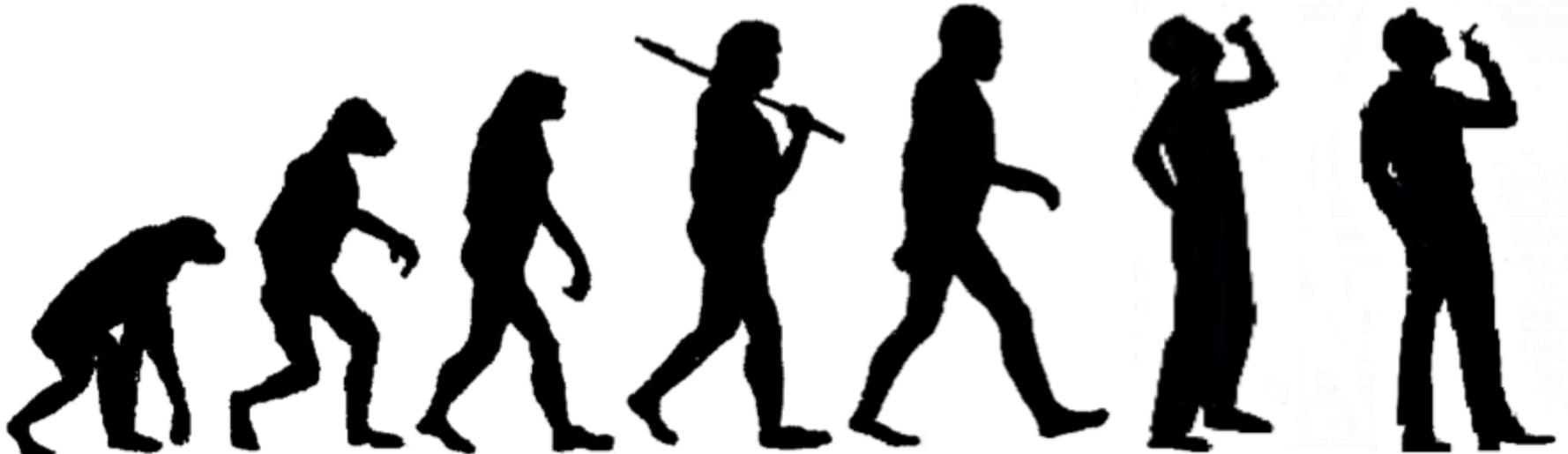


Approche évolutionniste des addictions

Henri-Jean Aubin

Hôpitaux Universitaires Paris-Sud

Centre de Recherche en Epidémiologie et Santé des
Populations (INSERM)



Approche évolutionniste des addictions

Profondeur du temps

Origine des mécanismes adaptatifs complexes

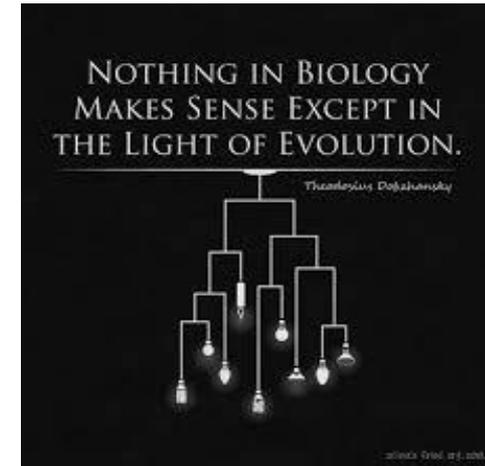
Perspective évolutionniste

Inadéquation évolutive

Pourquoi fume t-on ?

Théorie de l'histoire de vie

Rôle de l'épigénétique

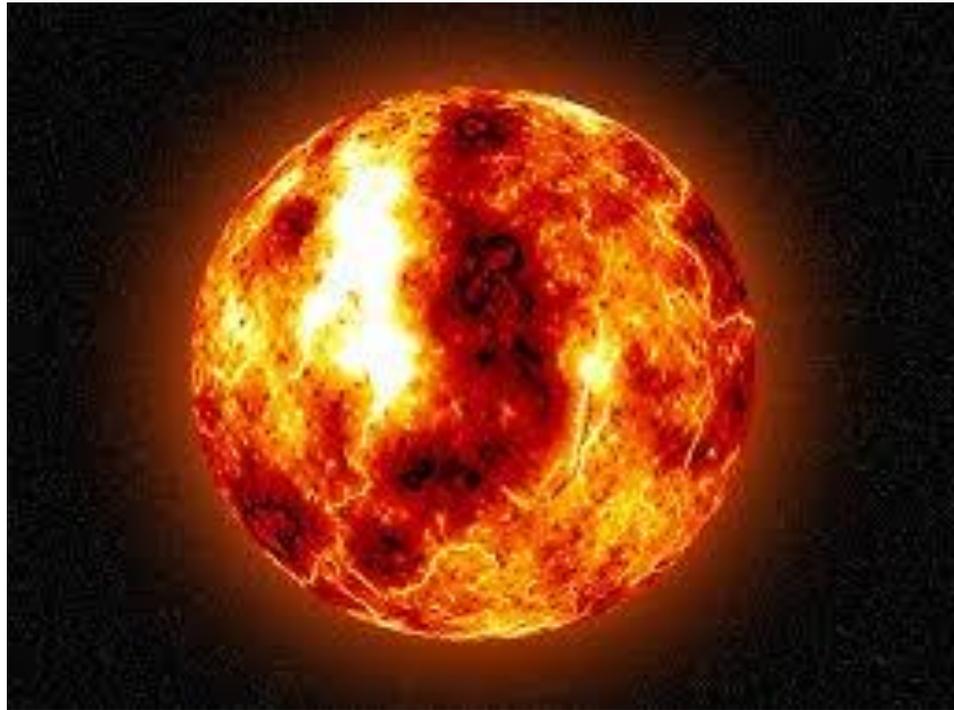


1. Profondeur du temps



1^{er} janvier

Formation de la terre



4,6 milliards d'années

2 Mars

Apparition de la vie



3,8 milliards d'années

29 Mars

Cellules procaryotes

Prokaryotic Cell Structure

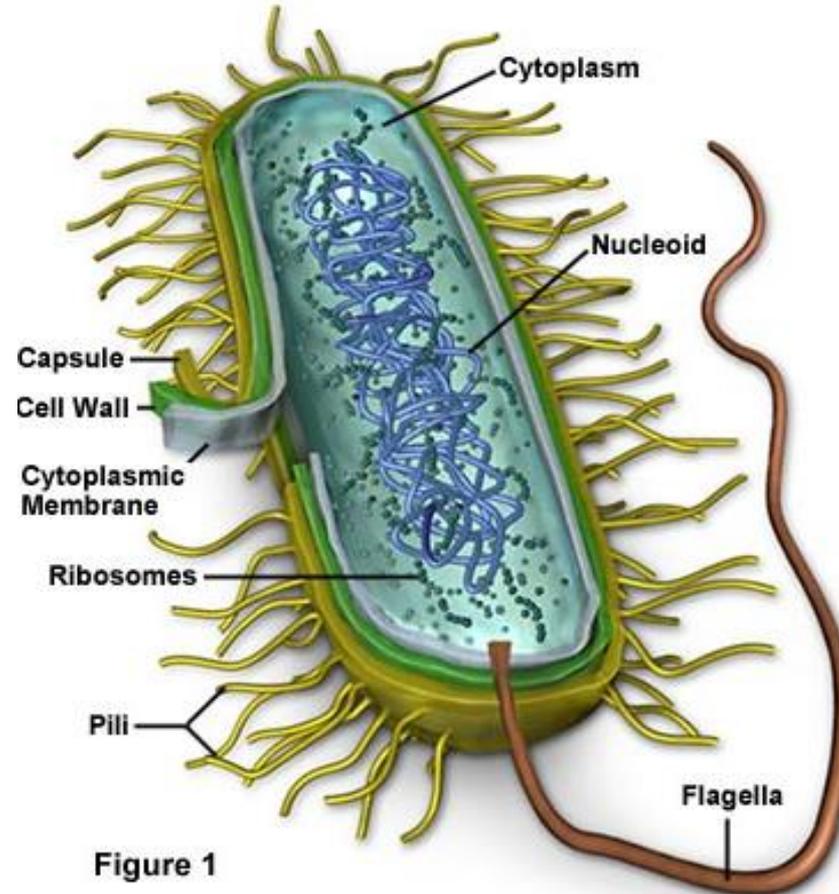


Figure 1

7 mai

Photosynthèse

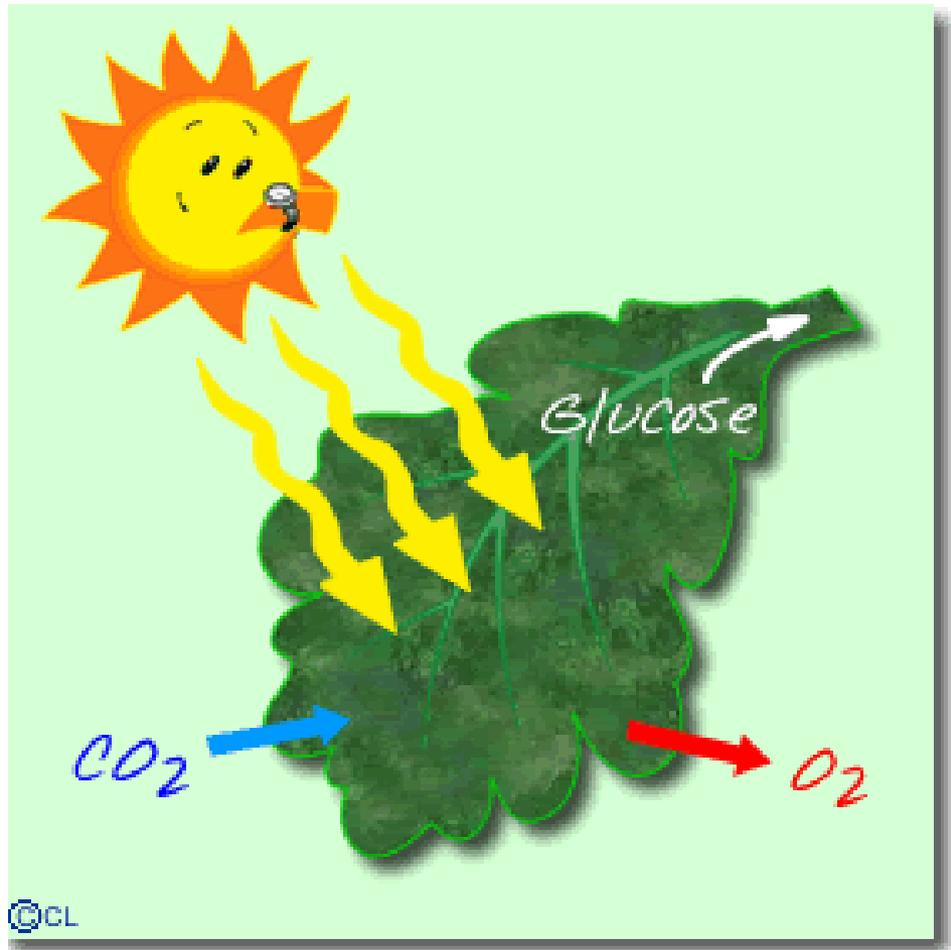
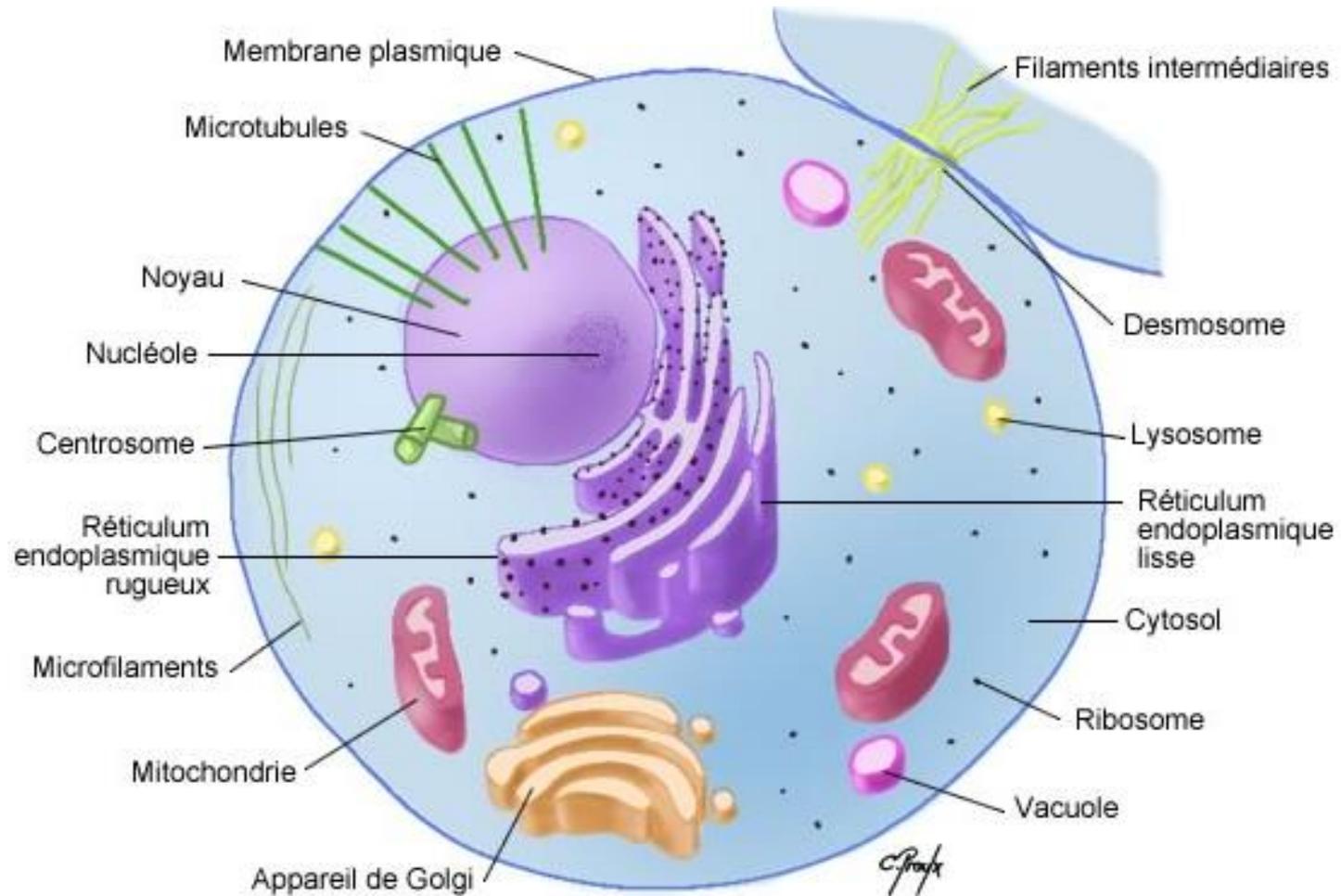


Schéma de la photosynthèse

17 juillet

Cellules eucaryotes



25 juillet

Vie multicellulaire



21 novembre

Poissons



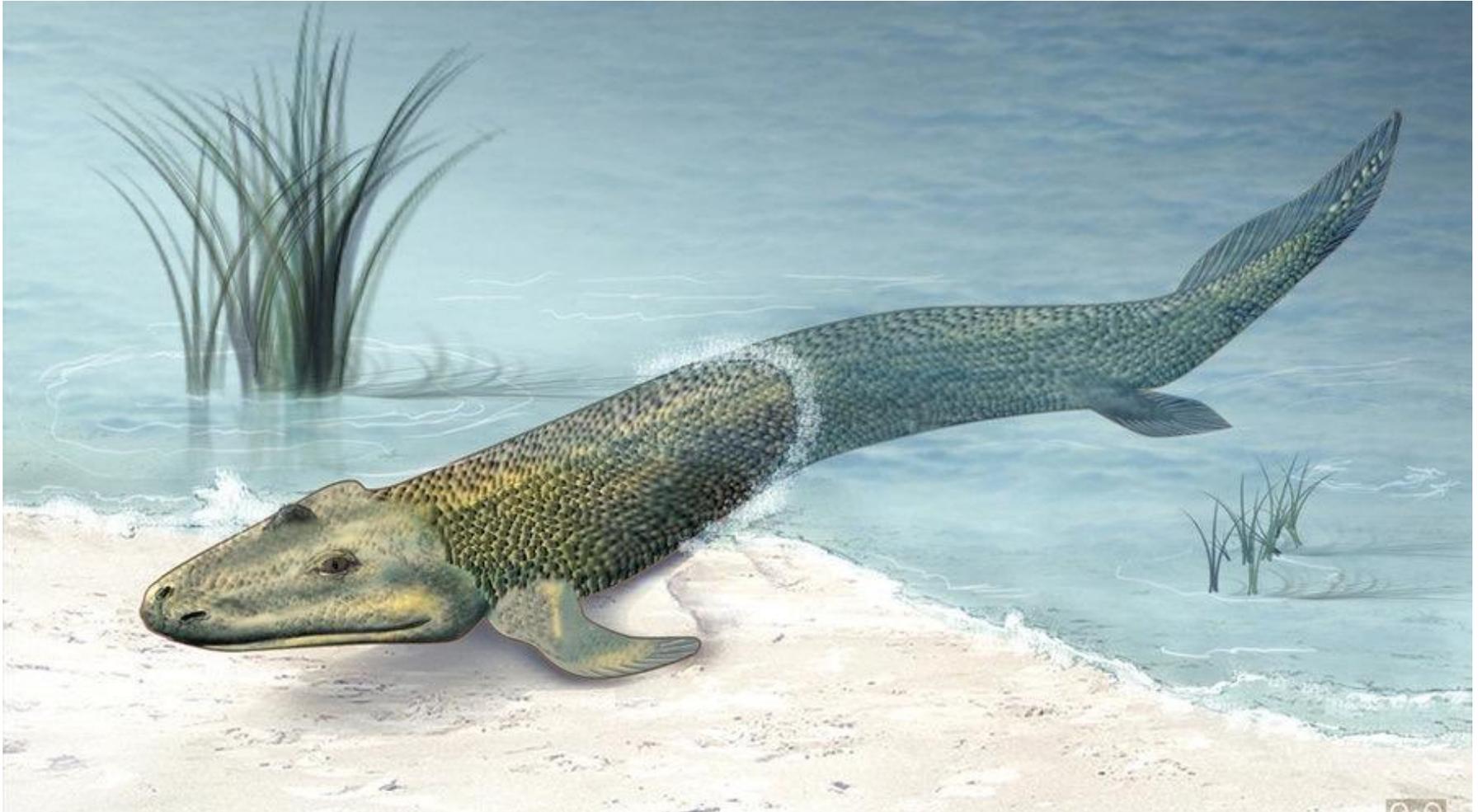
23 novembre

Plantes terrestres



26 novembre

Animaux terrestres



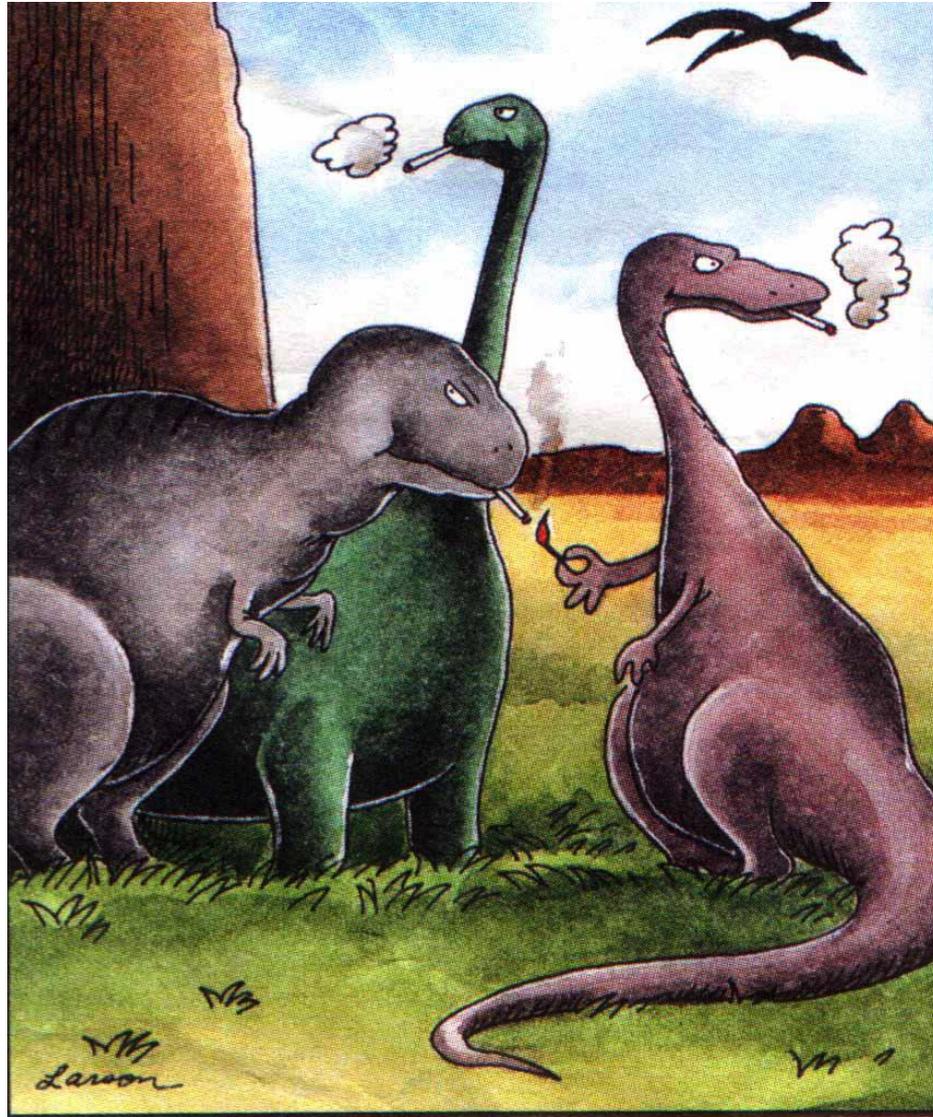
15 décembre
Mammifères



26 décembre

Extinction des dinosaures





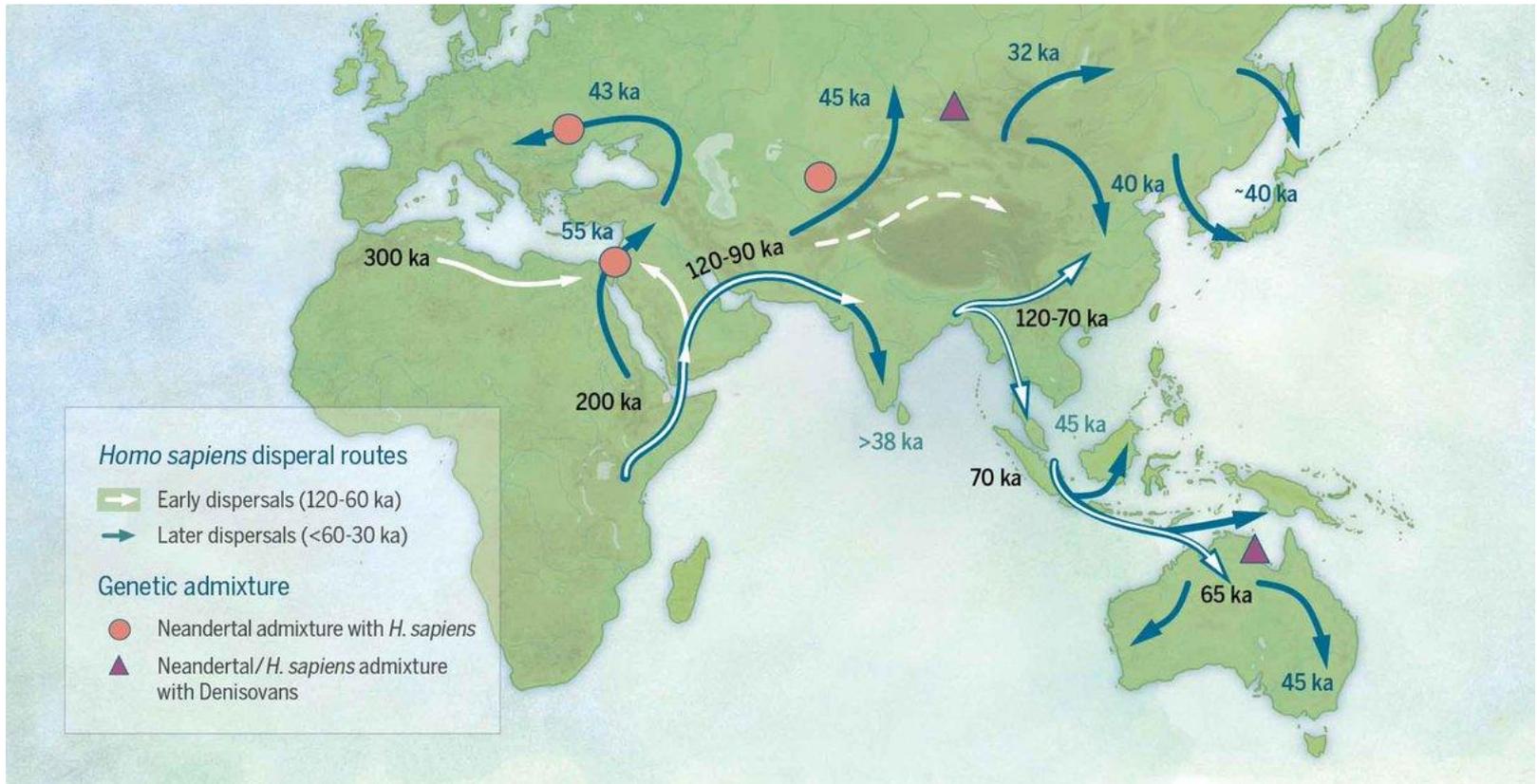
The real reason dinosaurs became extinct

