism

As more fatty acids rise to the surface, the droplet expands until its surface tension can no longer contain it, and it divides

The Los Alamos Bug

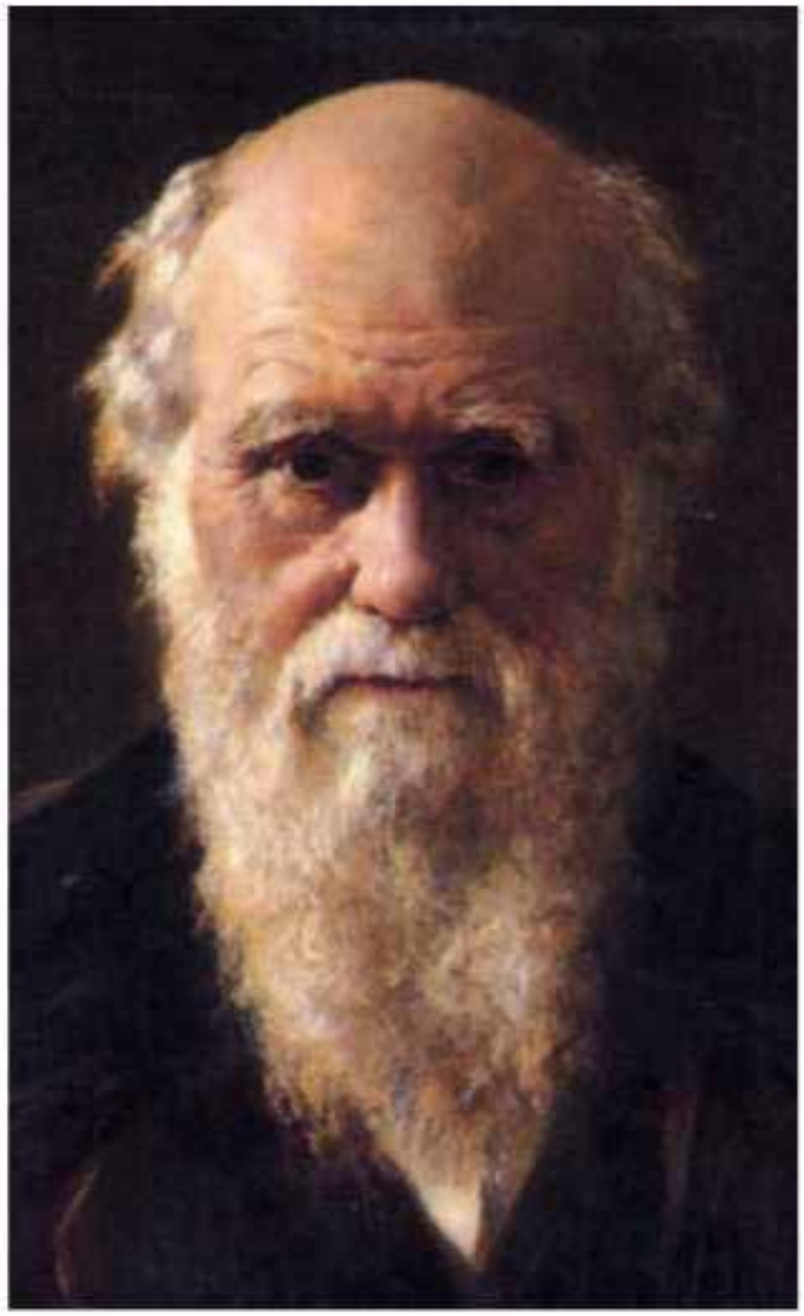
Evolution



As each bug divides, natural selection will favour those most efficient in reproducing