31 décembre 19h00
Primates hominidés



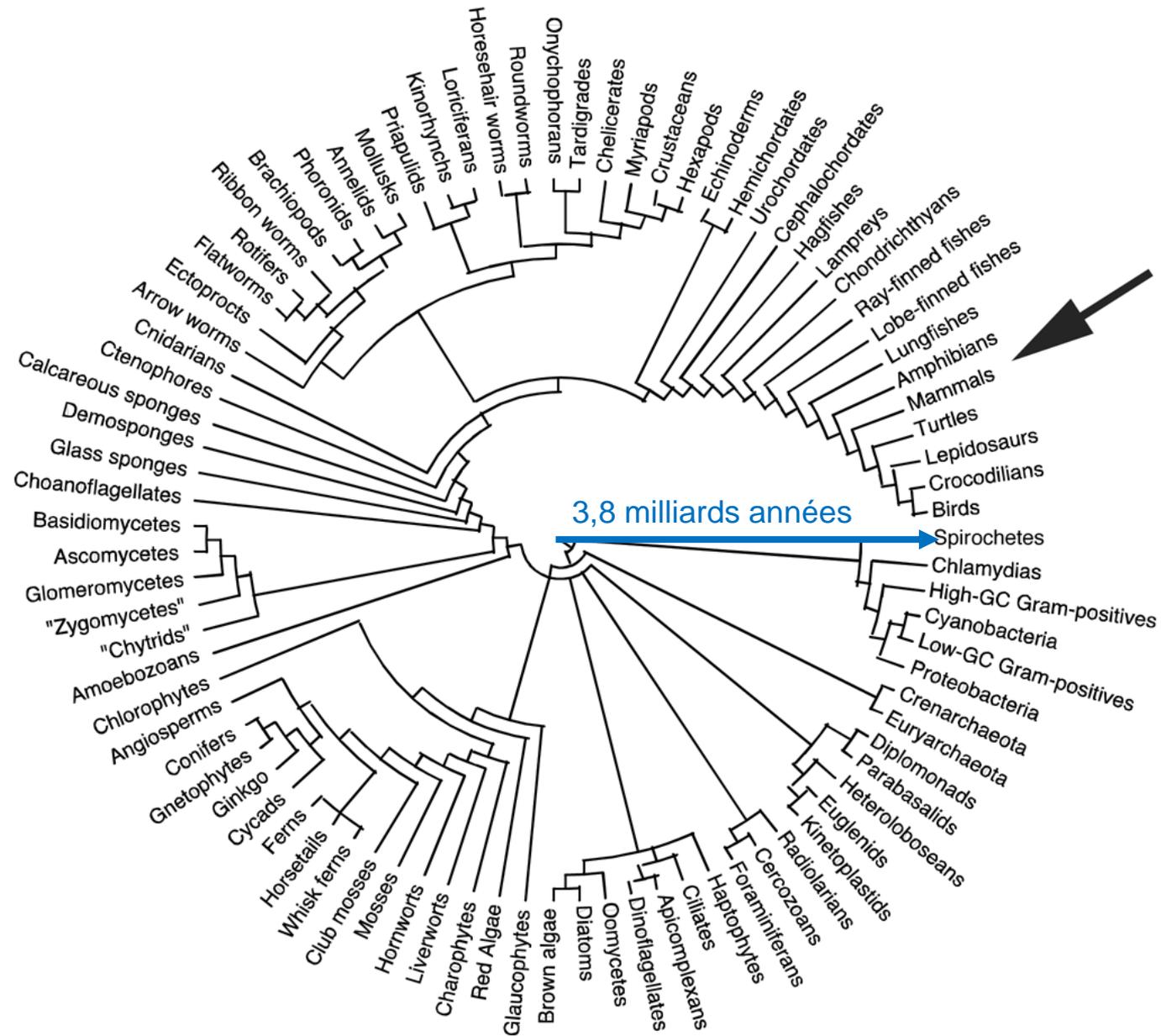
31 décembre 23h54

Sortie d'Afrique



31 décembre 23h59, 30 sec
Débuts de l'écriture





you
are
here



Biodiversité

Species	Earth			Ocean		
	Catalogued	Predicted	±SE	Catalogued	Predicted	±SE
Eukaryotes						
Animalia	953,434	7,770,000	958,000	171,082	2,150,000	145,000
Chromista	13,033	27,500	30,500	4,859	7,400	9,640
Fungi	43,271	611,000	297,000	1,097	5,320	11,100
Plantae	215,644	298,000	8,200	8,600	16,600	9,130
Protozoa	8,118	36,400	6,690	8,118	36,400	6,690
<i>Total</i>	1,233,500	8,740,000	1,300,000	193,756	2,210,000	182,000
Prokaryotes						
Archaea	502	455	160	1	1	0
Bacteria	10,358	9,680	3,470	652	1,320	436
<i>Total</i>	10,860	10,100	3,630	653	1,320	436
Grand Total	1,244,360	8,750,000	1,300,000	194,409	2,210,000	182,000

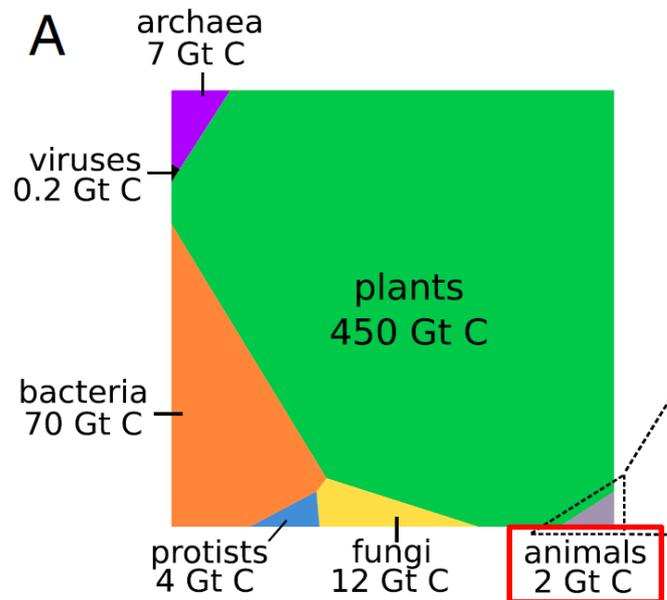
Predictions for prokaryotes represent a lower bound because they do not consider undescribed higher taxa. For protozoa, the ocean database was substantially more complete than the database for the entire Earth so we only used the former to estimate the total number of species in this taxon. All predictions were rounded to three significant digits.

doi:10.1371/journal.pbio.1001127.t002

The biomass distribution on Earth

Yinon M. Bar-On^a, Rob Phillips^{b,c}, and Ron Milo^{a,1}

Absolute biomass
of different taxa

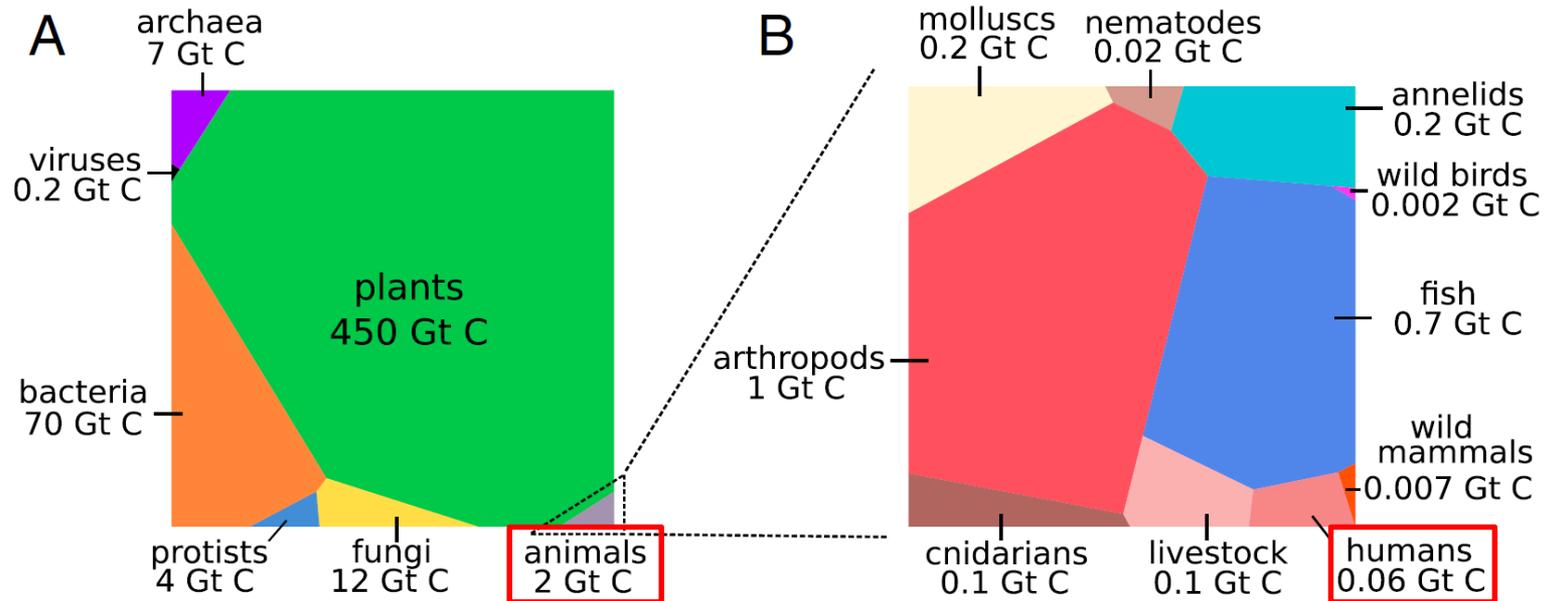


The biomass distribution on Earth

Yinon M. Bar-On^a, Rob Phillips^{b,c}, and Ron Milo^{a,1}

Absolute biomass
of different taxa

Absolute biomass
of different *animal*
taxa



The biomass distribution on Earth

Yinon M. Bar-On^a, Rob Phillips^{b,c}, and Ron Milo^{a,1}

Impact of human civilization on the biomass of mammals

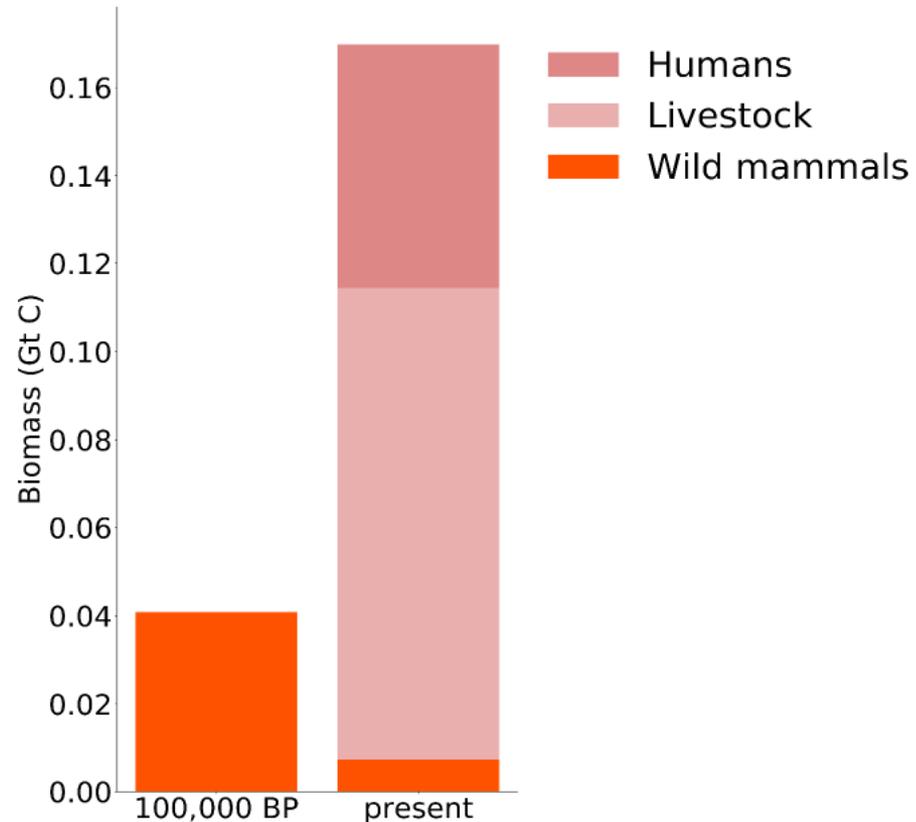


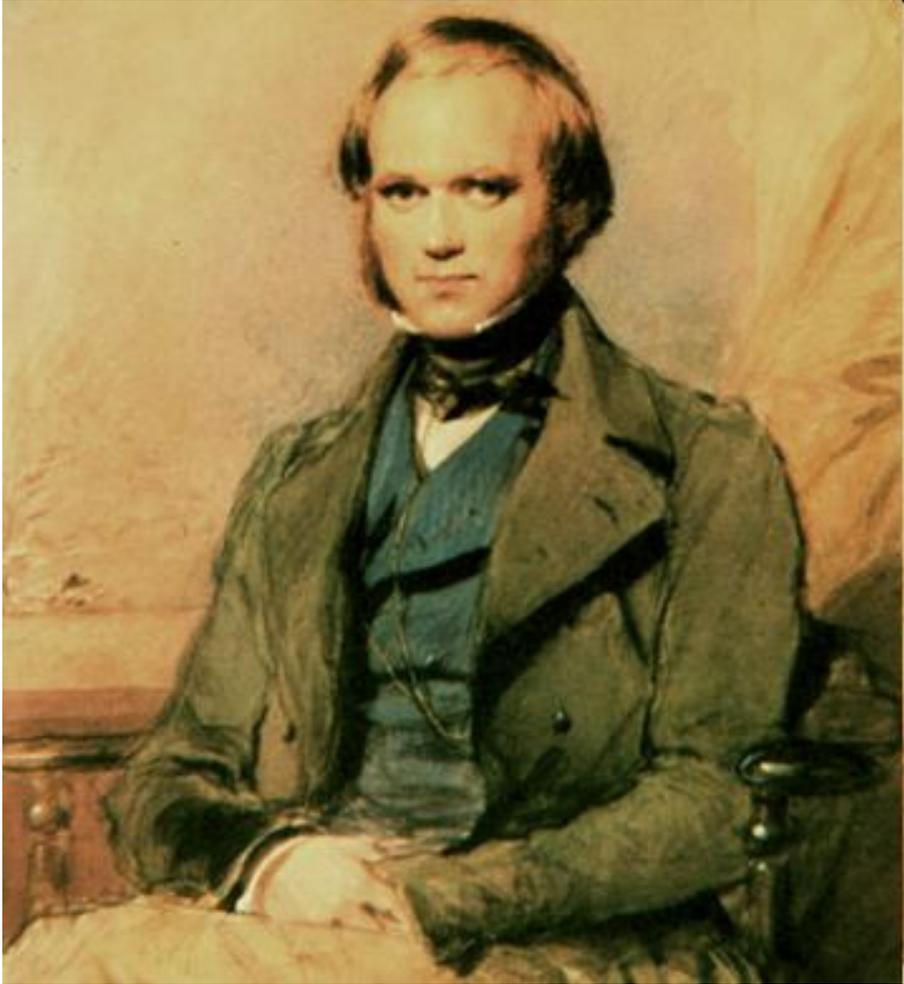
Fig. S5. The impact of human civilization on the biomass of mammals. The biomass of wild mammals, livestock (dominated by cattle) and humans before human civilization and at present. Values are based on estimates presented in detail in the relevant sections for humans and livestock, wild mammals and pre-human biomass.

2. Origine des mécanismes adaptatifs complexes

Créationnisme



Evolutionnisme



Charles Darwin

Sélection
naturelle

Sélection
sexuelle

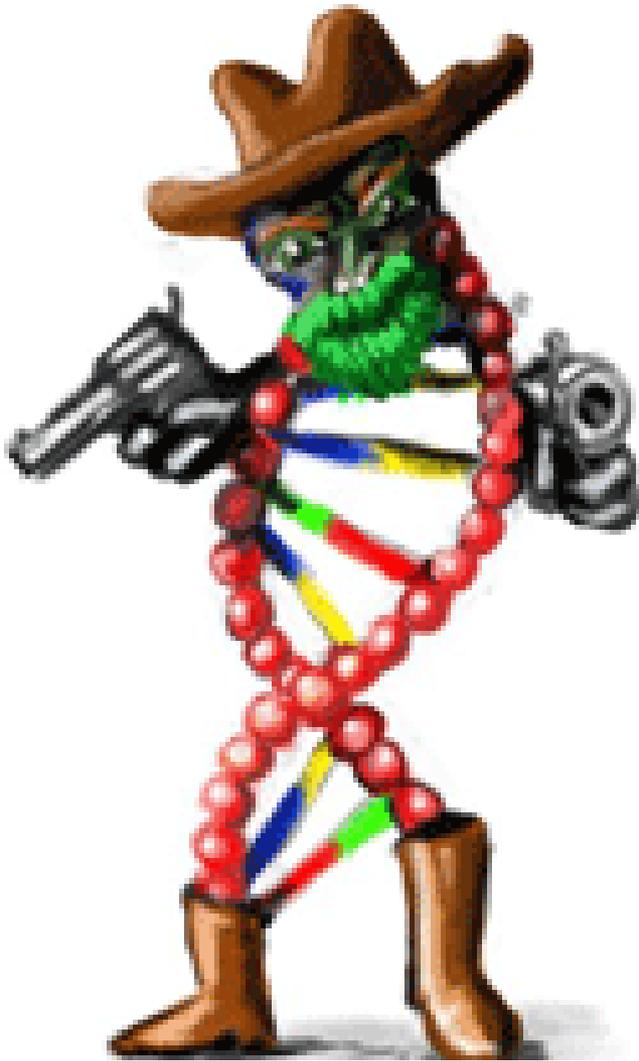
Adaptation à la survie...

des gènes

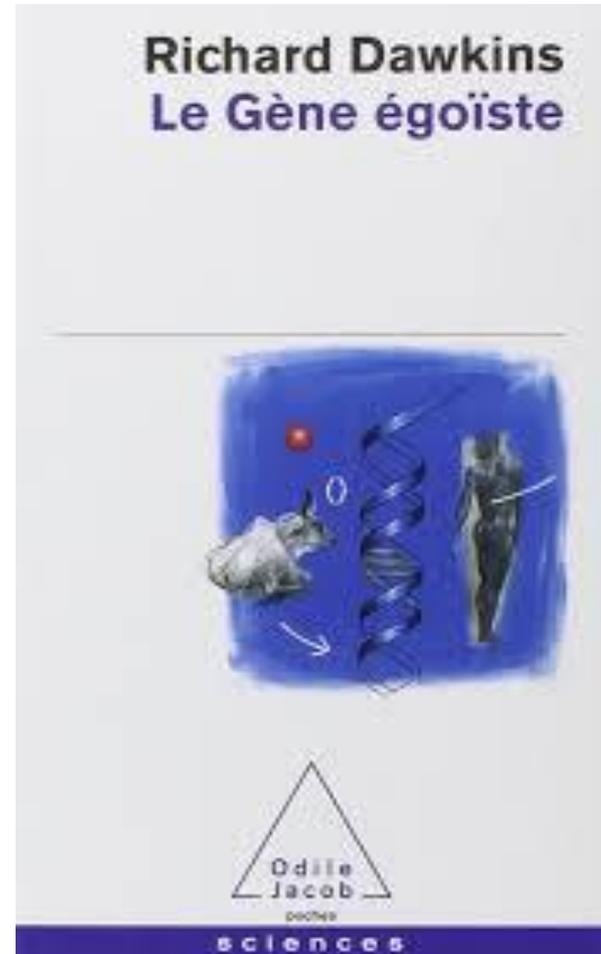
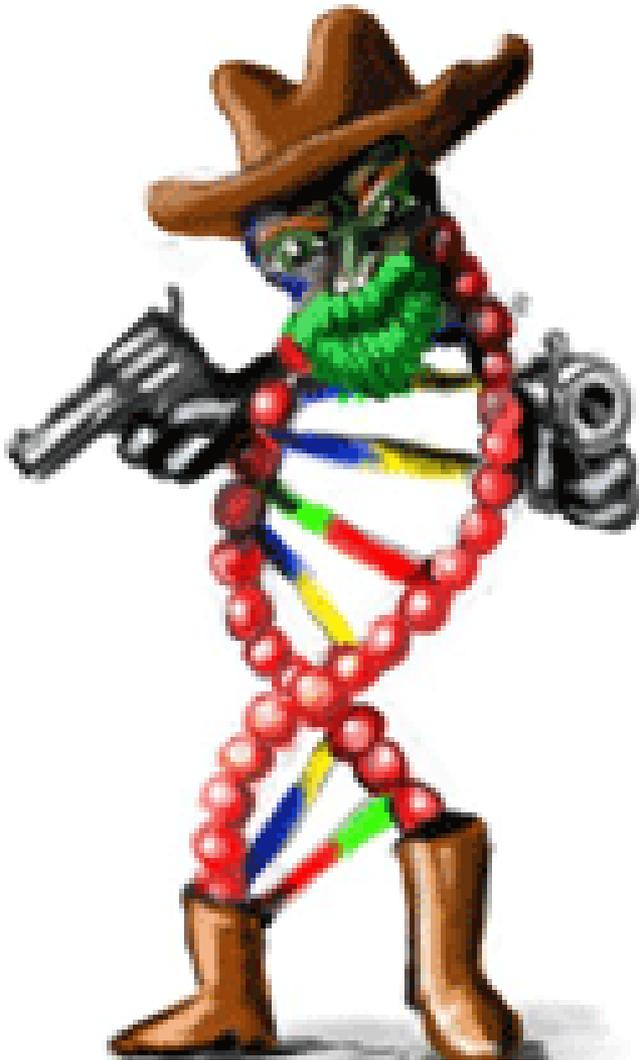


Survival of the fittest
Survie des plus aptes

« Gène égoïste »



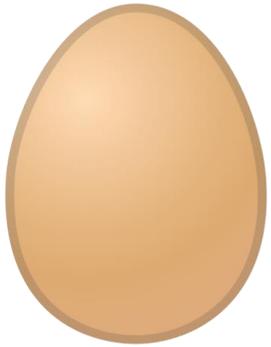
« Gène égoïste »

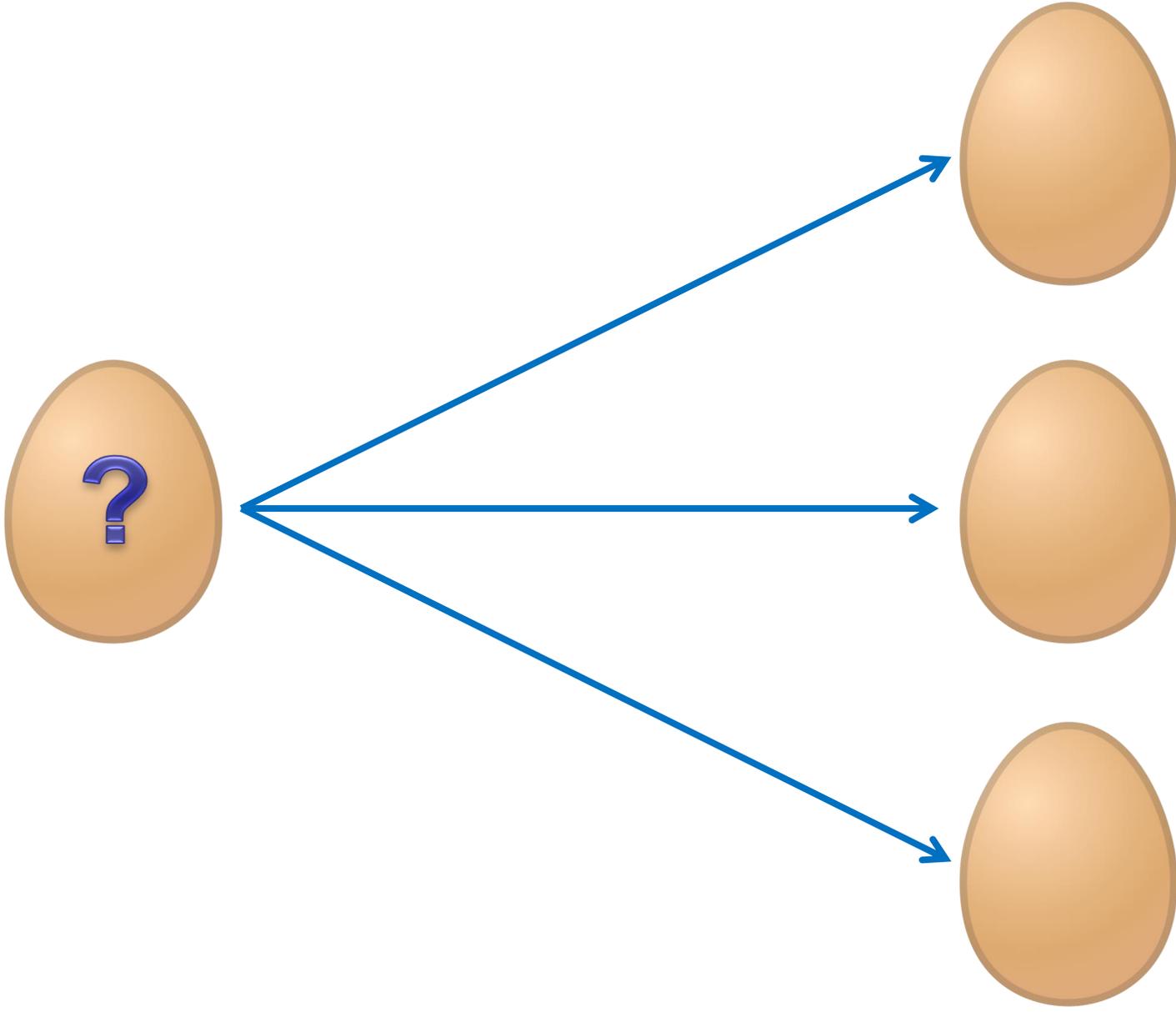


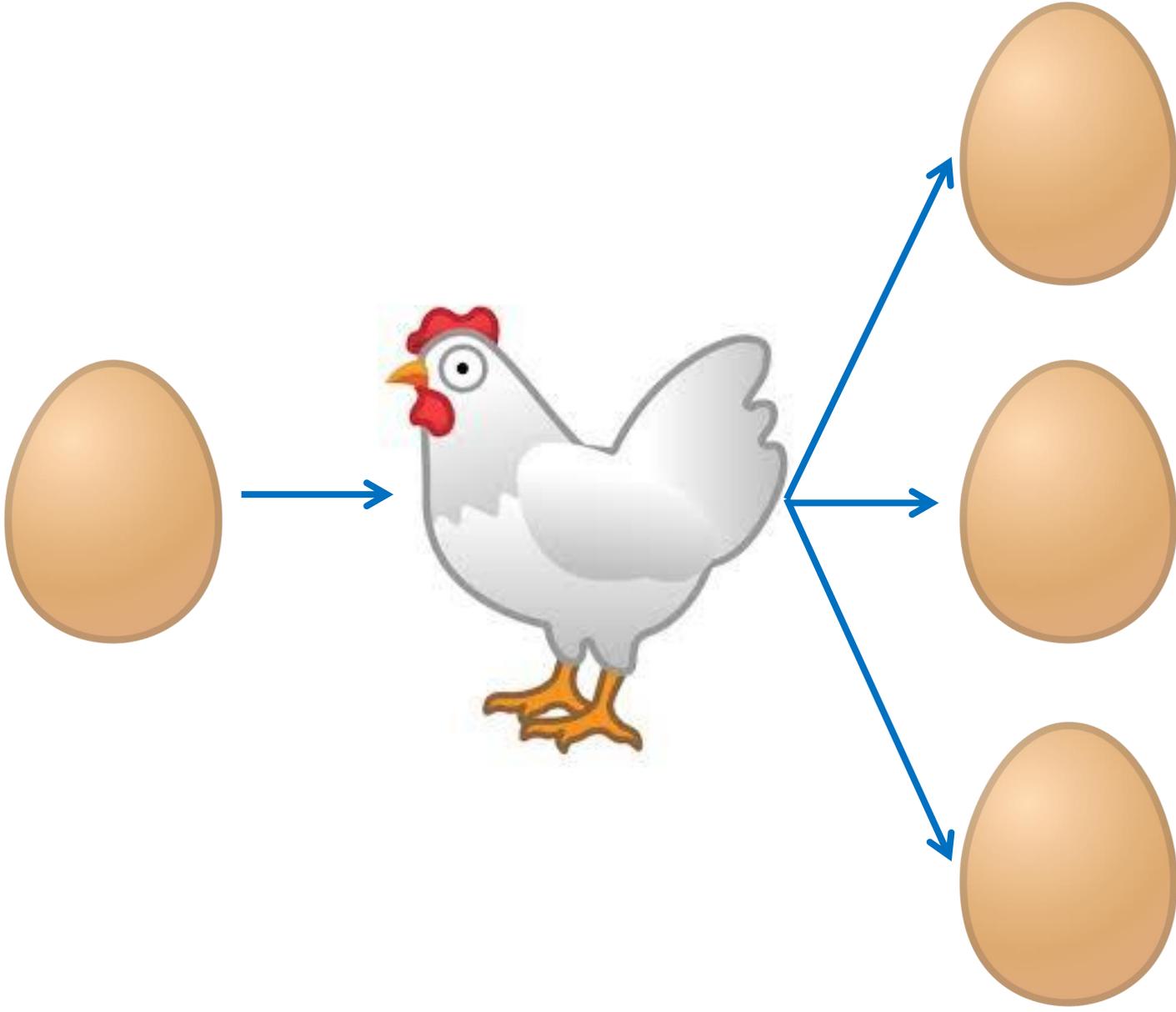
Théorie du gène égoïste

Le gène comme unité de sélection
(réplicateur)

Organisme comme véhicule

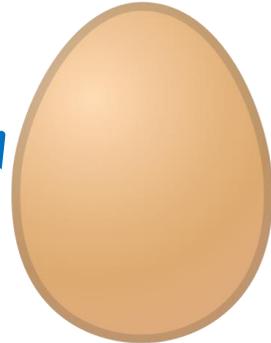
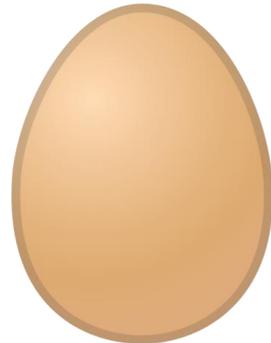
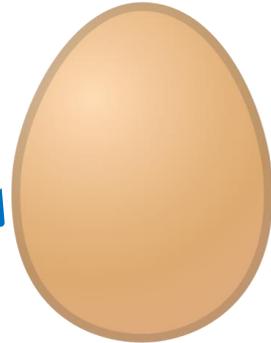
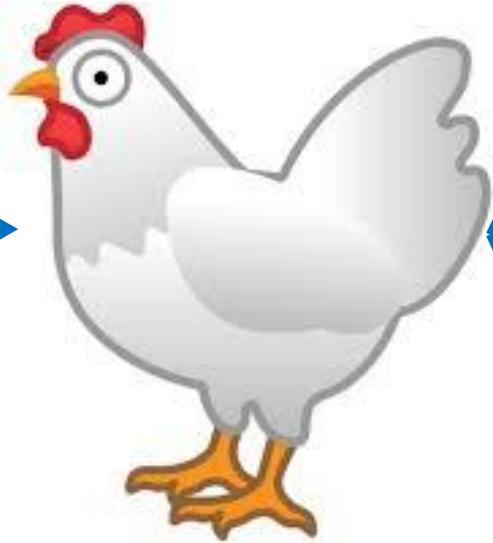
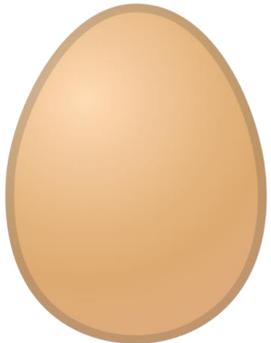


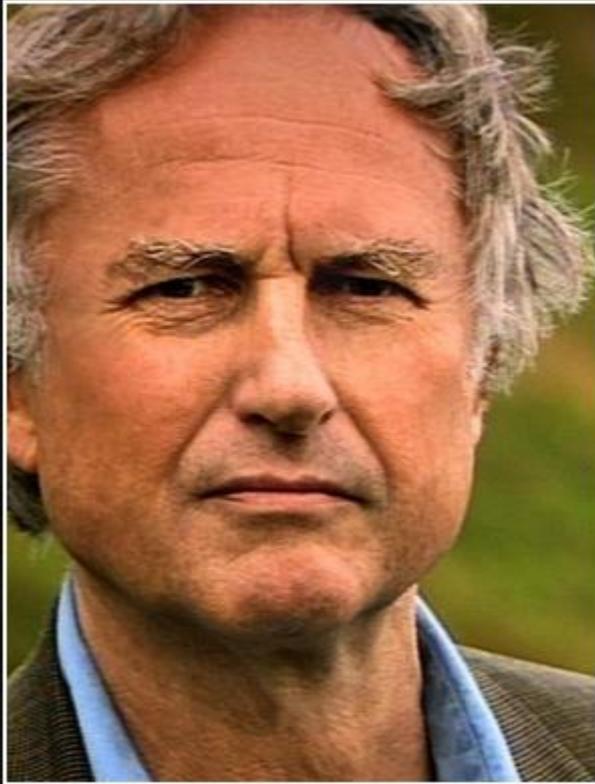




Réplicateur

Véhicule

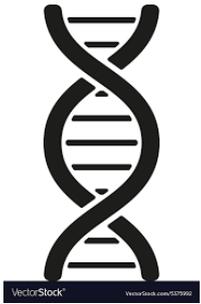




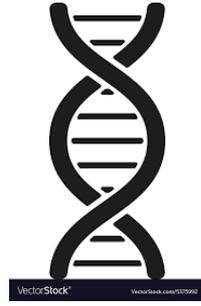
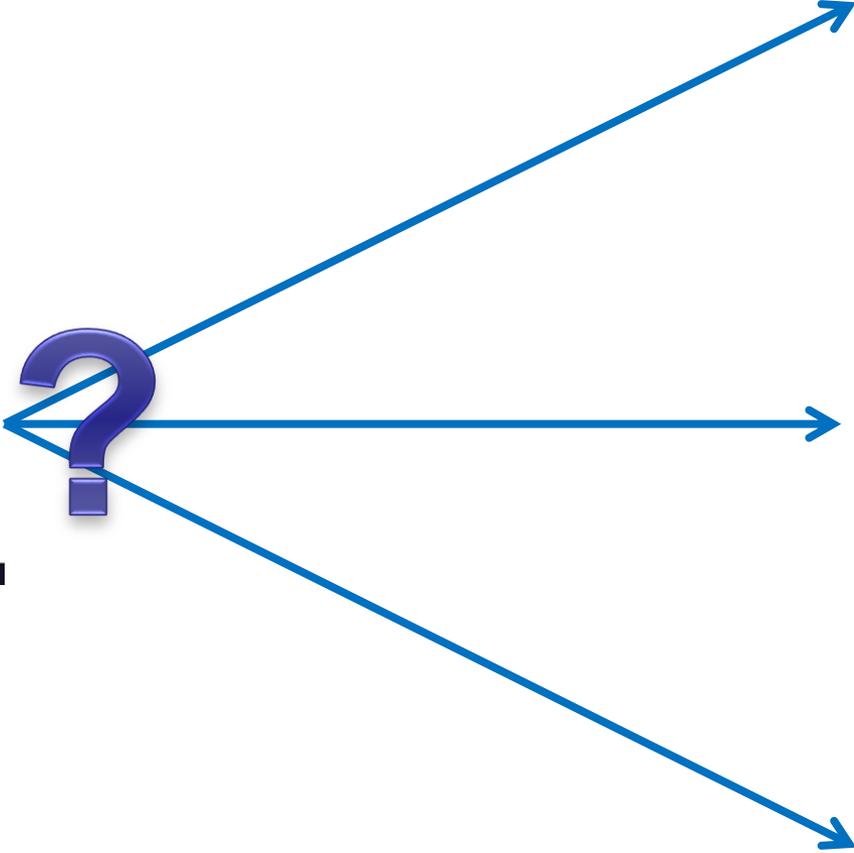
The chicken is only an egg's way for
making another egg.

— *Richard Dawkins* —

AZ QUOTES

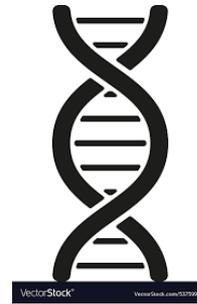
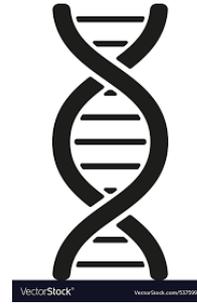
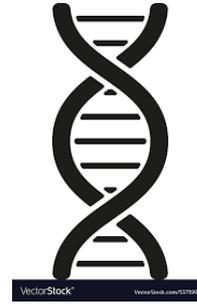
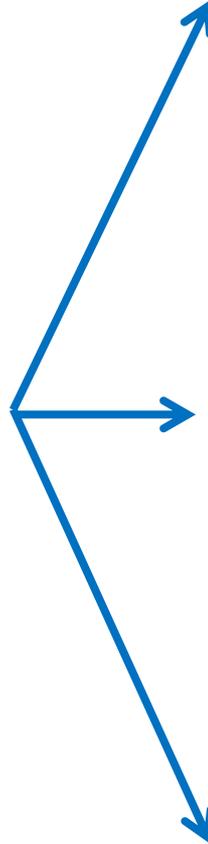


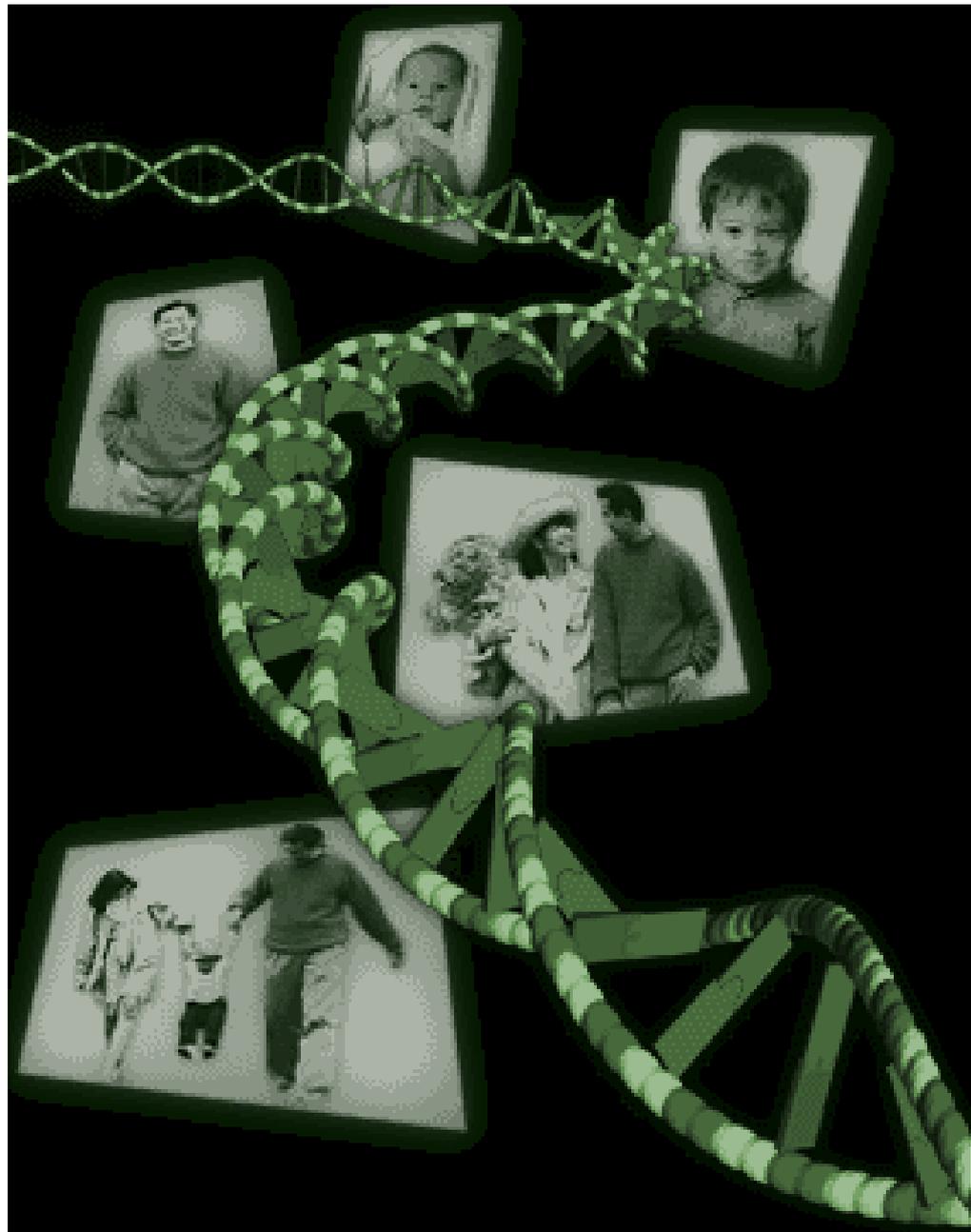
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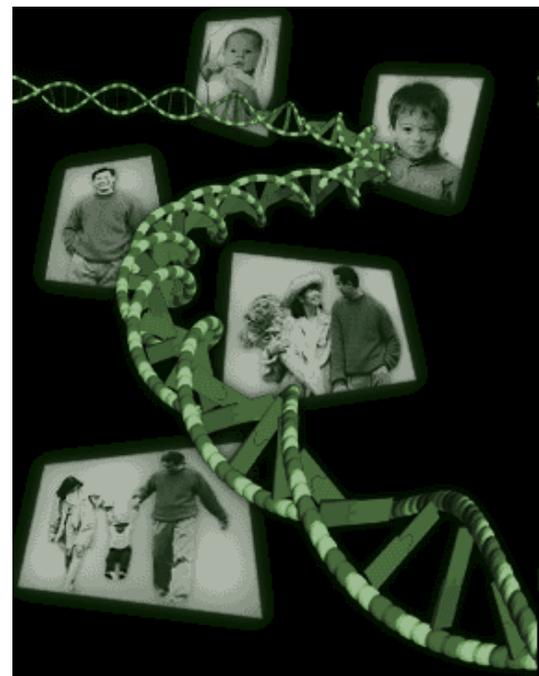
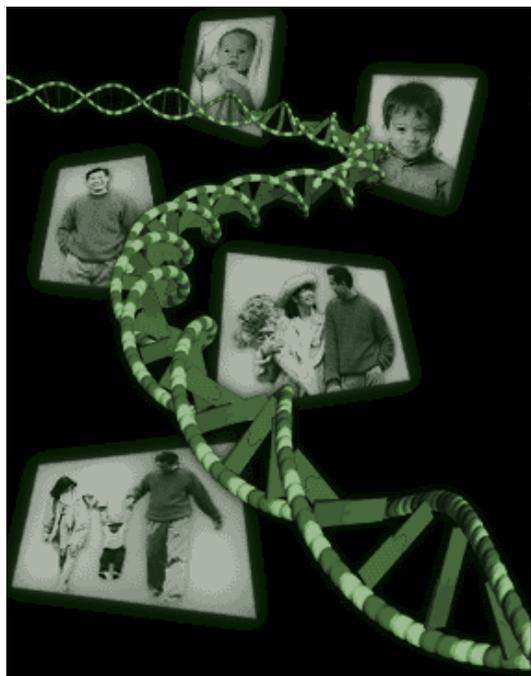
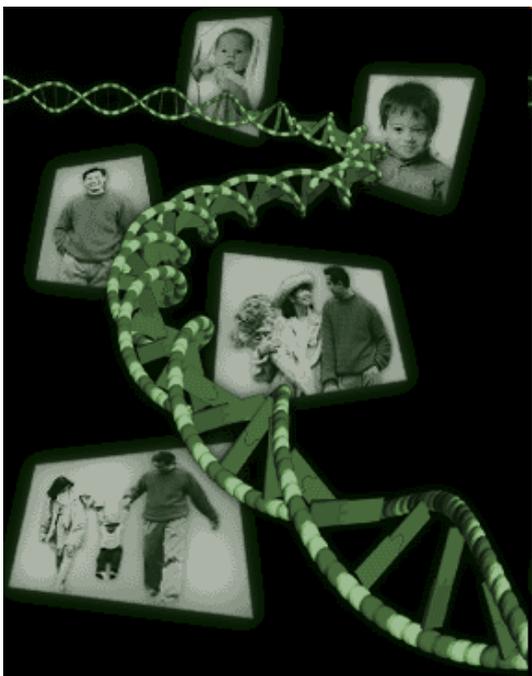
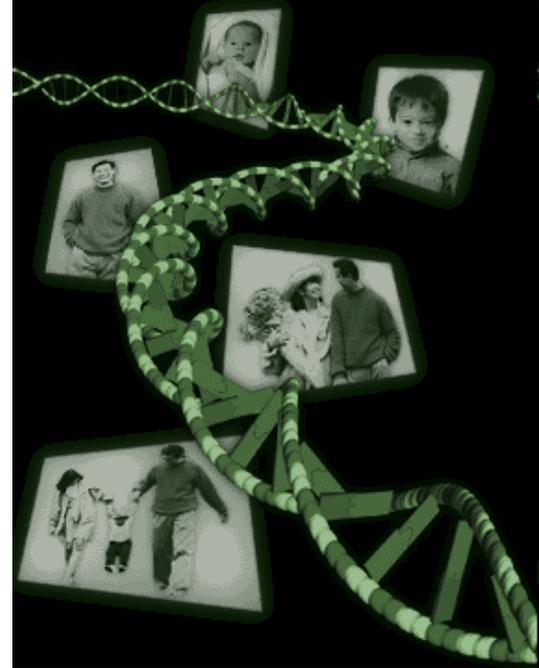
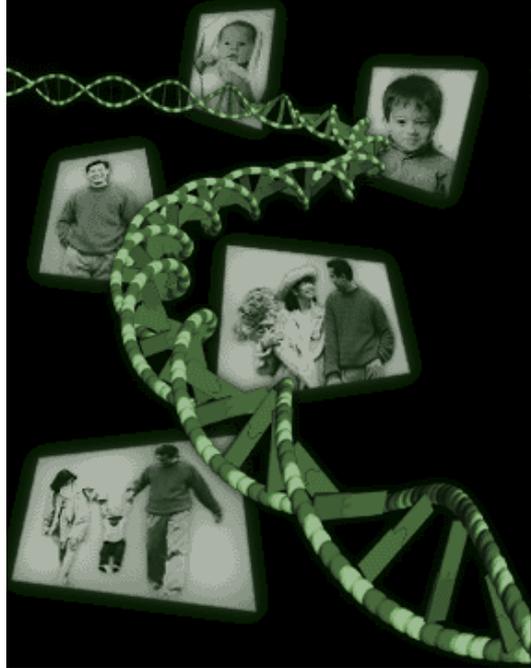
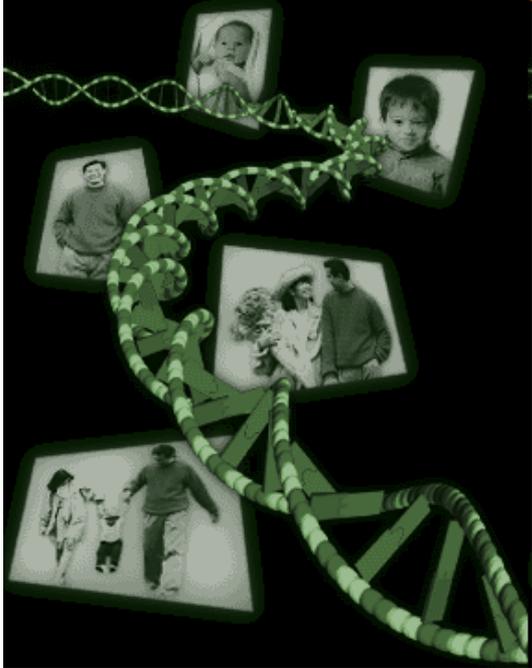