The Los Alamos Bug

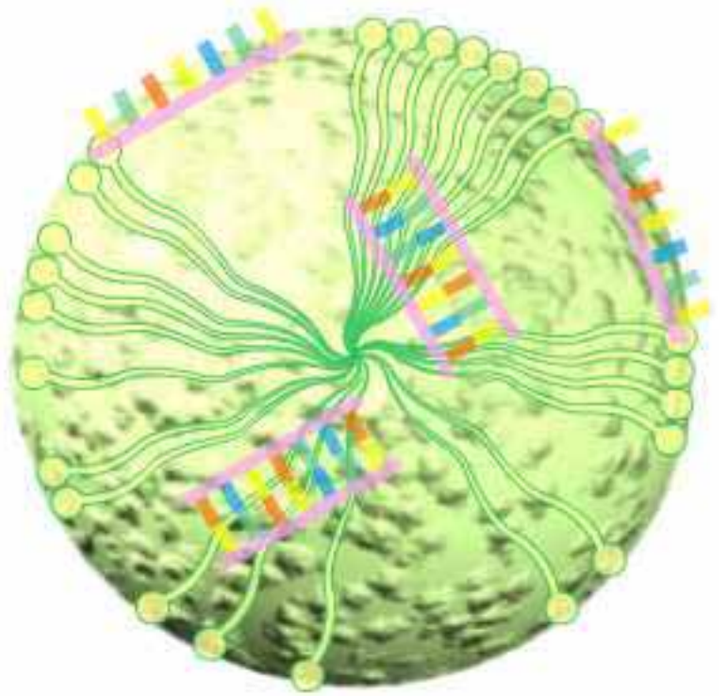
Evolution?



The Los Alamos Bug

Evolution?

Los Alamos – the end and the beginning of life!

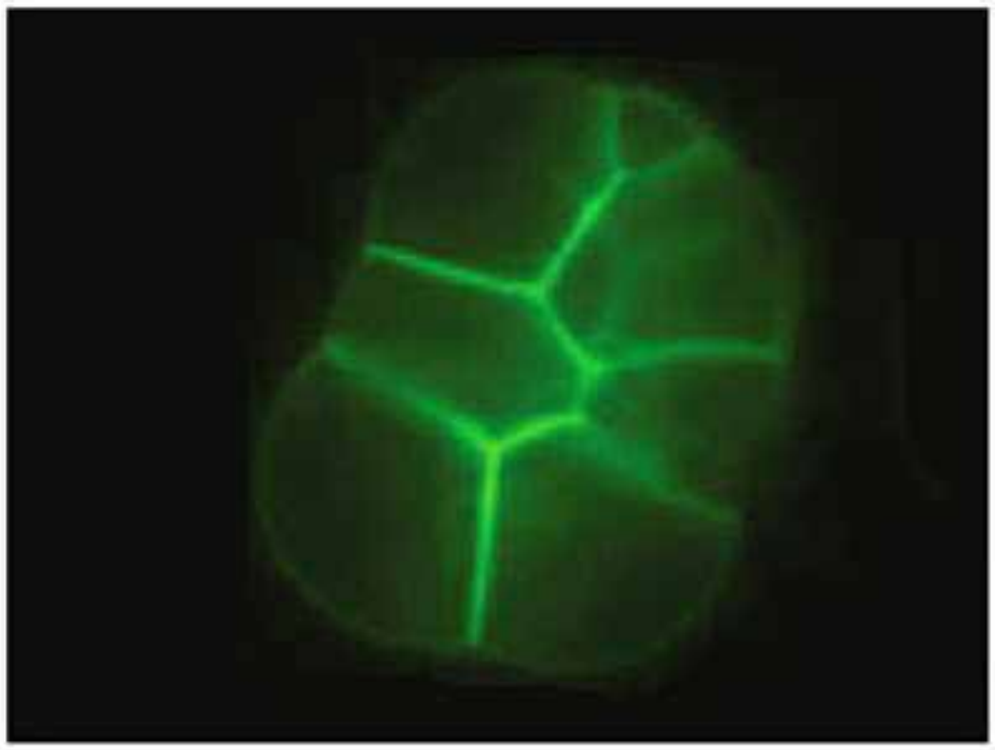


The Los Alamos Bug

Evolution?