Réplicateur

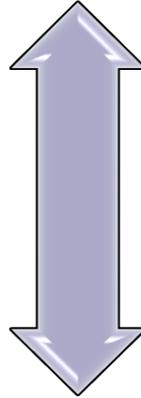
Véhicule



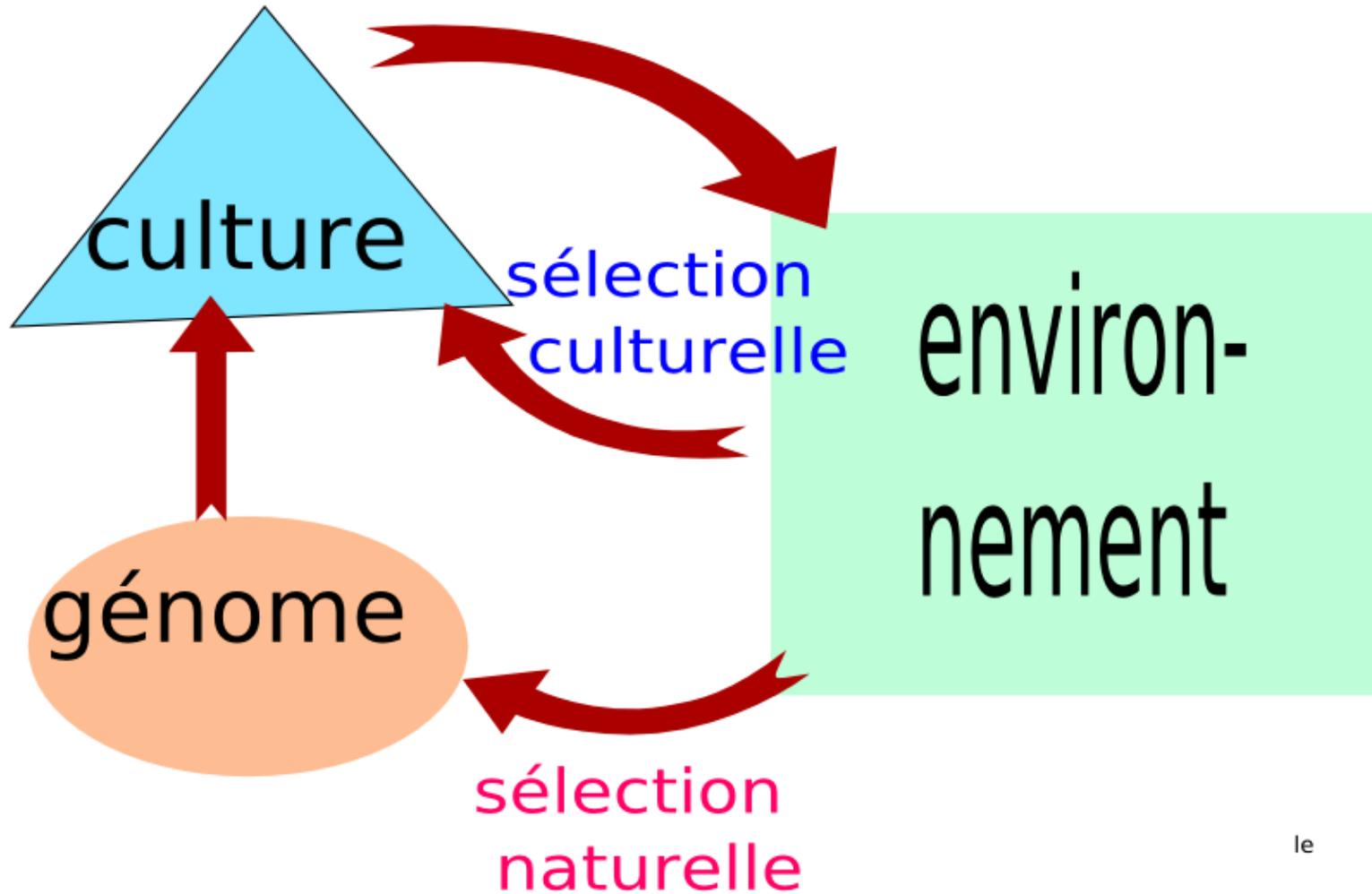




Gènes



Environnement



le

3. Perspective évolutionniste



Pourquoi le Titanic a t-il fait naufrage ?



Pourquoi le Titanic a t-il fait naufrage ?

Cause proximale

immédiate
apparente

- coque percée
- heurt iceberg

Cause ultime

distale
réelle

- heurt iceberg
- Gouvernail trop petit
- capitaine imprudent
- ...

Pourquoi les hommes sont-ils plus grands que les femmes ?



Pourquoi les hommes sont-ils plus grands que les femmes ?

Cause proximale

immédiate
apparente

- os plus longs

Cause ultime

distale
réelle

- sélection sexuelle

Evidence for Genetic Variation in Human Mate Preferences for Sexually Dimorphic Physical Traits

Karin J. H. Verweij^{1,2*}, Andrea V. Burri³, Brendan P. Zietsch^{1,2*}

Table 1. Frequencies for dichotomous mate preferences for morphological traits.

		Proportion preferring each trait	
		Women	Men
Height	Tall	0.90	0.53
	Short ^a	0.10	0.47
Skin colour	Fair skin ^{a,b}	0.90	0.39
	Olive skin	0.10	0.61
Hair colour	Blond hair ^a	0.21	0.39
	Brown hair	0.79	0.61
Hair length	Short ^{a,b}	0.55	0.63
	Long	0.45	0.37
Chest hair	Hairy chest	0.40	–
	Smooth chest ^a	0.60	–
Facial hair	Beard/moustache ^a	0.13	–
	Clean-shaven	0.87	–
Breast size	Large breasts	–	0.57
	Small breasts	–	0.43

Superscript 'a' ('b') indicates older women (men) were significantly (i.e. $p < .05$) more likely to prefer this trait than younger women (men).

doi:10.1371/journal.pone.0049294.t001

Evidence for Genetic Variation in Human Mate Preferences for Sexually Dimorphic Physical Traits

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	Short ^a	0.10	0.47
Skin colour	Fair skin ^{a,b}	0.90	0.39

Table 3. Estimates (and 95% confidence intervals) of the proportion of variance in mate preferences accounted for by additive genetic (A), nonadditive genetic (D), family environmental (C), and residual (E) influences.

		Height	Skin colour	Hair colour	Hair length	Chest hair	Facial hair	Breast size
Females	A	0.18 (0.00–0.46)	0.00 (0.00–0.33)	0.00 (0.00–0.24)	0.24 (0.00–0.54)	0.06 (0.00–0.38)	0.06 (0.00–0.47)	–
	D	0.13 (0.00–0.48)	–	0.25 (0.00–0.38)	0.24 (0.00–0.57)	–	0.32 (0.00–0.53)	–
	A+D	0.31 (0.14–0.48)	0.00 (0.00–0.33)	0.25 (0.11–0.38)	0.48 (0.38–0.58)	0.06 (0.00–0.38)	0.38 (0.21–0.53)	–
	C	–	0.35 (0.07–0.47)	–	–	0.26 (0.00–0.37)	–	–
	E	0.69 (0.52–0.86)	0.65 (0.52–0.79)	0.75 (0.62–0.89)	0.52 (0.42–0.62)	0.68 (0.57–0.78)	0.62 (0.47–0.79)	–
Males	A	0.53 (0.00–0.78)	0.00 (0.00–0.49)	0.00 (0.00–0.29)	0.00 (0.00–0.50)	–	–	0.00 (0.00–0.70)
	D	0.04 (0.00–0.78)	0.28 (0.00–0.59)	–	–	–	–	–
	A+D	0.57 (0.29–0.79)	0.28 (0.00–0.59)	0.00 (0.00–0.29)	0.00 (0.00–0.50)	–	–	0.00 (0.00–0.70)
	C	–	–	0.00 (0.00–0.23)	0.20 (0.00–0.45)	–	–	0.50 (0.00–0.69)
	E	0.43 (0.21–0.71)	0.72 (0.41–1.00)	1.00 (0.71–1.00)	0.80 (0.50–1.00)	–	–	0.50 (0.27–0.73)



4. Inadéquation évolutive



MISMATCH PODIUM

Environnement évolutif Pleistocène : 2,5Ma-11Ka



Environnement évolutif

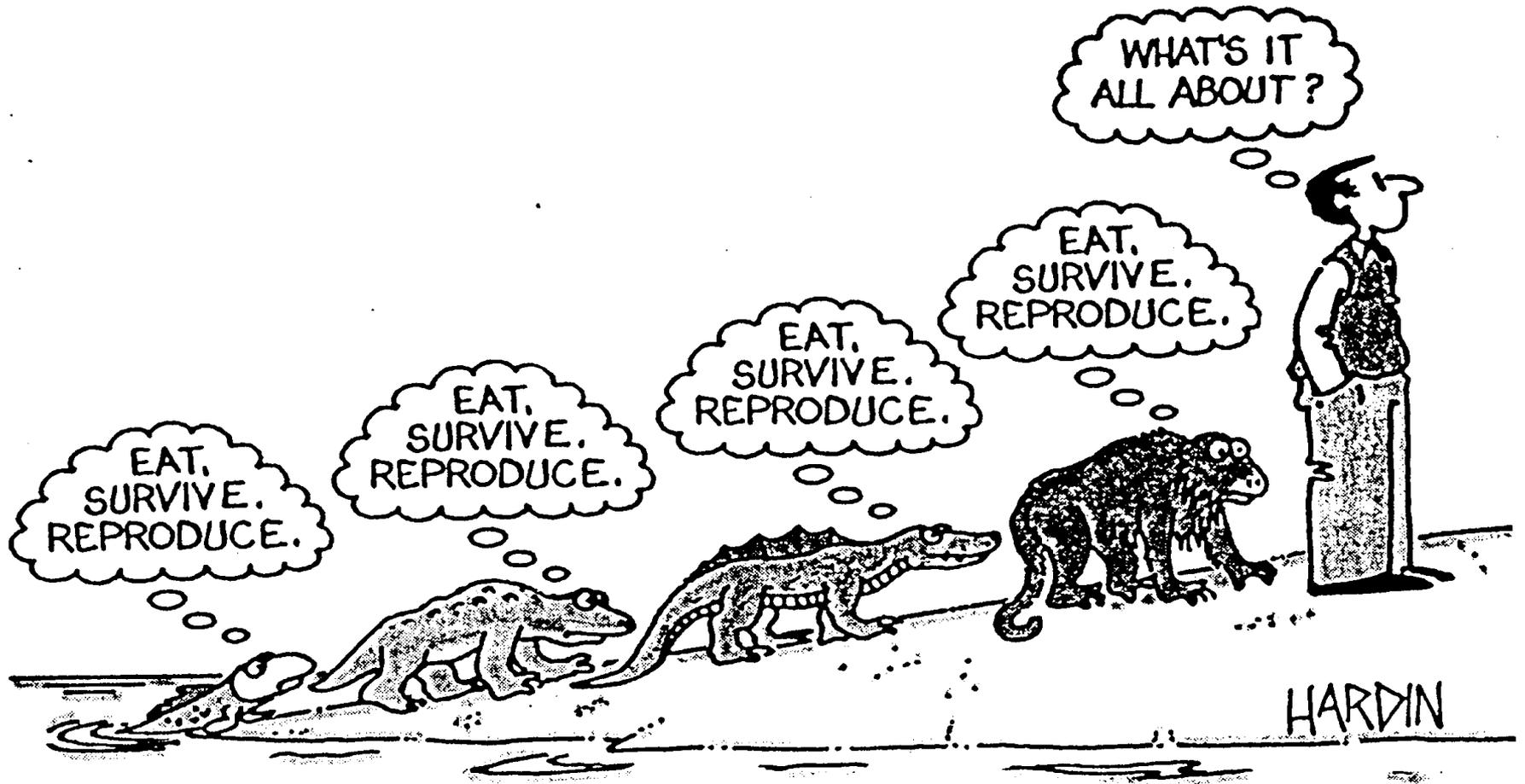
Pleistocène : 2,5Ma-11Ka



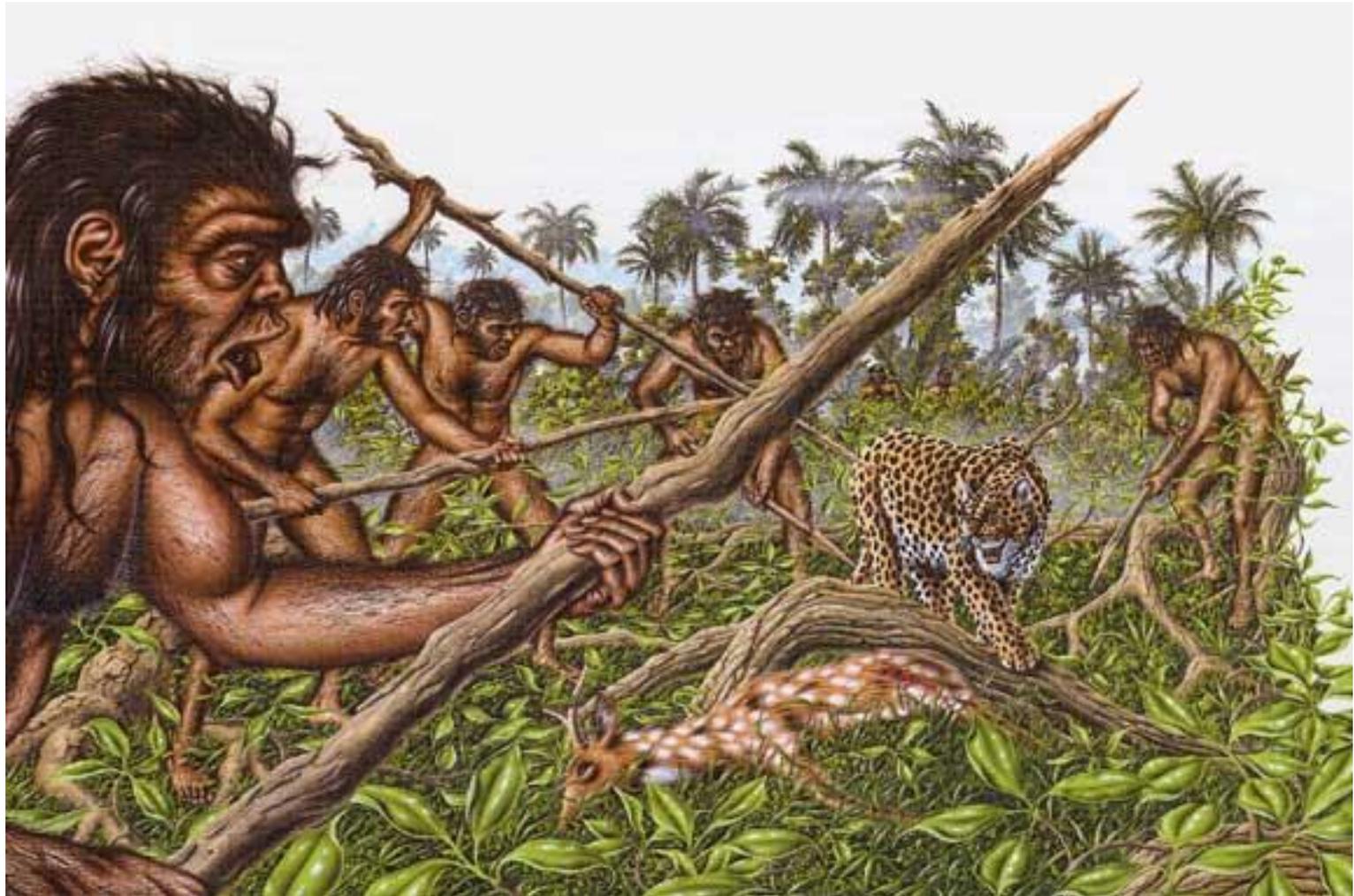
Mismatch



Environnement évolutif pré-humain







Inadéquation évolutive





Inadéquation évolutive

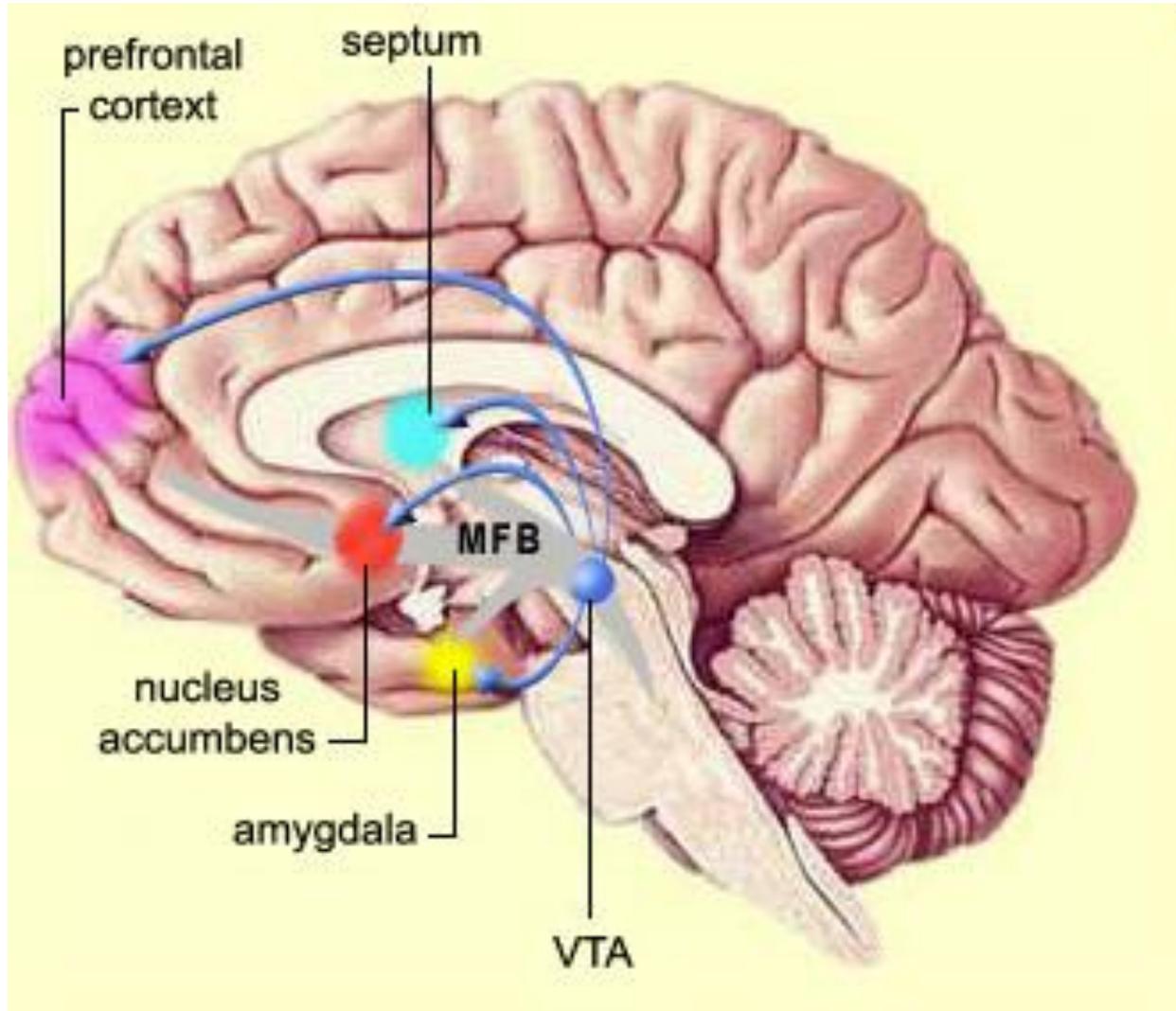


5. Pourquoi fume t-on ?



Pour le
plaisir

Centre du plaisir



Le plaisir

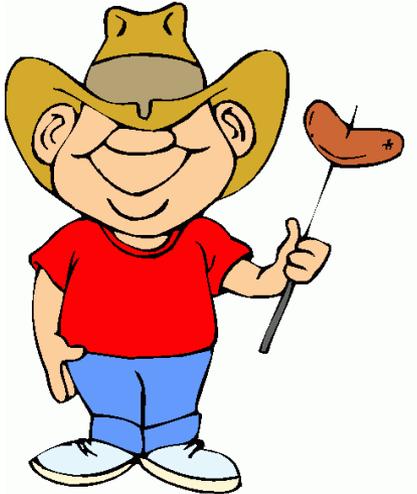
Explication proximale

- Recherche de bien-être
- Recherche de bonheur

Explication ultime

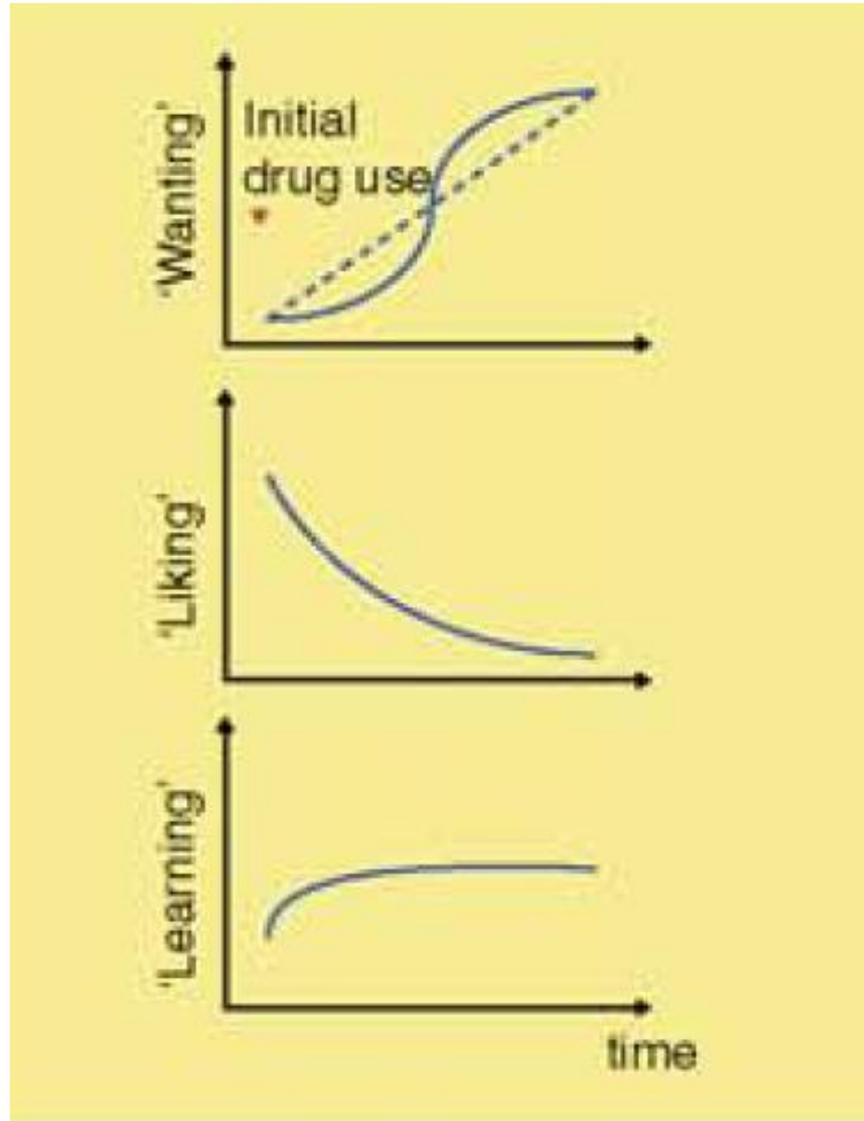
- Renforcement
- Apprentissage
- Survie du matériel génétique

Les comportements à forte valeur adaptative

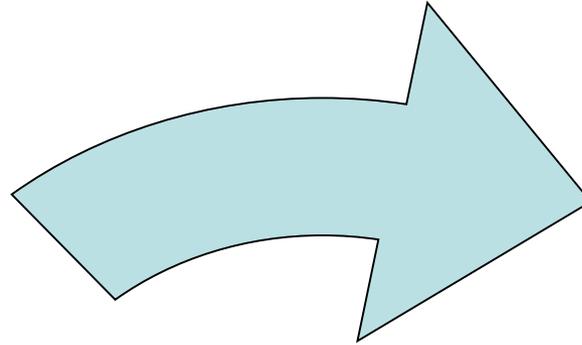


Les 3 composantes du renforcement

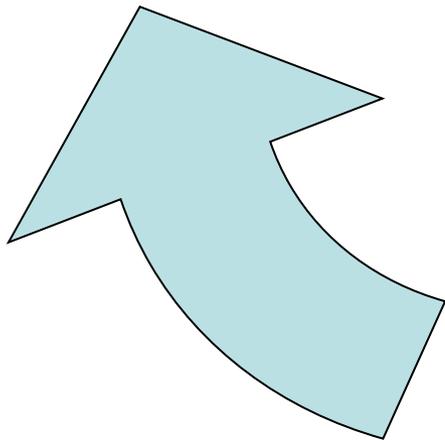
- « liking »
 - Plaisir (impact hédonique)
 - Signale la valeur adaptative du comportement
- « wanting »
 - Saillance de la valeur (incentive salience)
 - Motivation à produire le comportement
- « learning »
 - Associations entre situations et la réponse



Comportement

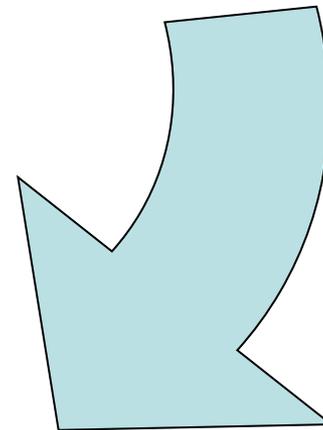


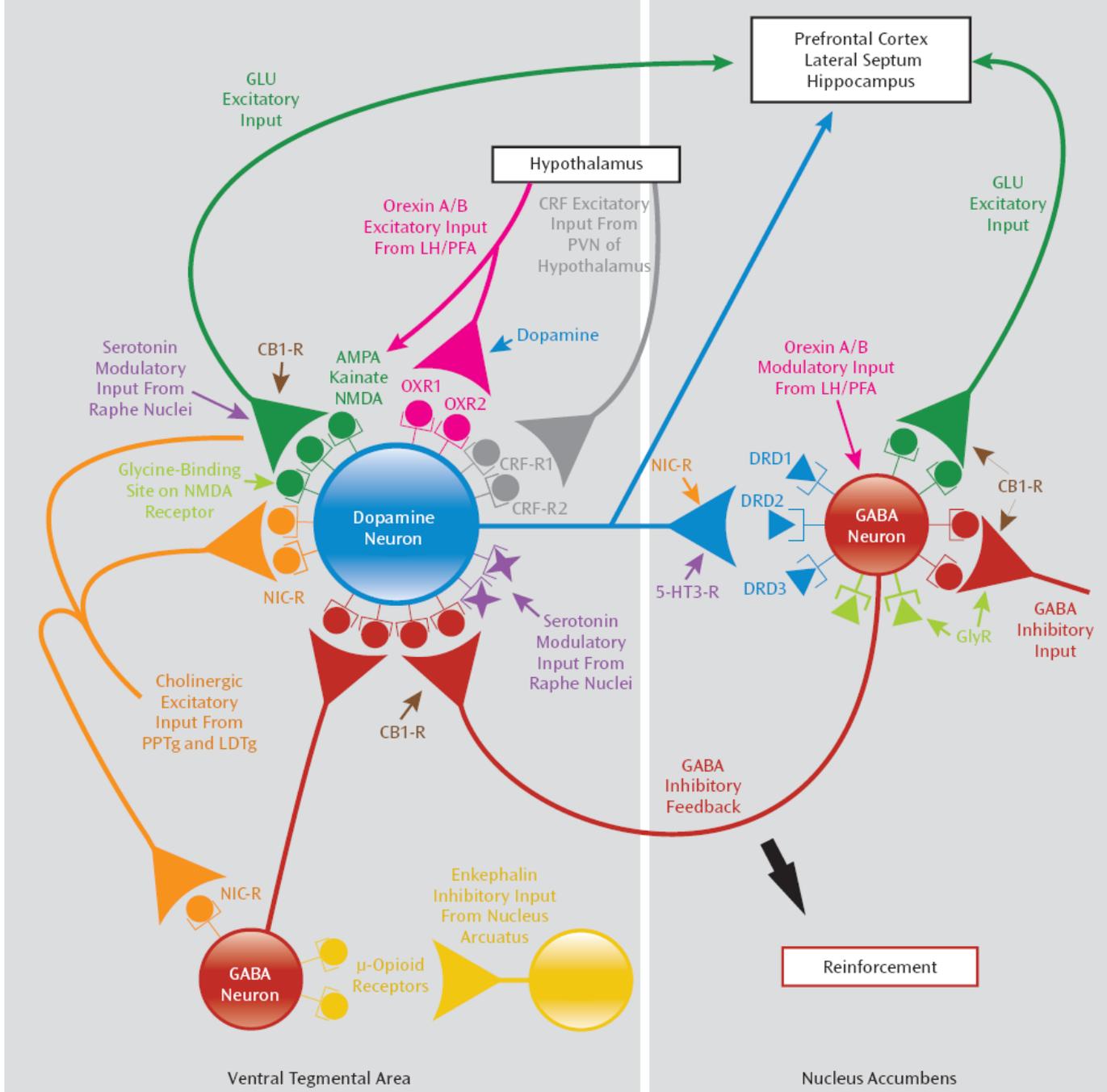
Fitness
Nourriture
Reproduction
Relations sociales
Éducation des enfants



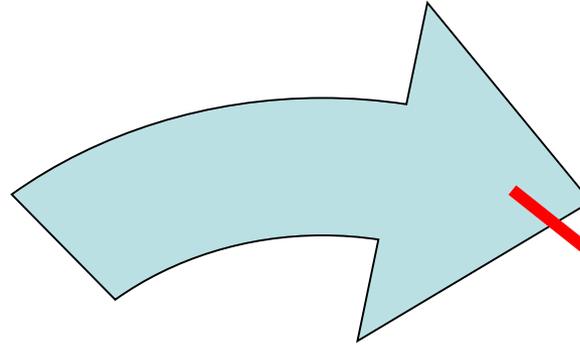
Renforcement

Liking
Wanting
Learning

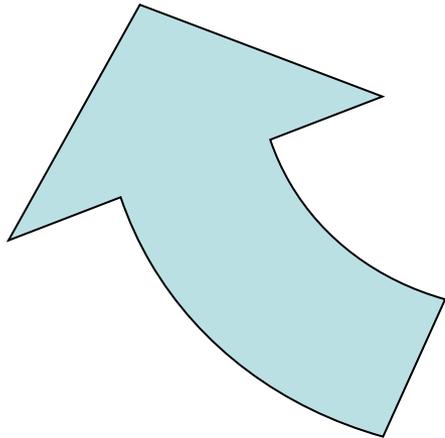




Tabagisme

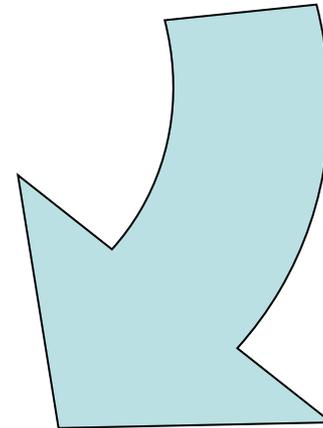


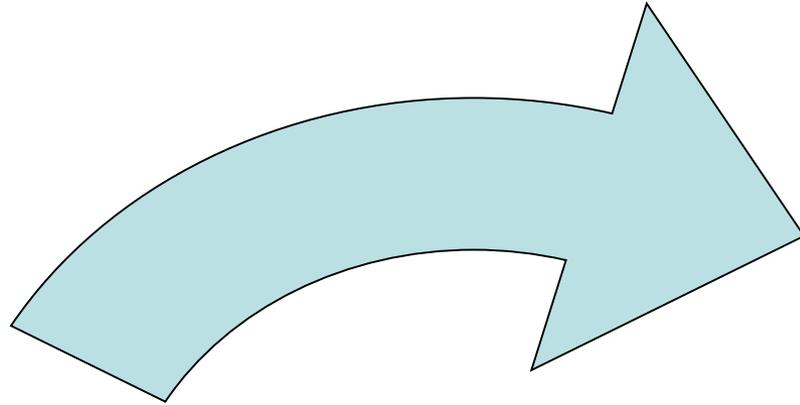
Fitness
Nourriture
Reproduction
Relations sociales
Éducation des enfants



Renforcement

Liking
Wanting
Learning

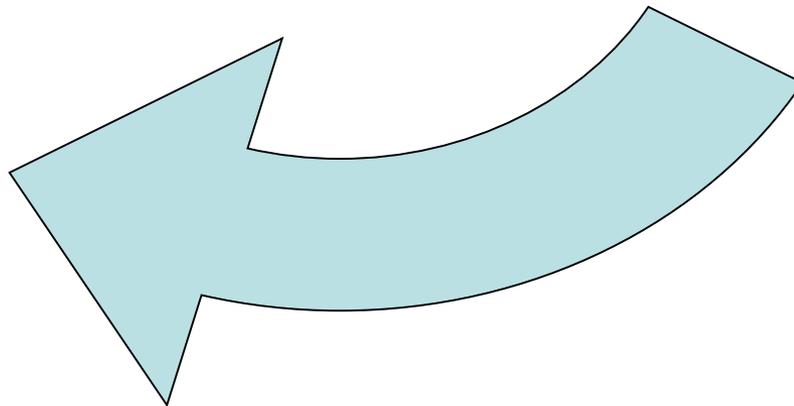




Tabagisme

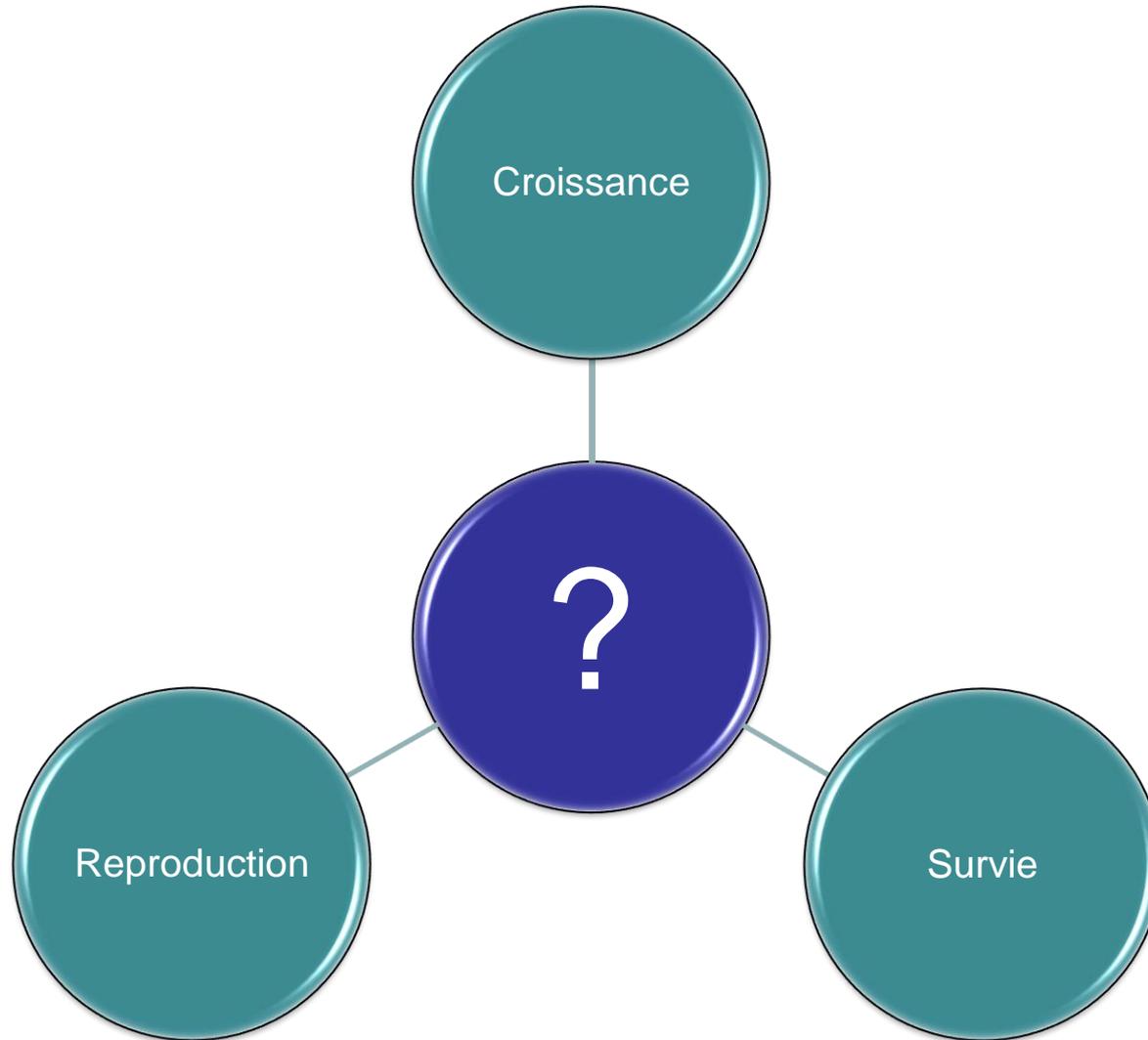
Renforcement

Liking
Wanting
Learning



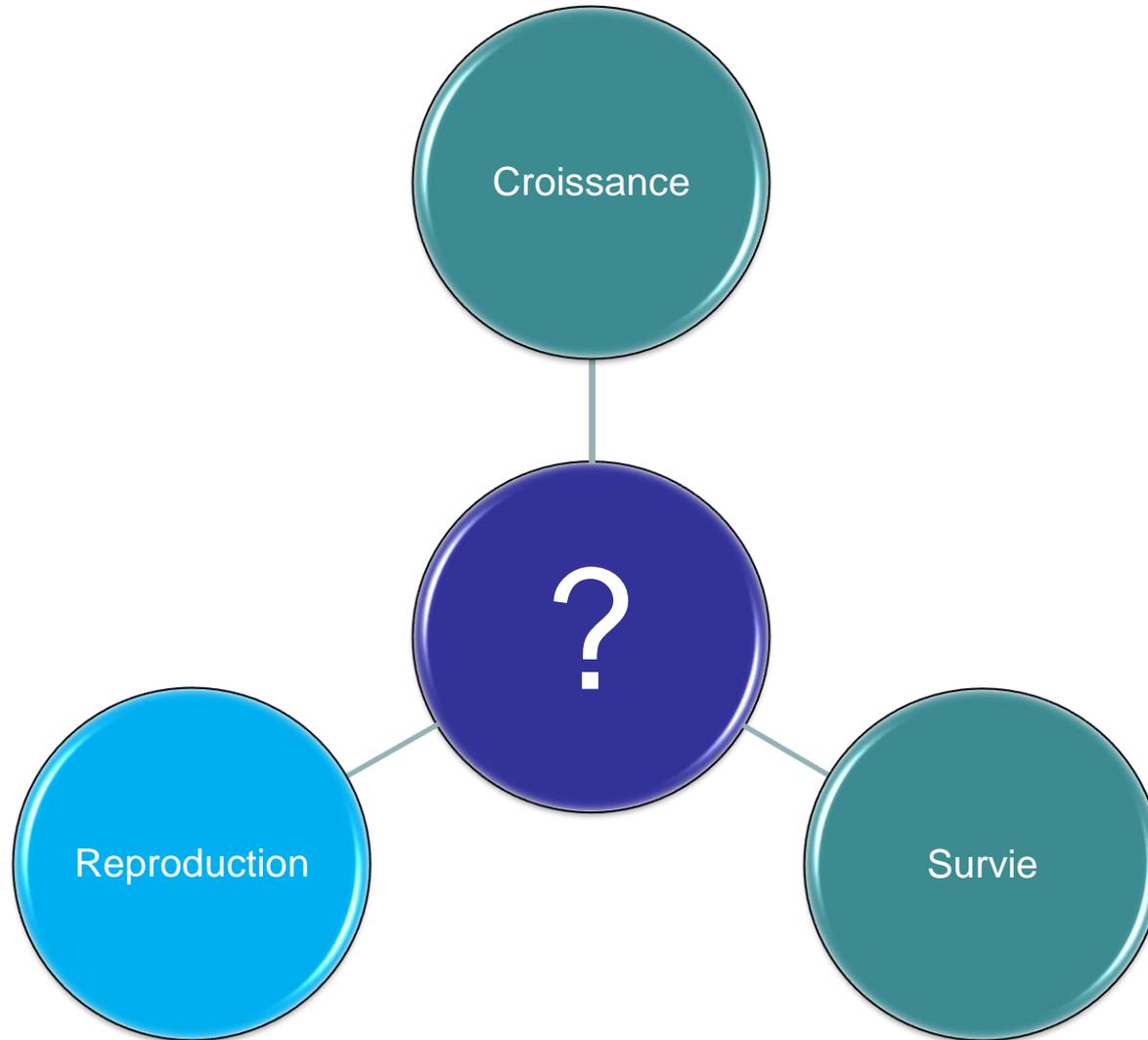
6. Théorie de l'histoire de vie

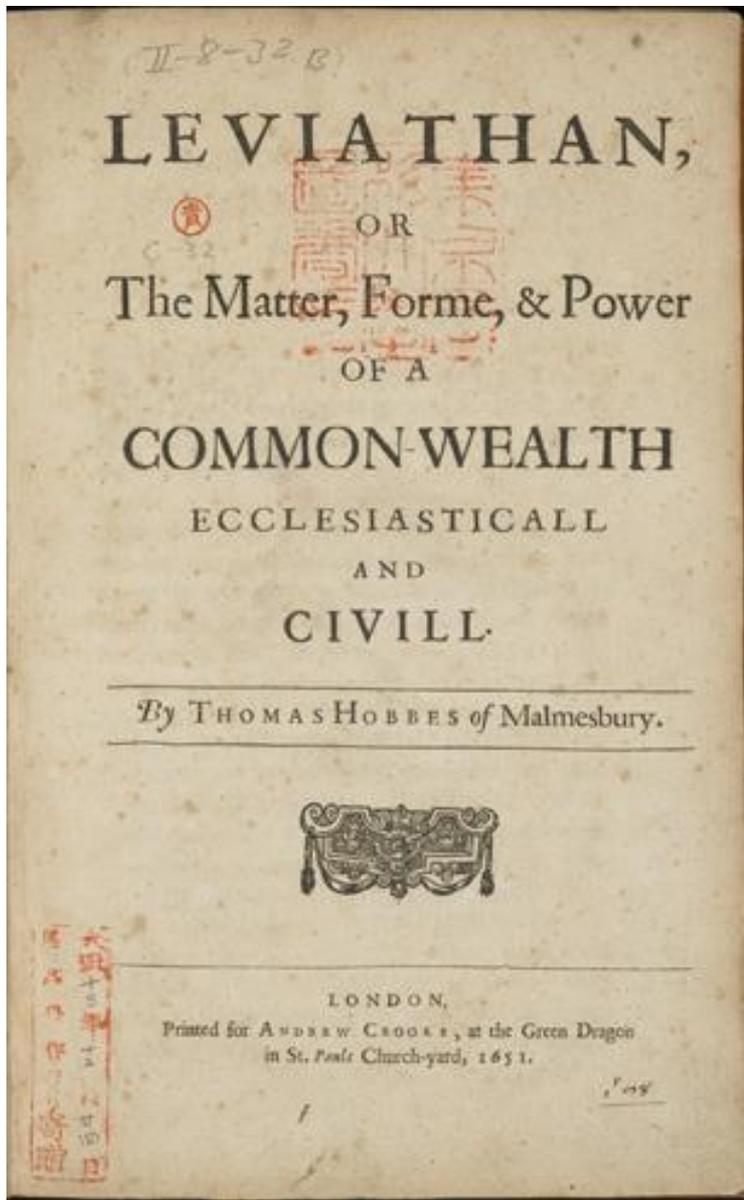
Allocation des ressources



6. Théorie de l'histoire de vie

Enjeux liés à la reproduction





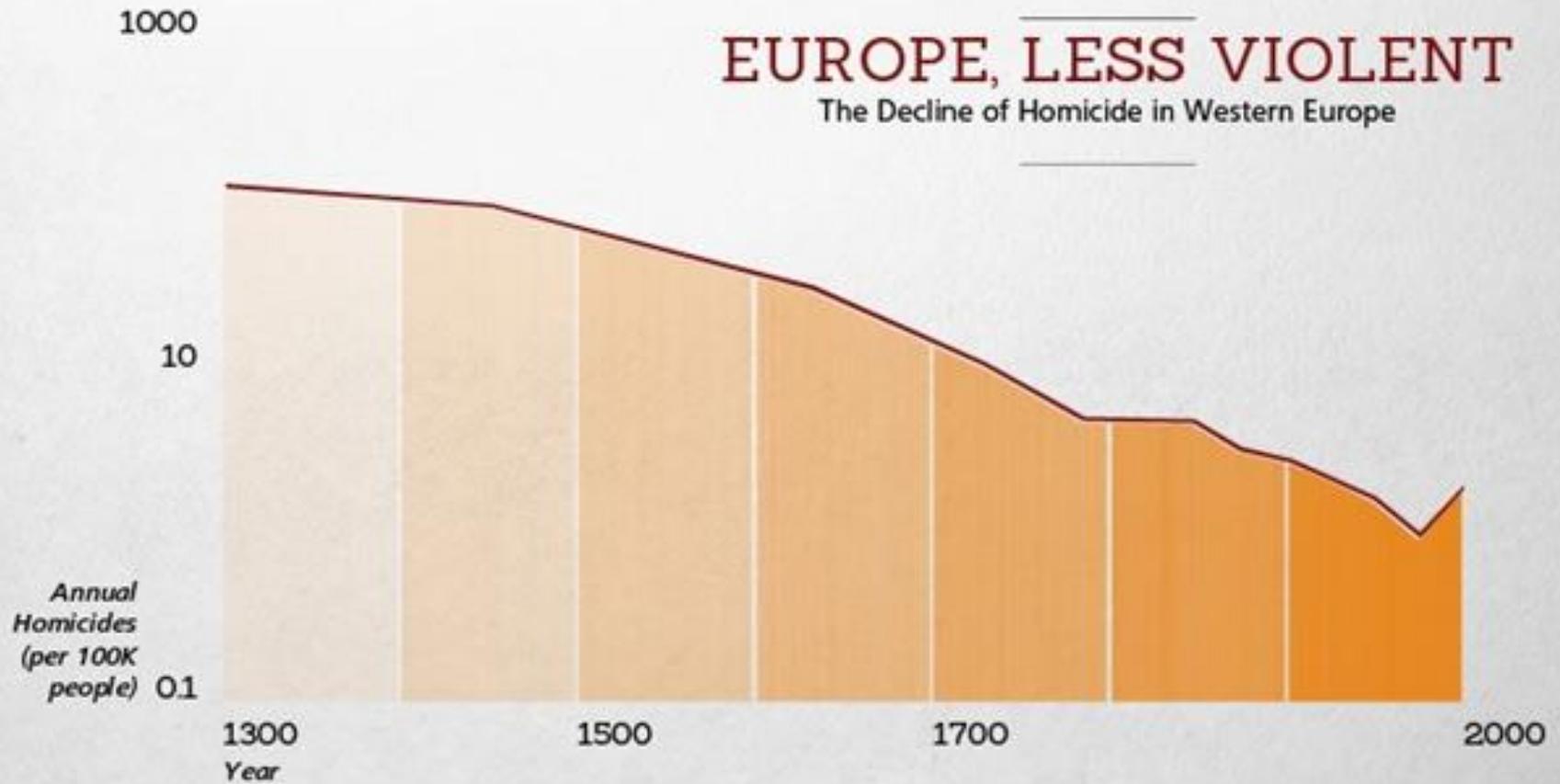
L'homme est un loup pour l'homme
Thomas Hobbes, 1651