Los Alamos – the end and the beginning of life!

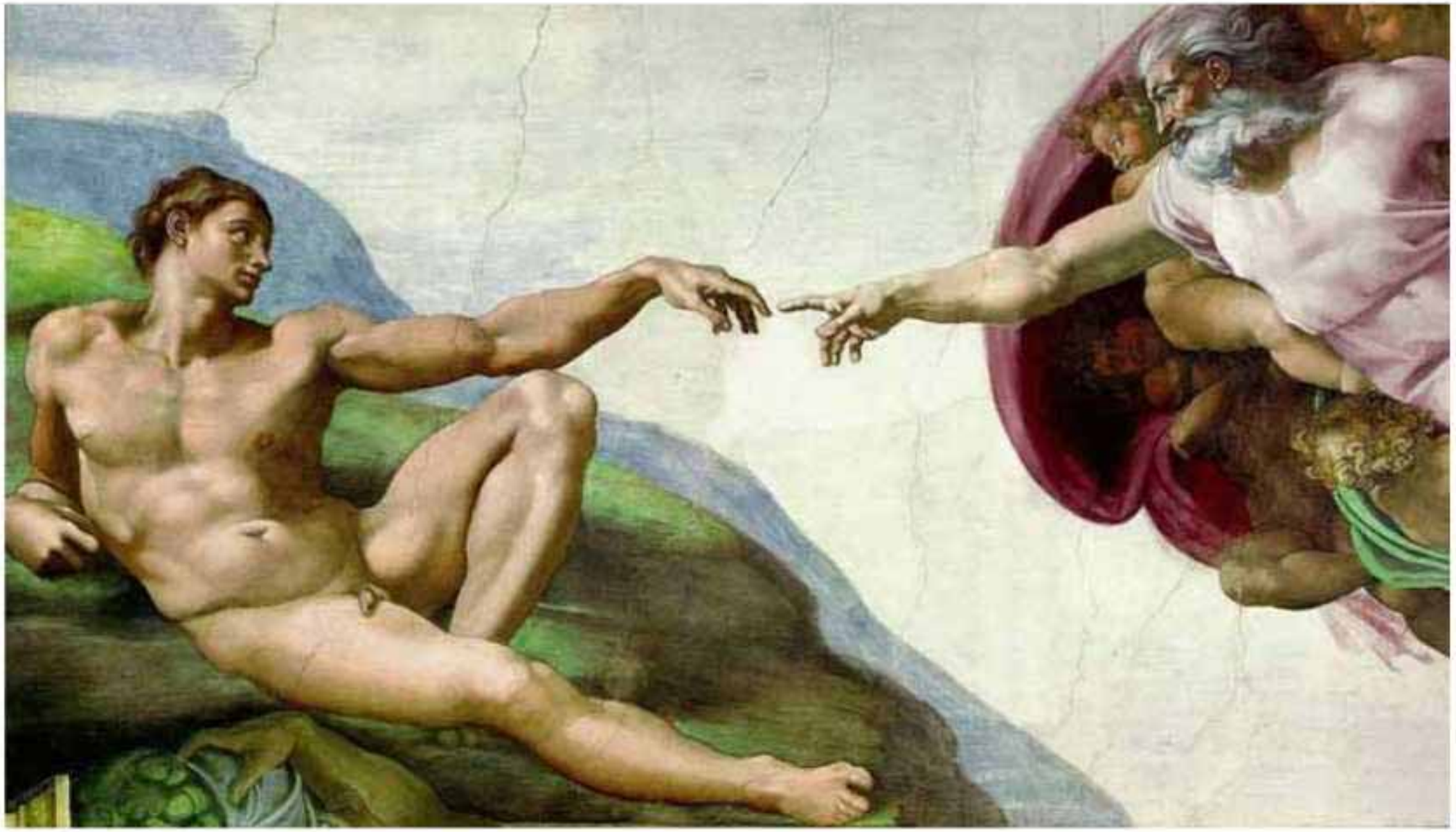
Synthetic vesicles capable of gene transcription



Noireaux and Libchaber 2004

So what could this lead to?