L'homme est naturellement bon
Jean-Jacques Rousseau, 1755

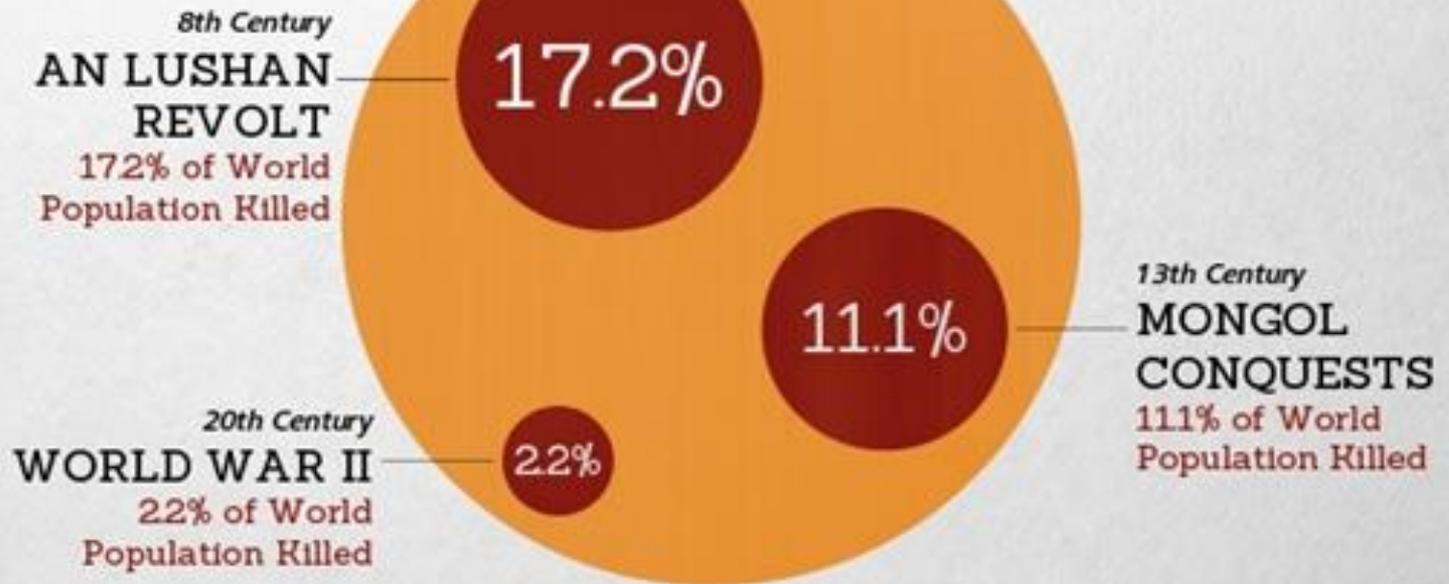
EUROPE, LESS VIOLENT

The Decline of Homicide in Western Europe



MODERN WARFARE

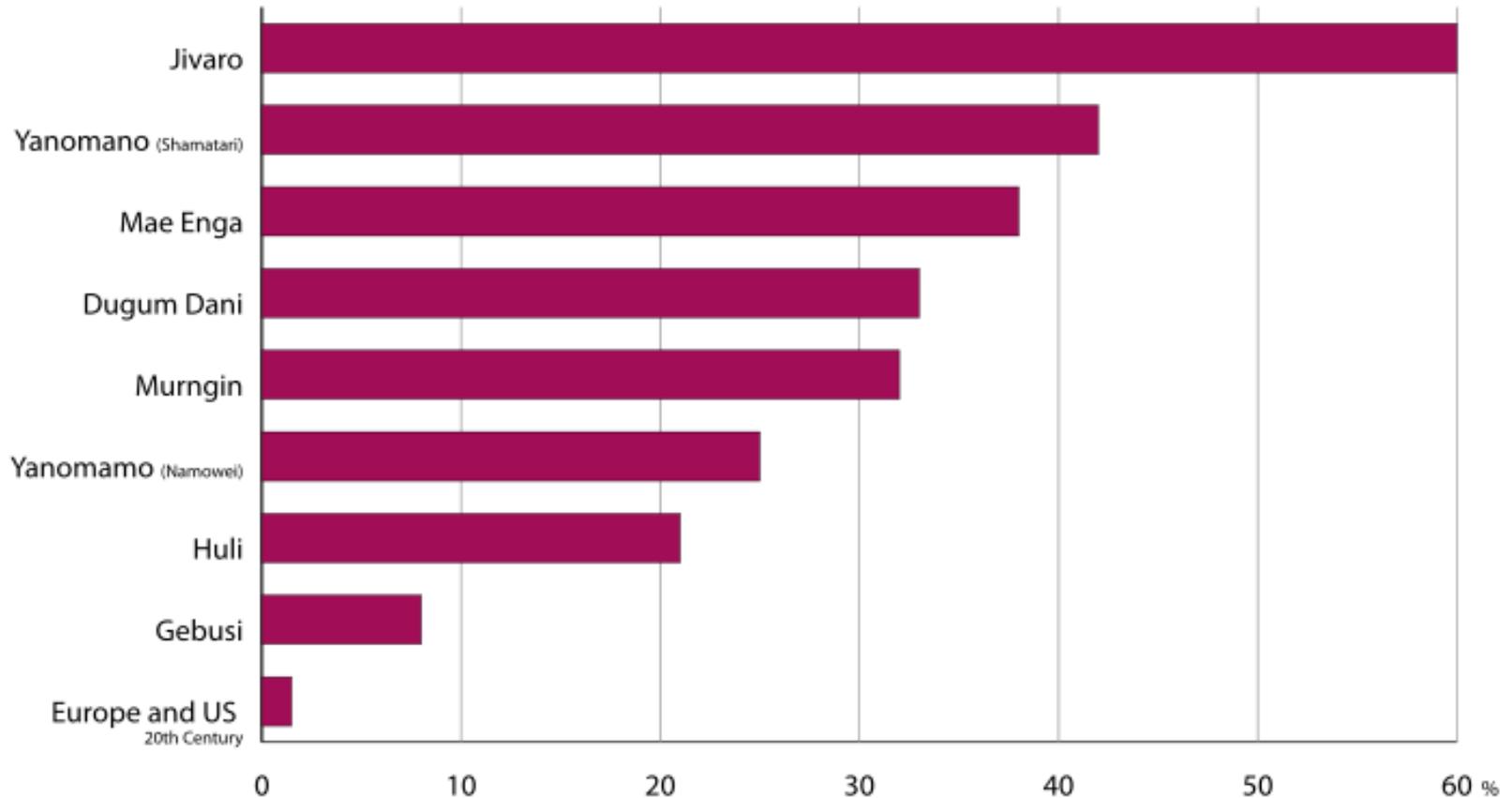
Was WWII Truly the Bloodiest Battle in History?



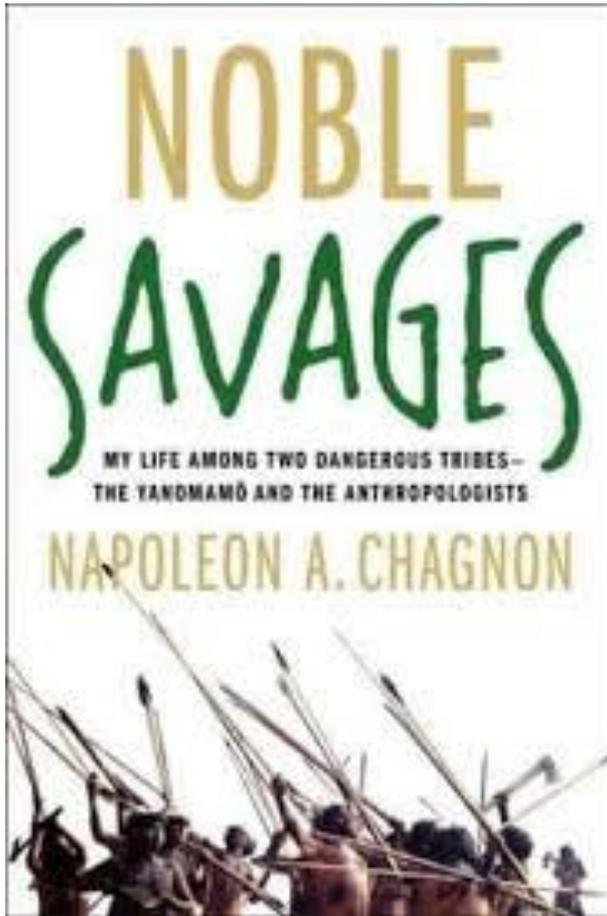
Percentage of male deaths caused by warfare

Sources: Keeley, Lawrence (1996). *War Before Civilization: the Myth of the Peaceful Savage*. New York: Oxford University Press. as referenced in Pinker, Steven (2002). *The Blank Slate*. New York: Penguin.

SOCIETY / TRIBE



Yanomomö



Chagnon NA: Noble Savages: My Life Among Two Dangerous Tribes -- the Yanomamo and the Anthropologists, Simon & Schuster; 2014.

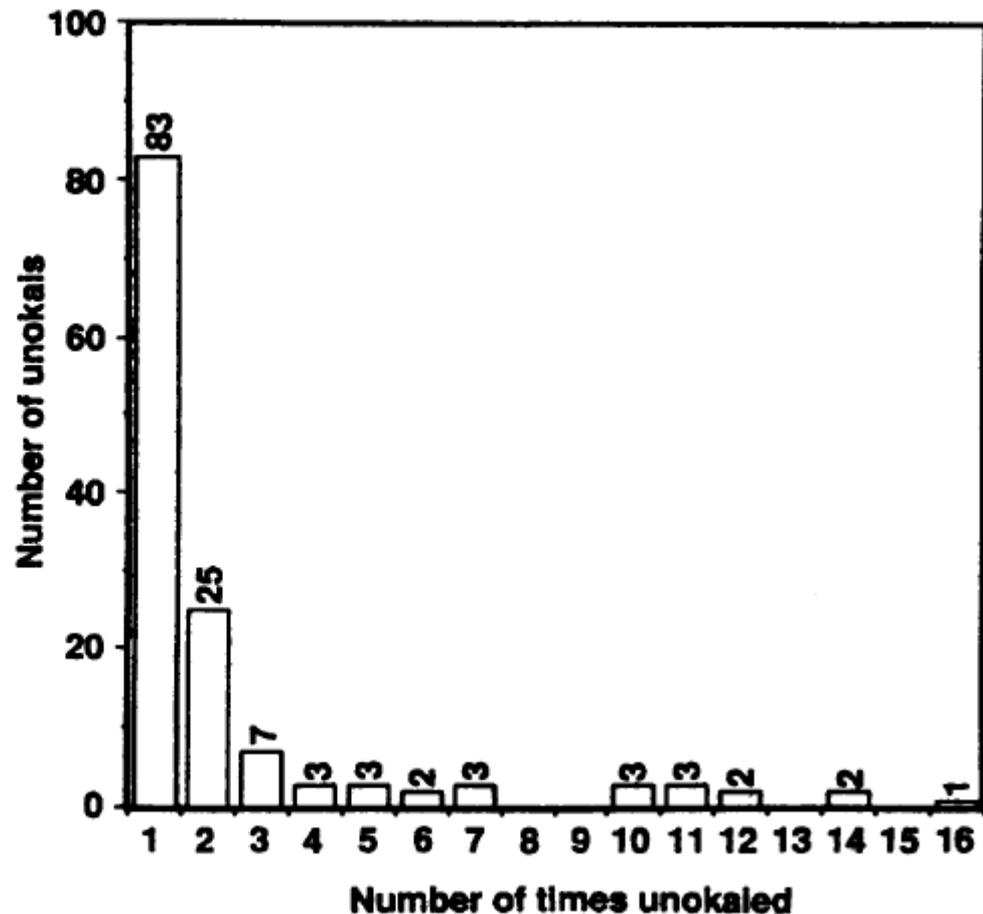






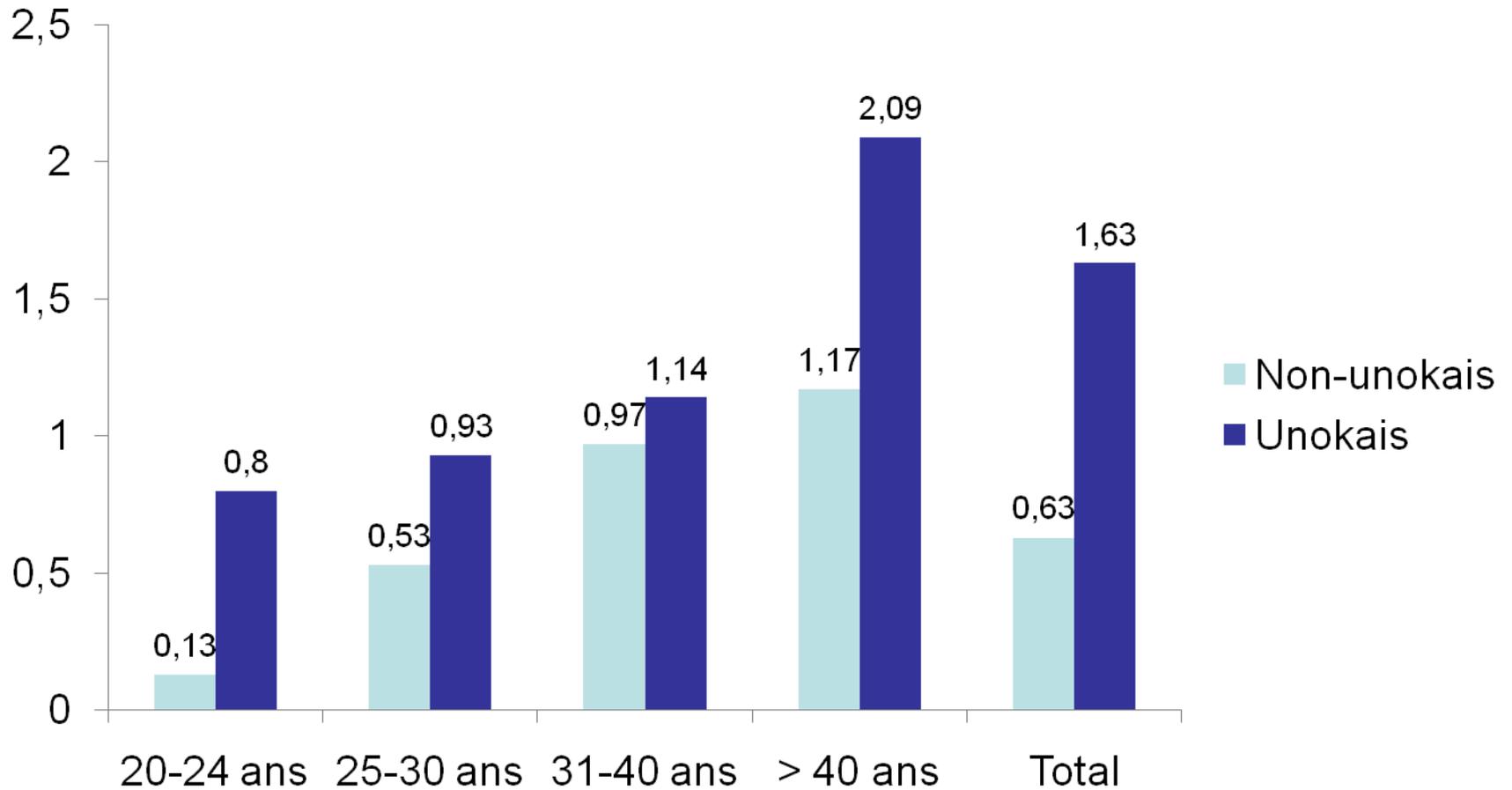
Les Unokai chez les Yanomomö

Fig. 1. Number of victims for which living killers *unokaied*. Sixty percent (83 of 137) of Yanomamö *unokais* have participated in only one killing; one man participated in 16 different killings.