Gods of the planet?



Good bugs

Food production

Good bugs

Food production

Energy production

Good bugs

Food production

Energy production

Pollution control

Good bugs

Food production

Energy production

Pollution control

Waste control

Good bugs

Food production

Energy production

Pollution control

Waste control

Diagnosing and treating human disease

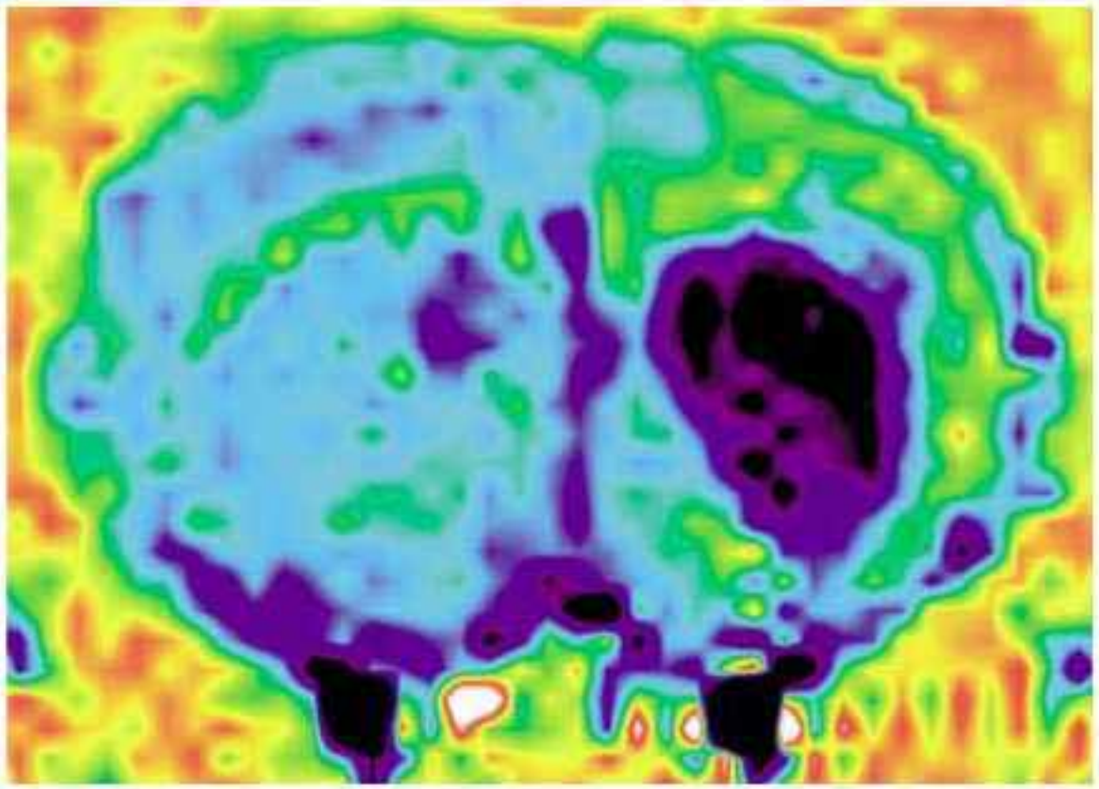
Good bugs

Food production