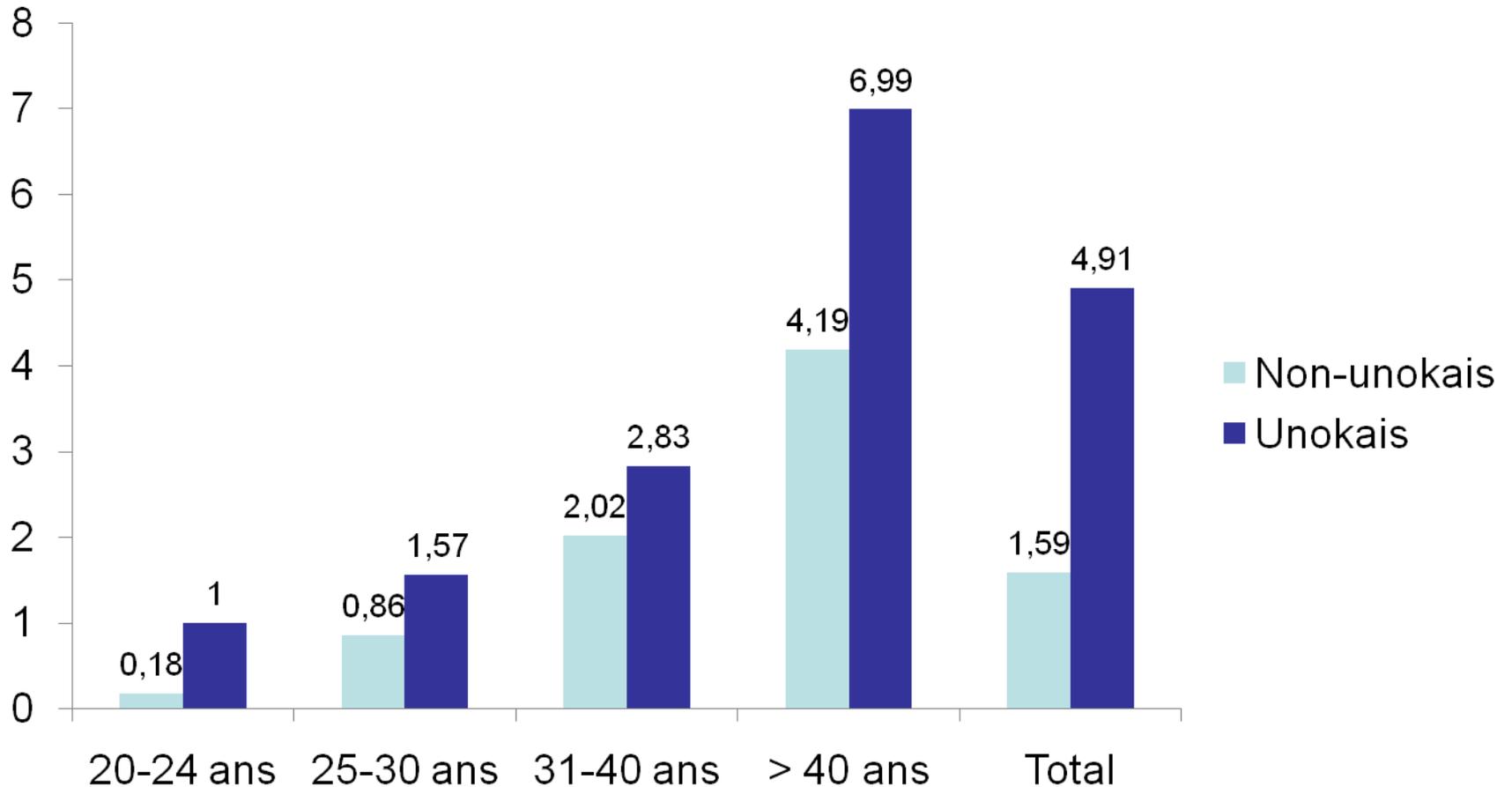




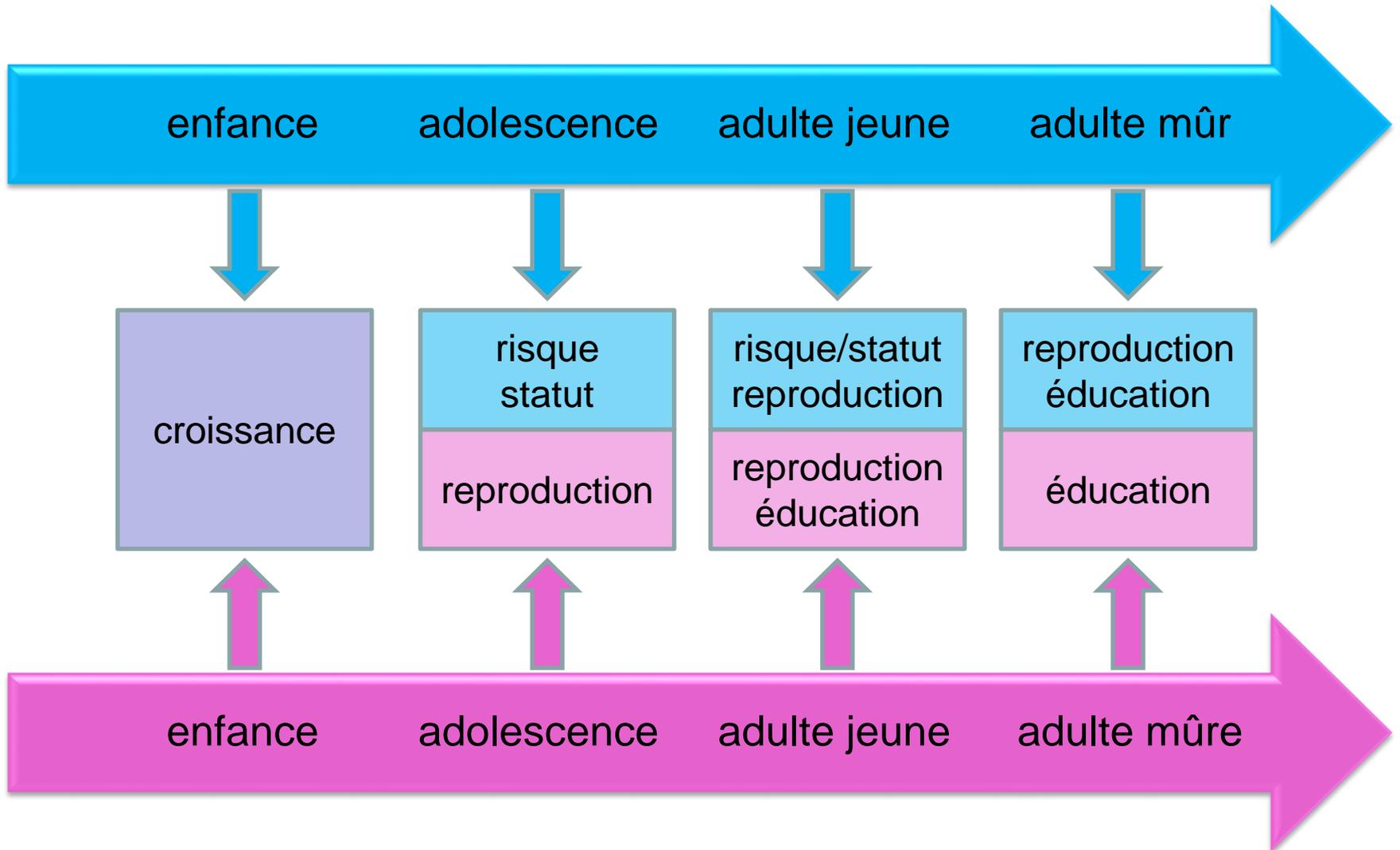
Succès marital



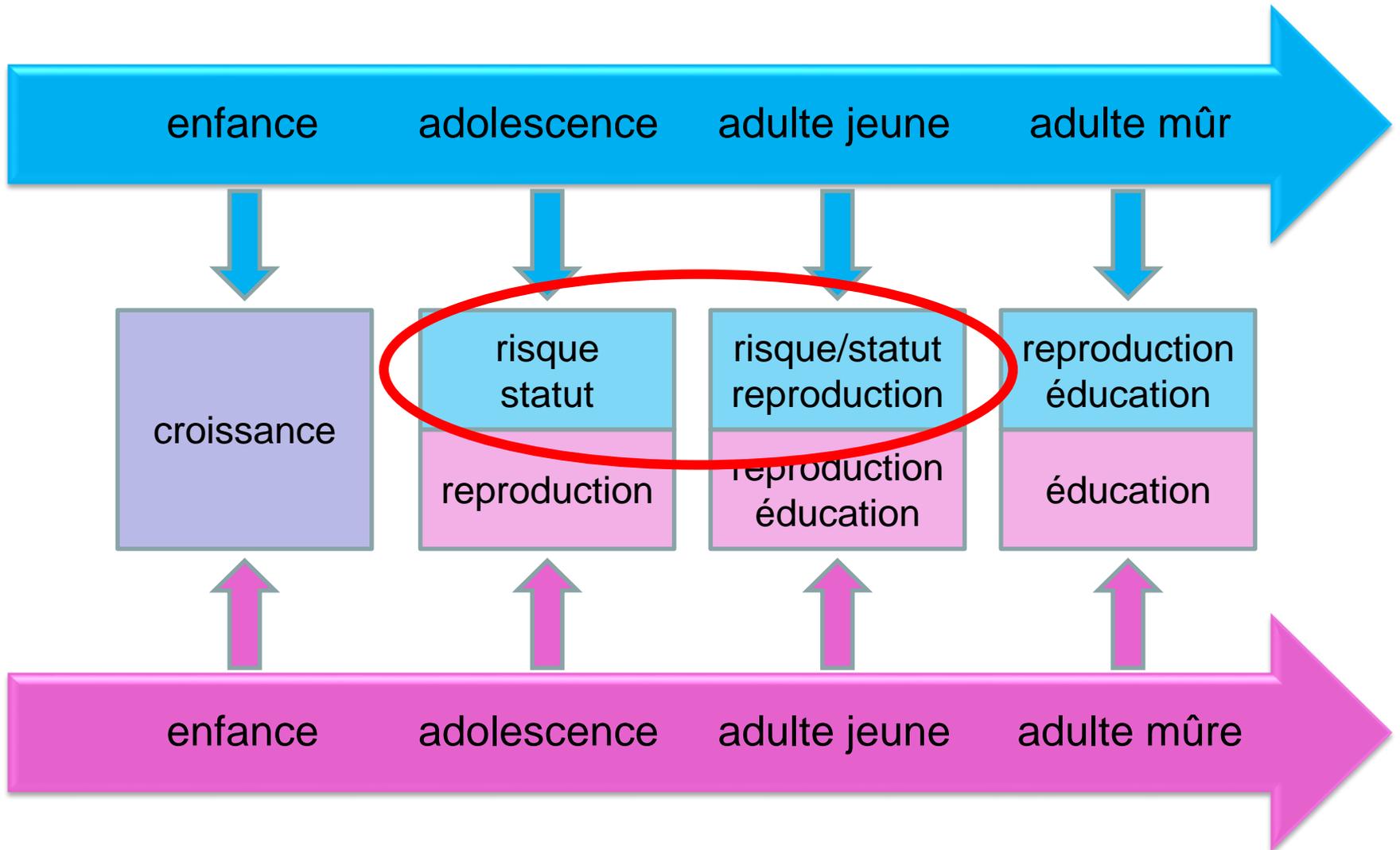
Succès reproductif

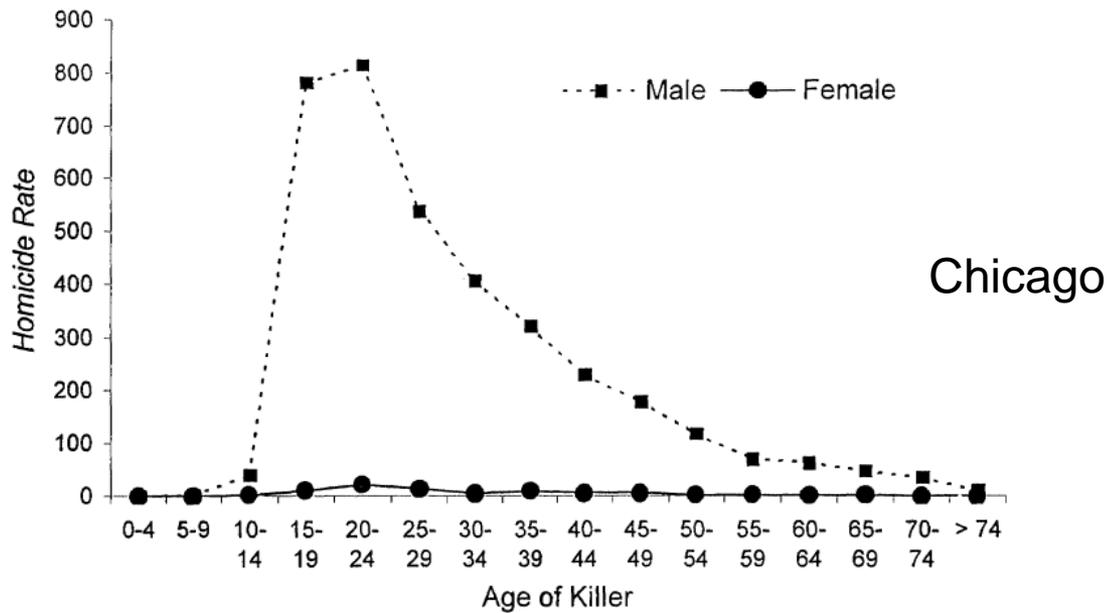
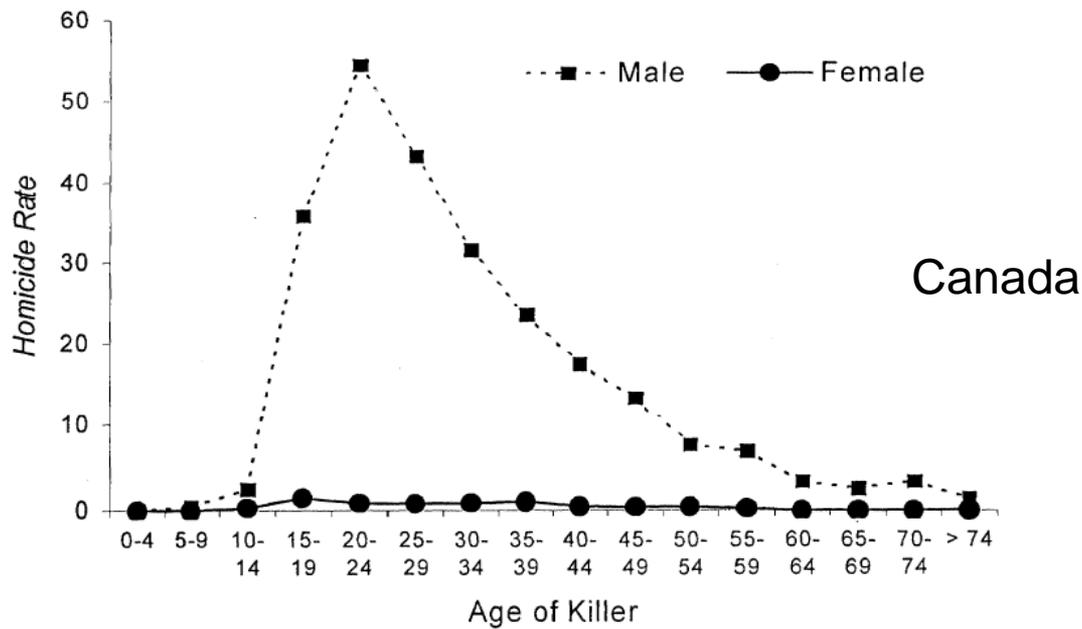


Théorie de l'histoire de vie



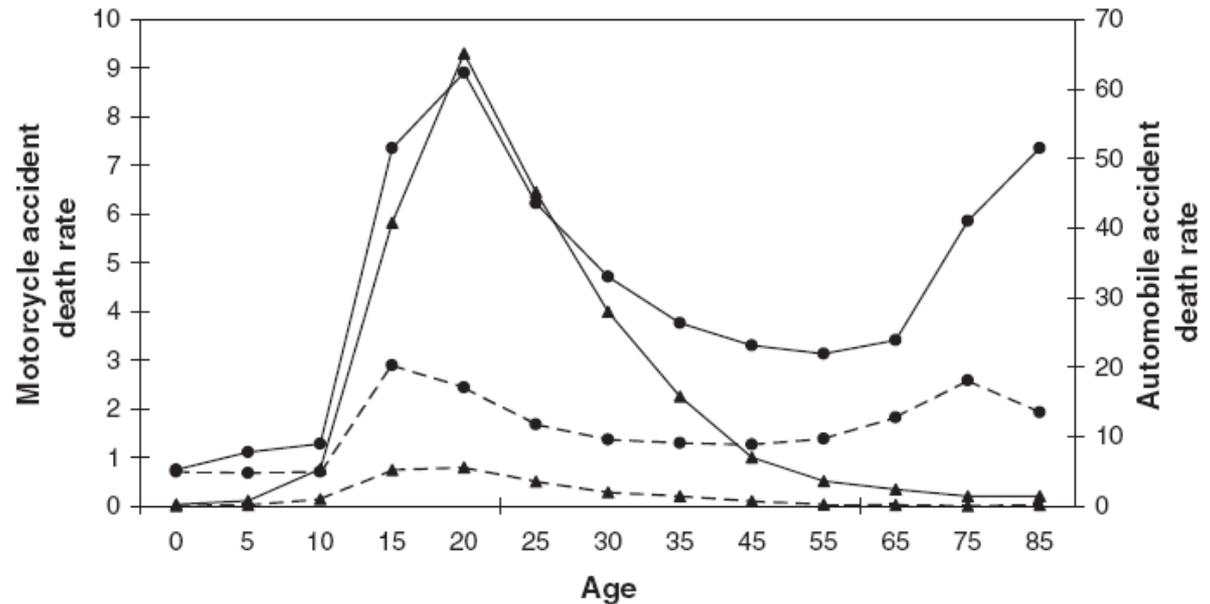
Théorie de l'histoire de vie





Mortalité par accident de la route

Figure 1 Risk of death from motorcycle accidents (▲) and passenger car accidents (●) per 100 000 US population during 1980–86 for males (solid lines) and females (dashed lines) (Appendix, Tables 3 and 5 in Baker *et al.* 1992)



Abus d'alcool

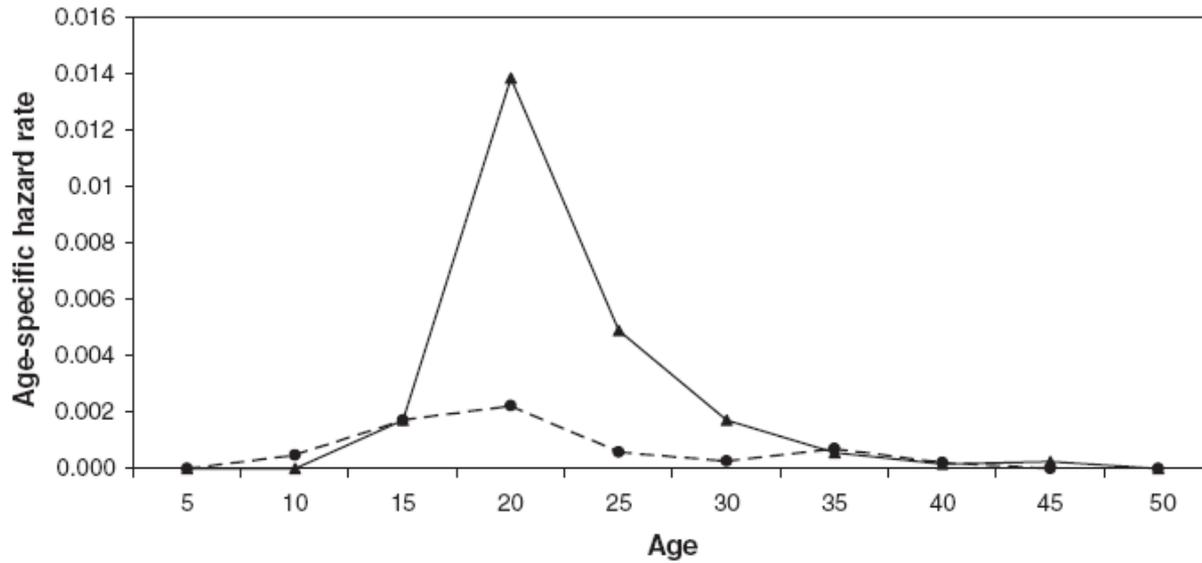
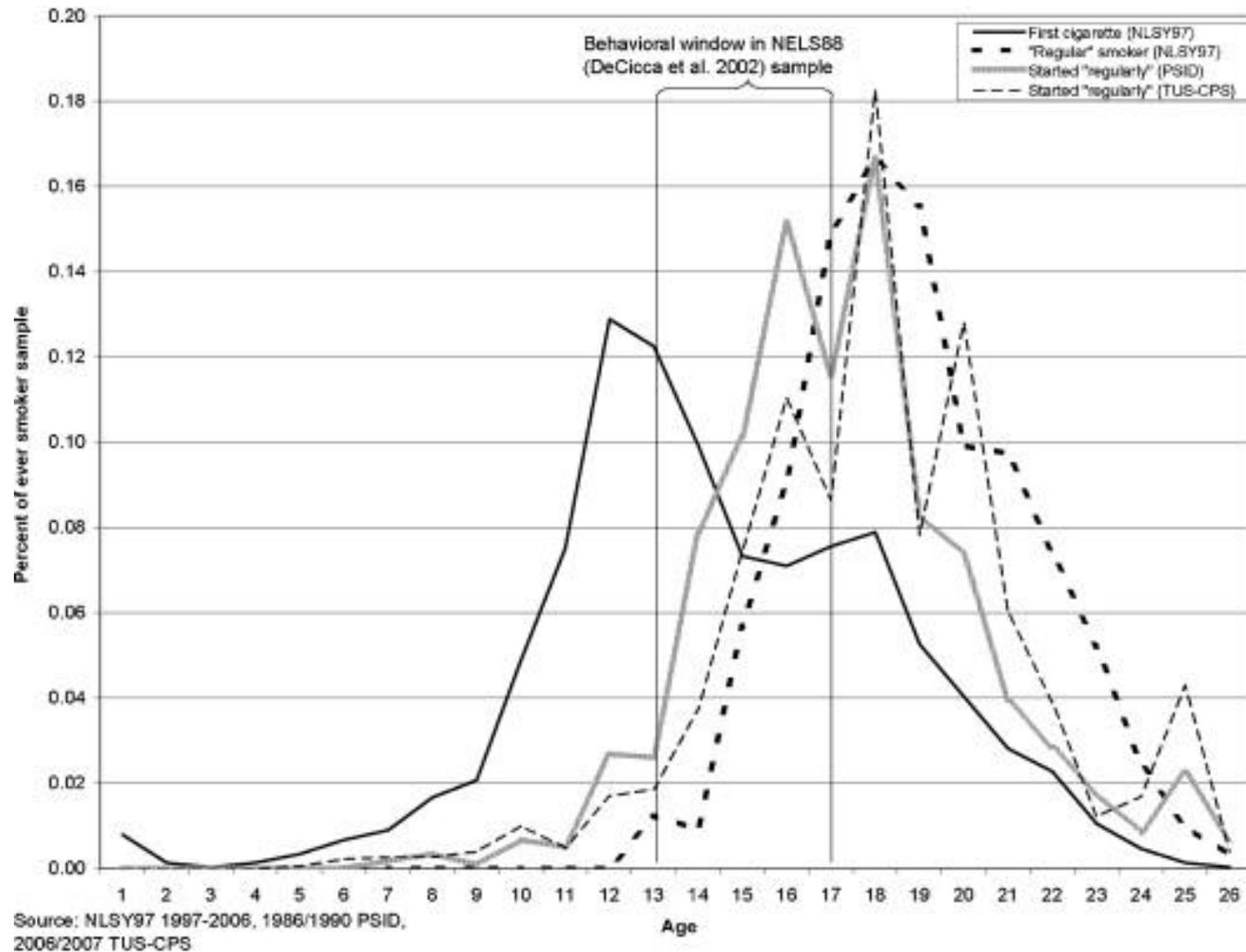
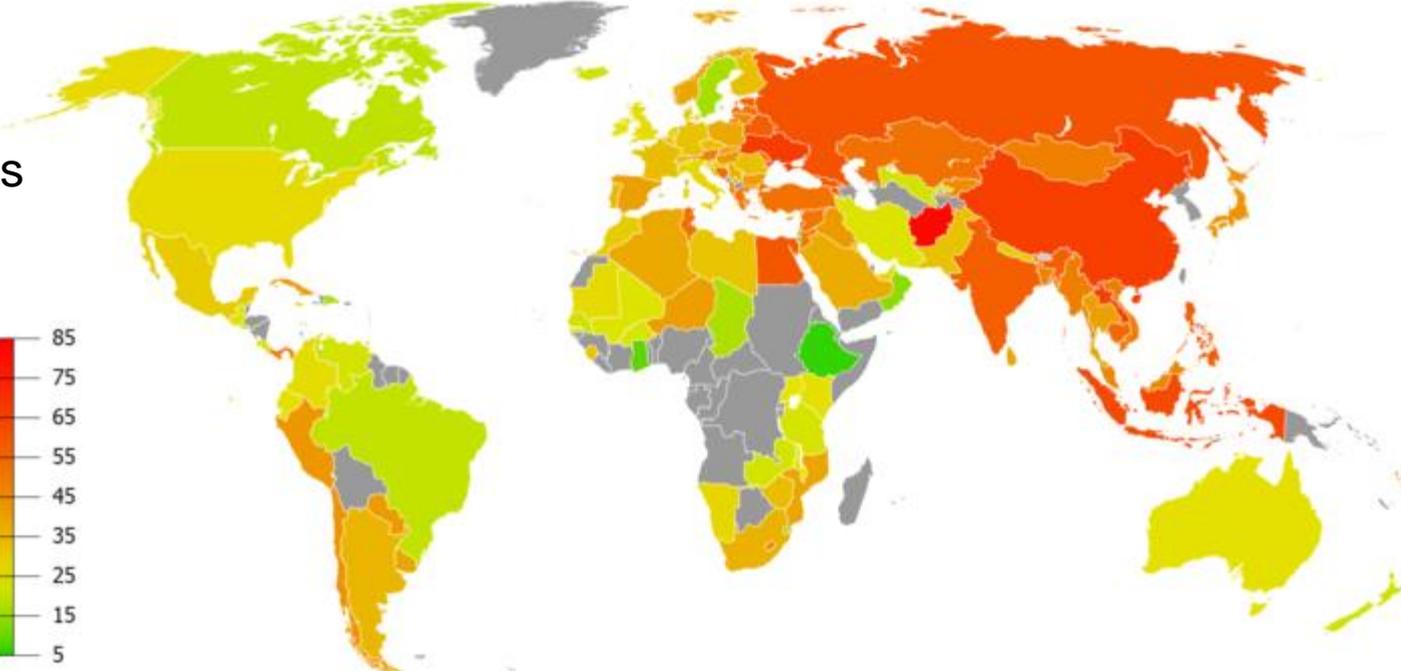
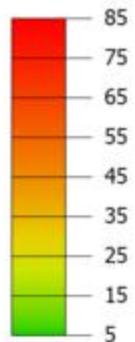


Figure 2 Age-specific hazard rate of alcohol abuse for males (solid lines) and females (dashed lines) from the Ontario Health Survey (data provided by David DeWit)

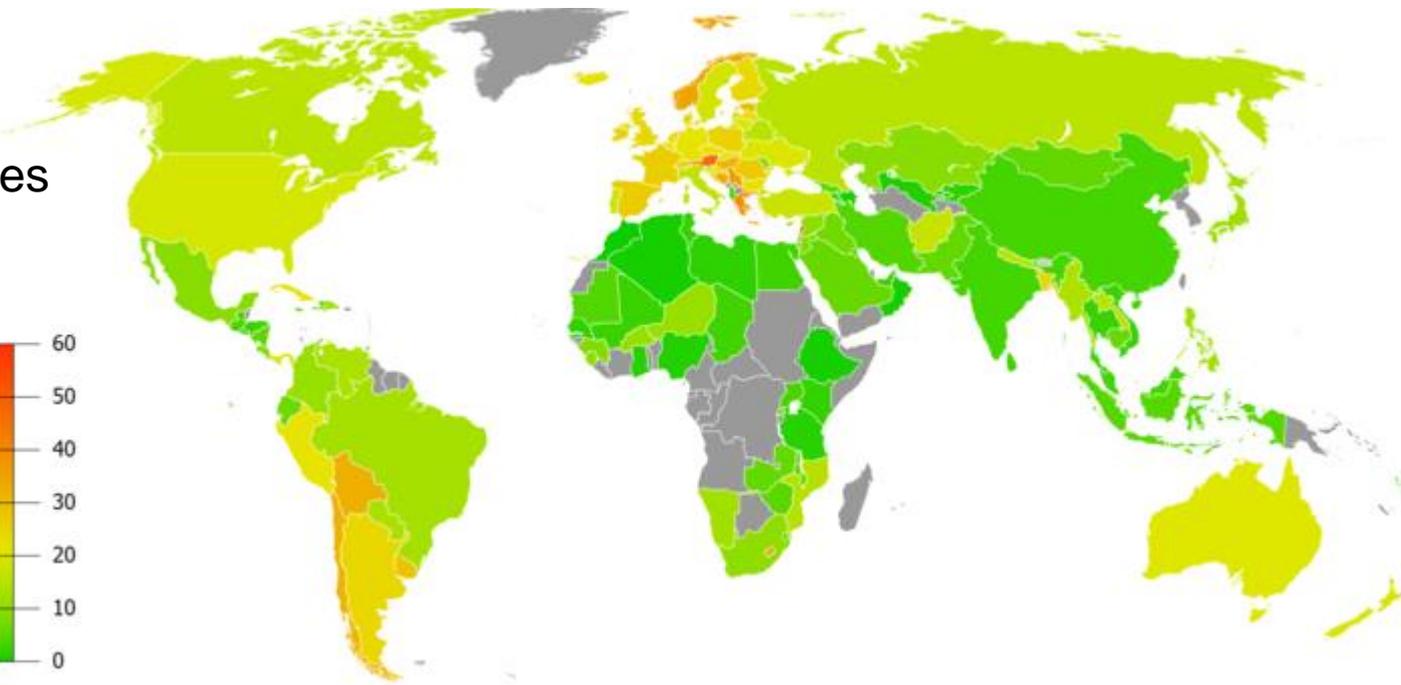
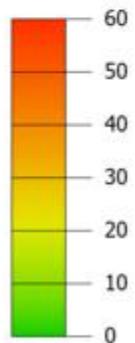
Initiation du tabagisme



Hommes

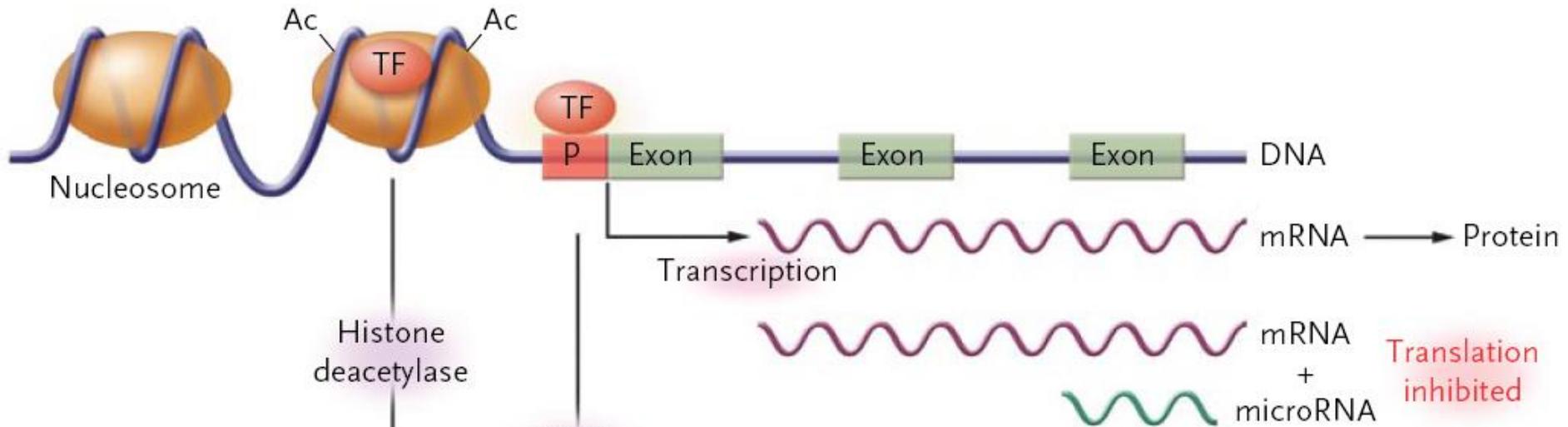


Femmes

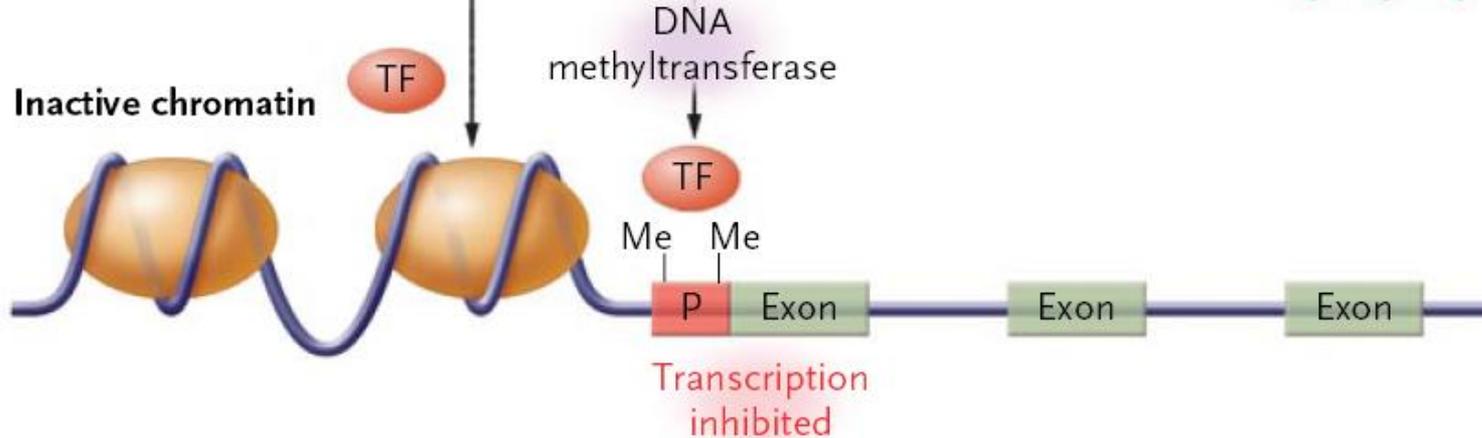


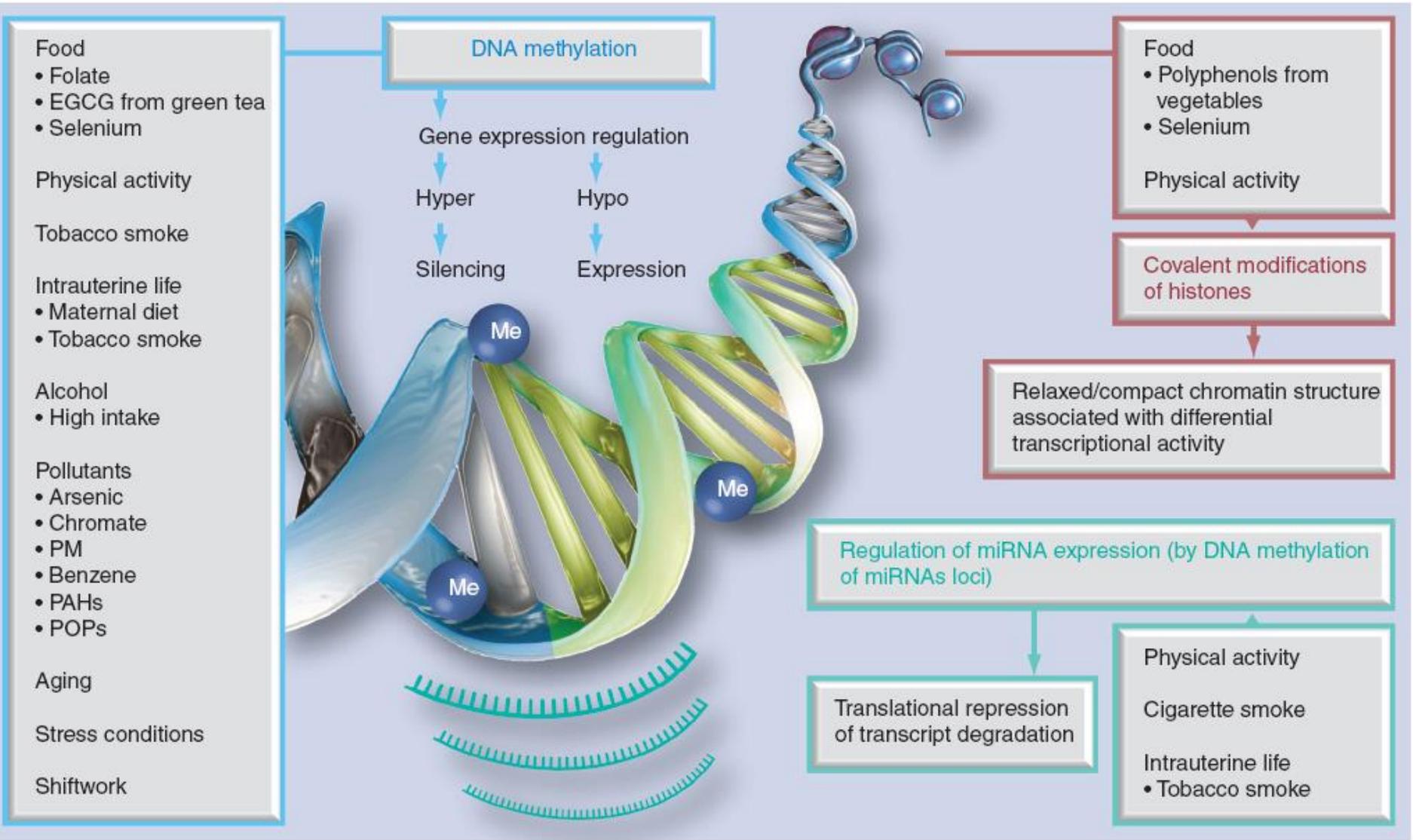
7. Rôle de l'épigénétique

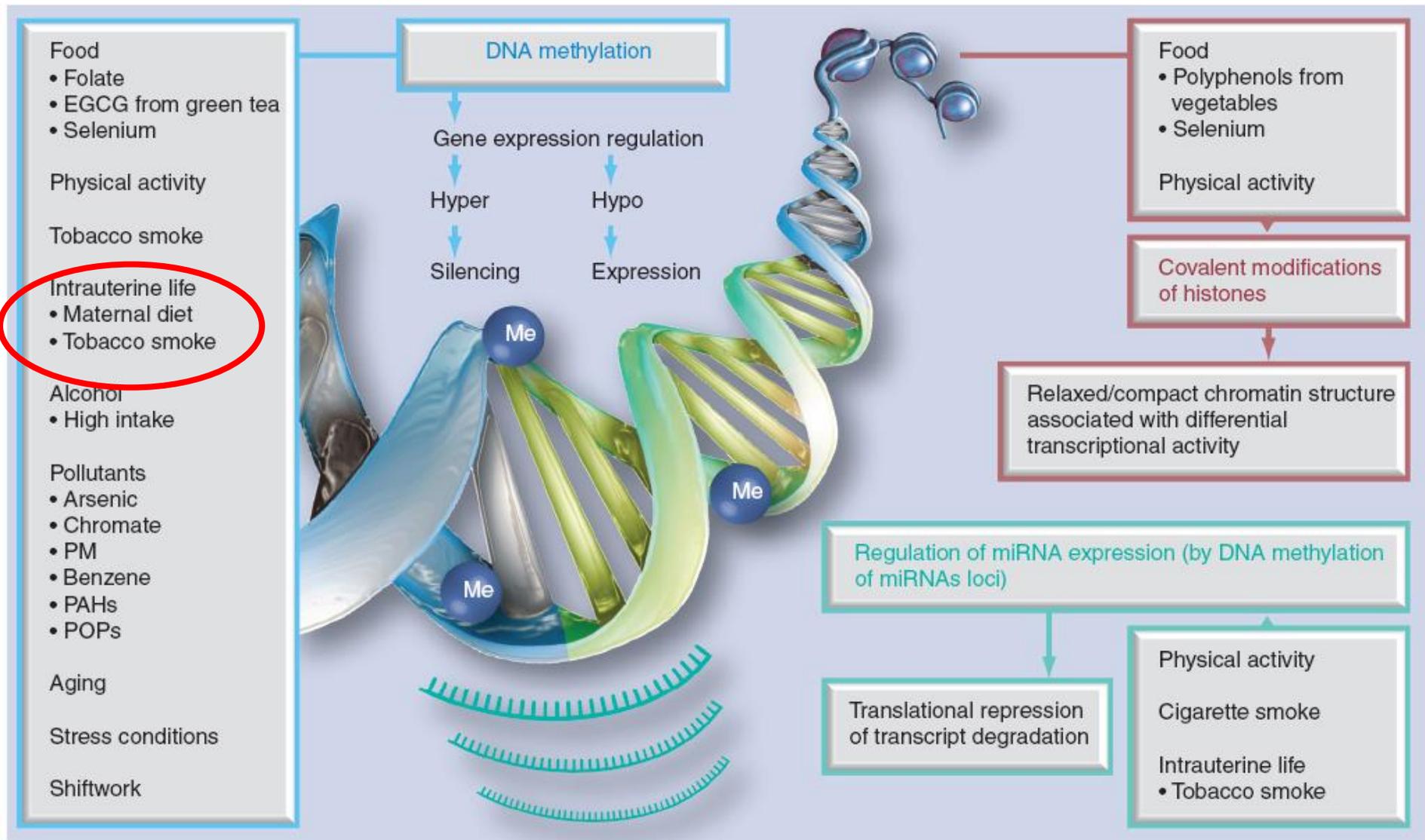
Active chromatin



Inactive chromatin







DNA Methylation in Newborns and Maternal Smoking in Pregnancy: Genome-wide Consortium Meta-analysis

Bonnie R. Joubert,^{1,58} Janine F. Felix,^{2,3,4,58} Paul Yousefi,^{5,58} Kelly M. Bakulski,^{6,58} Allan C. Just,^{7,58} Carrie Breton,^{8,58} Sarah E. Reese,^{1,58} Christina A. Markunas,^{1,9,58} Rebecca C. Richmond,^{10,58} Cheng-Jian Xu,^{11,12,13,58} Leanne K. Küpers,^{14,58} Sam S. Oh,^{15,58} Cathrine Hoyo,^{16,58} Olena Gruzieva,^{17,58} Cilla Söderhäll,^{18,58} Lucas A. Salas,^{19,20,21,58} Nour Baiz,^{22,58} Hongmei Zhang,^{23,58} Johanna Lepeule,²⁴ Carlos Ruiz,^{19,20,21} Symen Ligthart,² Tianyuan Wang,¹ Jack A. Taylor,¹ Liesbeth Duijts,^{2,4,25,26} Gemma C. Sharp,¹⁰ Soesma A. Jankipersadsing,^{11,12} Roy M. Nilsen,²⁷ Ahmad Vaez,^{14,28} M. Daniele Fallin,⁶ Donglei Hu,¹⁵ Augusto A. Litonjua,²⁹ Bernard F. Fuemmeler,³⁰ Karen Huen,⁵ Juha Kere,¹⁸ Inger Kull,¹⁷ Monica Cheng Munthe-Kaas,³¹ Ulrike Gehring,³² Mariona Bustamante,^{19,20,21,33} Marie José Saurel-Coubizolles,³⁴ Bilal M. Quraishi,²³ Jie Ren,⁸ Jörg Tost,³⁵ Juan R. Gonzalez,^{19,20,21} Marjolein J. Peters,³⁶ Siri E. Håberg,³⁷ Zongli Xu,¹ Joyce B. van Meurs,³⁶ Tom R. Gaunt,¹⁰ Marjan Kerkhof,¹³ Eva Corpeleijn,¹⁴ Andrew P. Feinberg,³⁸ Celeste Eng,¹⁵

(Author list continued on next page)

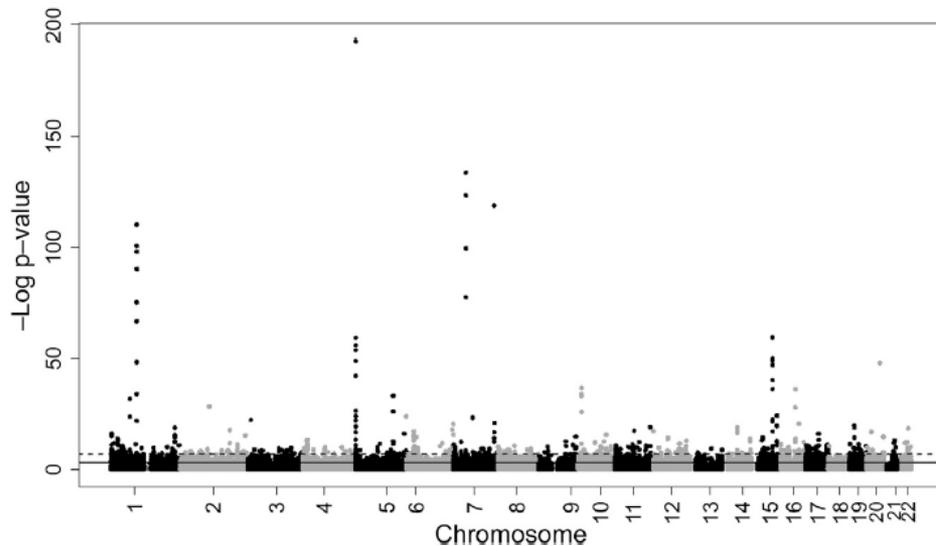


Figure 1. Meta-analysis of the Association between Sustained Maternal Smoking during Pregnancy and DNA Methylation in Newborn Cord Blood

A total of 6,073 CpGs were considered statistically significant when using FDR correction (solid horizontal line); 568 were Bonferroni significant (dashed horizontal line).

Testing Causal Effects of Maternal Smoking During Pregnancy on Offspring’s Externalizing and Internalizing Behavior

C. V. Dolan¹ · L. Geels¹ · J. M. Vink^{1,4} · C. E. M. van Beijsterveldt¹ · M. C. Neale^{1,2} · M. Bartels^{1,3,4} · Dorret I. Boomsma^{1,3,4}

Table 4 *P* values in the regression of the dependent phenotype (column 1) on the covariates and the predictor of interest (“maternal SDP”; column 7)

Dependent phenotype	SES	SEX	Birth weight	Alcohol	Age mother	Maternal SDP	R ² total (%)	R ² change (%)
Internalizing	<0.001	<0.001	<0.001	0.247	<0.001	0.071	2.5	0.15
Anxious depression	<0.001	0.001	0.012	0.147	0.001	0.193	1.4	0.10
Withdrawn	<0.001	<0.001	<0.001	0.876	<0.001	0.068	3.0	0.14
Externalizing	<0.001	<0.001	<0.001	0.289	<0.001	<i><0.001</i>	4.0	<i>0.52</i>
Overactiveness	<0.001	<0.001	<0.001	0.048	<0.001	<i>0.004</i>	4.5	<i>0.28</i>
Aggression	0.001	<0.001	0.004	0.730	<0.001	<i>0.001</i>	7.5	<i>0.42</i>
Oppositional	<0.001	0.004	0.001	0.525	<0.001	<i><0.001</i>	2.9	<i>0.43</i>

The *p* values of interest are associated with maternal SDP (column 7). These *p* values concern the omnibus test of an effect of maternal SDP (see Table 5 for contrasts relative to no SDP). The *p* values smaller than the alpha (0.05/7 = 0.007) are italicized. The columns “R² total” (8) and “R² change” (9) contain the total R² (explained variance) and the R² change due adding SDP

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Smoking
During
Pregnancy

Table 4 *P* values in the regression of the dependent phenotype (column 1) on the covariates (column 2–6) and the variable of interest (“maternal SDP”; column 7)

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ORIGINAL RESEARCH

Testing Causal Effects of Maternal Smoking During Pregnancy on Offspring’s Externalizing and Internalizing Behavior

C. V. Dolan¹ · L. Geels¹ · J. M. Vink^{1,4} · C. E. M. van Beijsterveldt¹ · M. C. Neale^{1,2} · M. Bartels^{1,3,4} · Dorret I. Boomsma^{1,3,4}

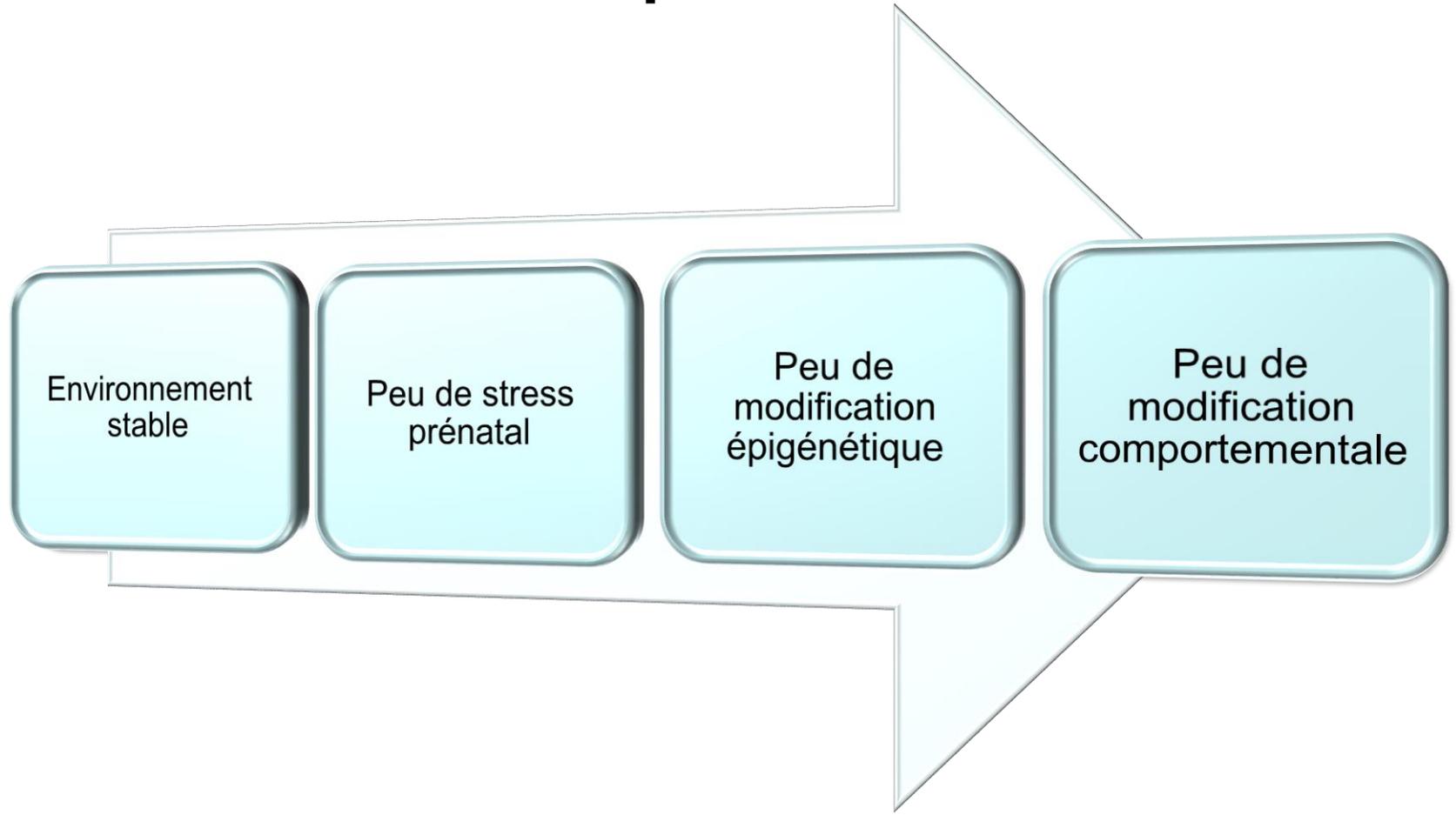
Smoking
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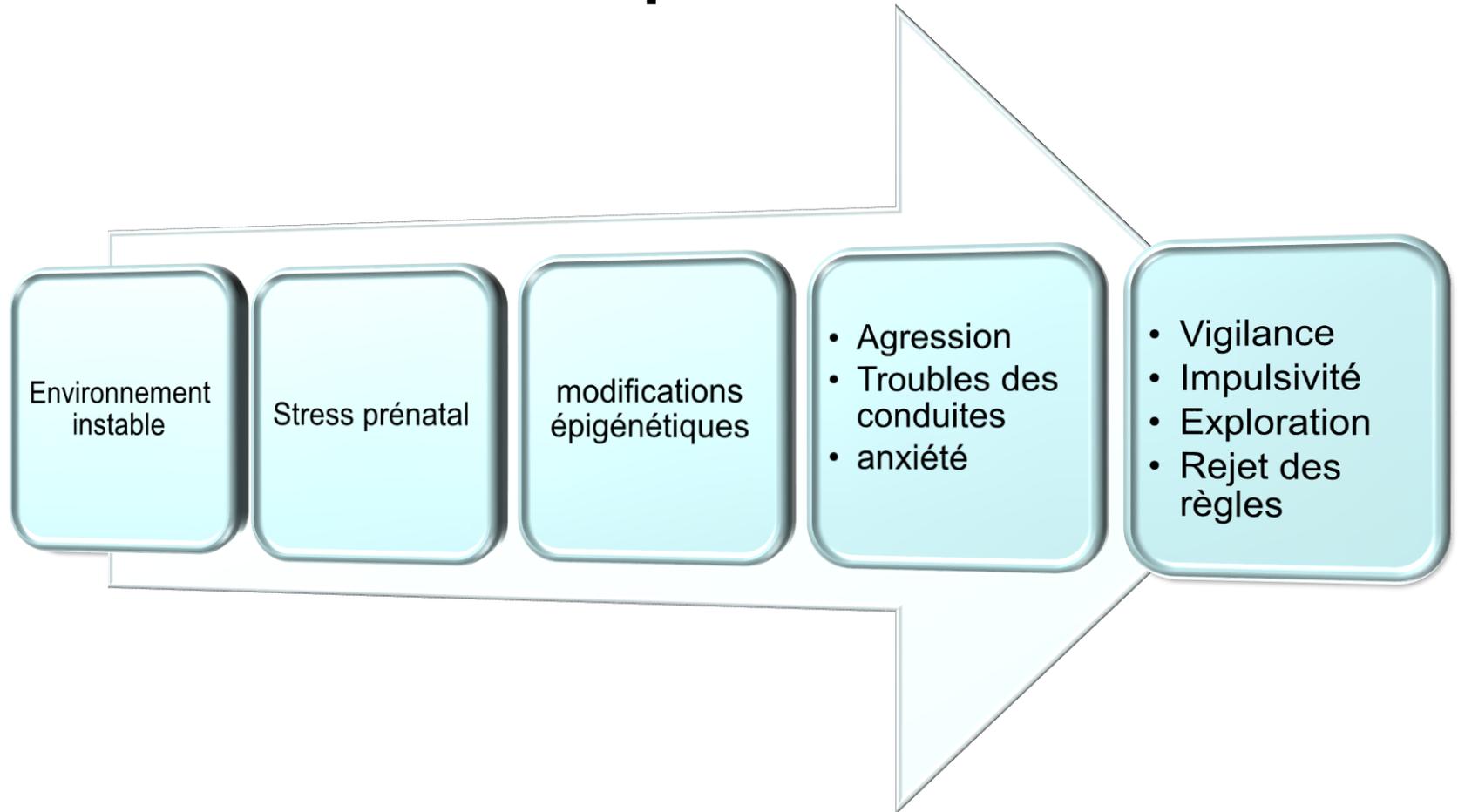
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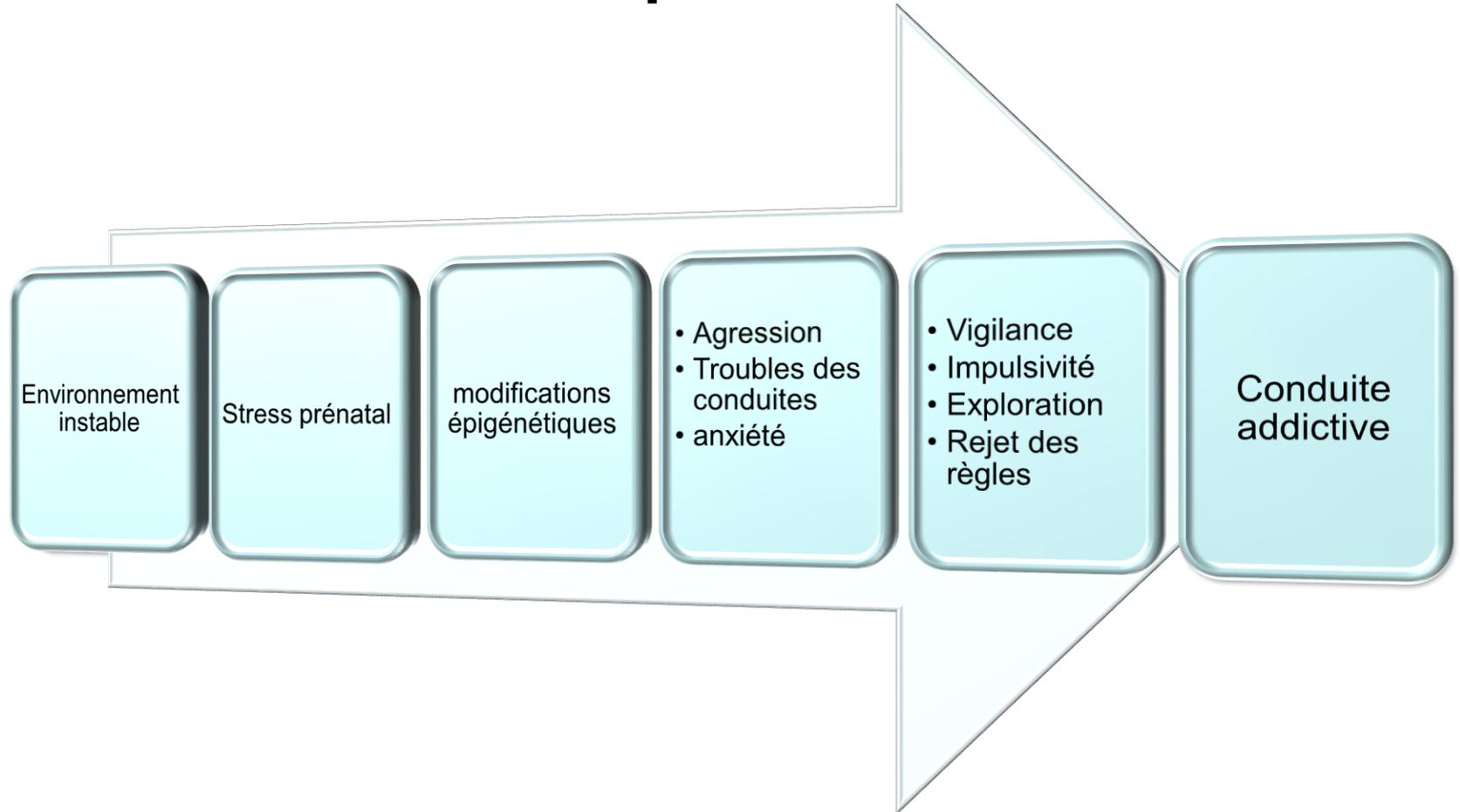
Effet psychopathologique du stress prénatal



Effet psychopathologique du stress prénatal



Effet psychopathologique du stress prénatal



Conclusion

- Approche évolutionniste
 - Adaptation à la survie... des gènes
 - Causes ultimes/proximales
 - Inadéquation évolutive environnement ancestral/moderne
- Mécanismes de renforcement
 - Nourriture
 - Reproduction
 - Attachement
 - Liens sociaux
- Théorie de l'histoire de vie
 - Prise de risque chez l'homme jeune
- Rôle adaptatif de l'épigénétique ?