Energy production

Pollution control

Waste control



Diagnosing and treating human disease

Repairing damaged organs

Good bugs

Food production

Energy production

Pollution control

Waste control

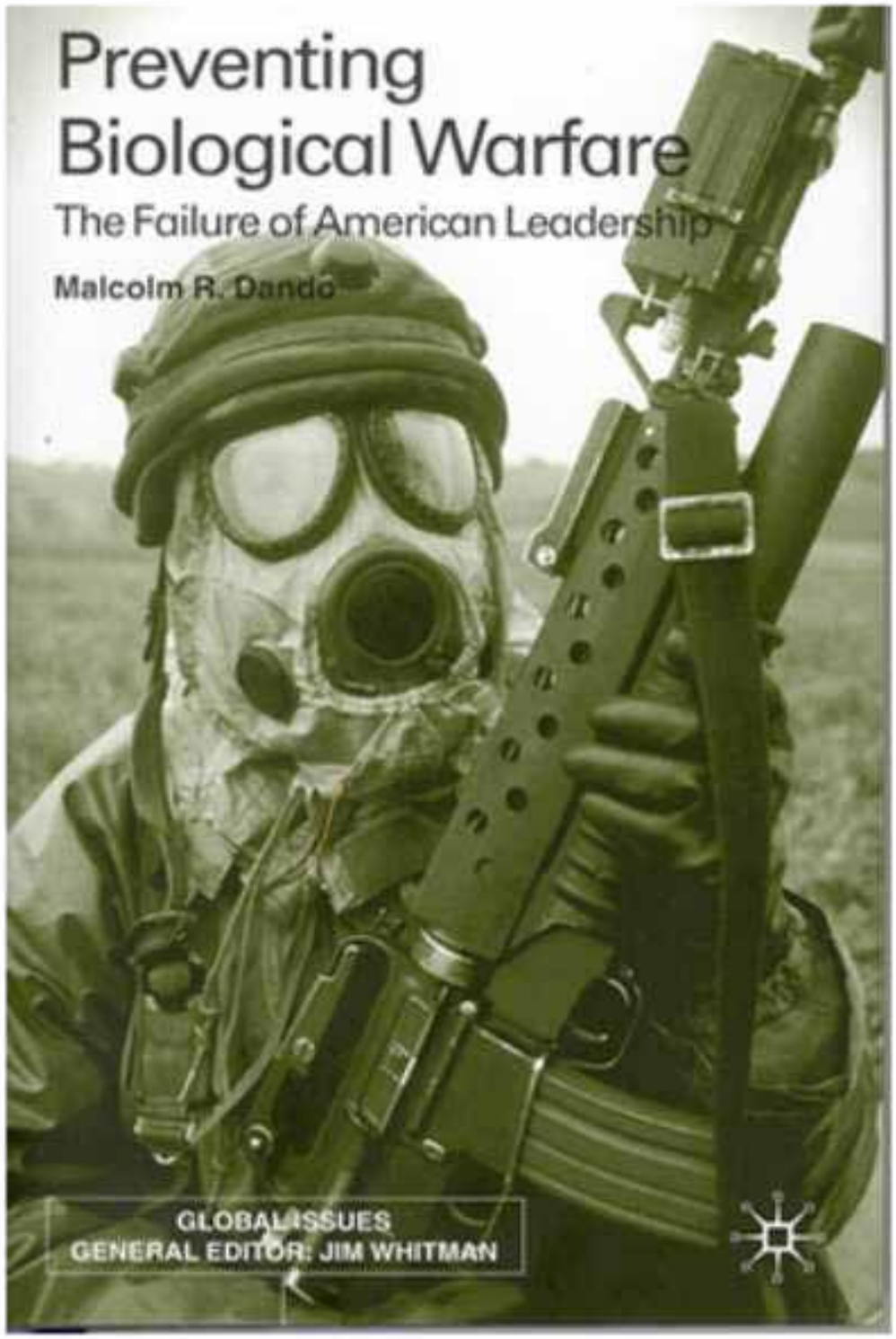
Diagnosing and treating human disease

Repairing damaged organs

Biorobots

Bad bugs

Biological warfare



The perfect companion animal?

Homo truly sapiens?

Homo truly sapiens?