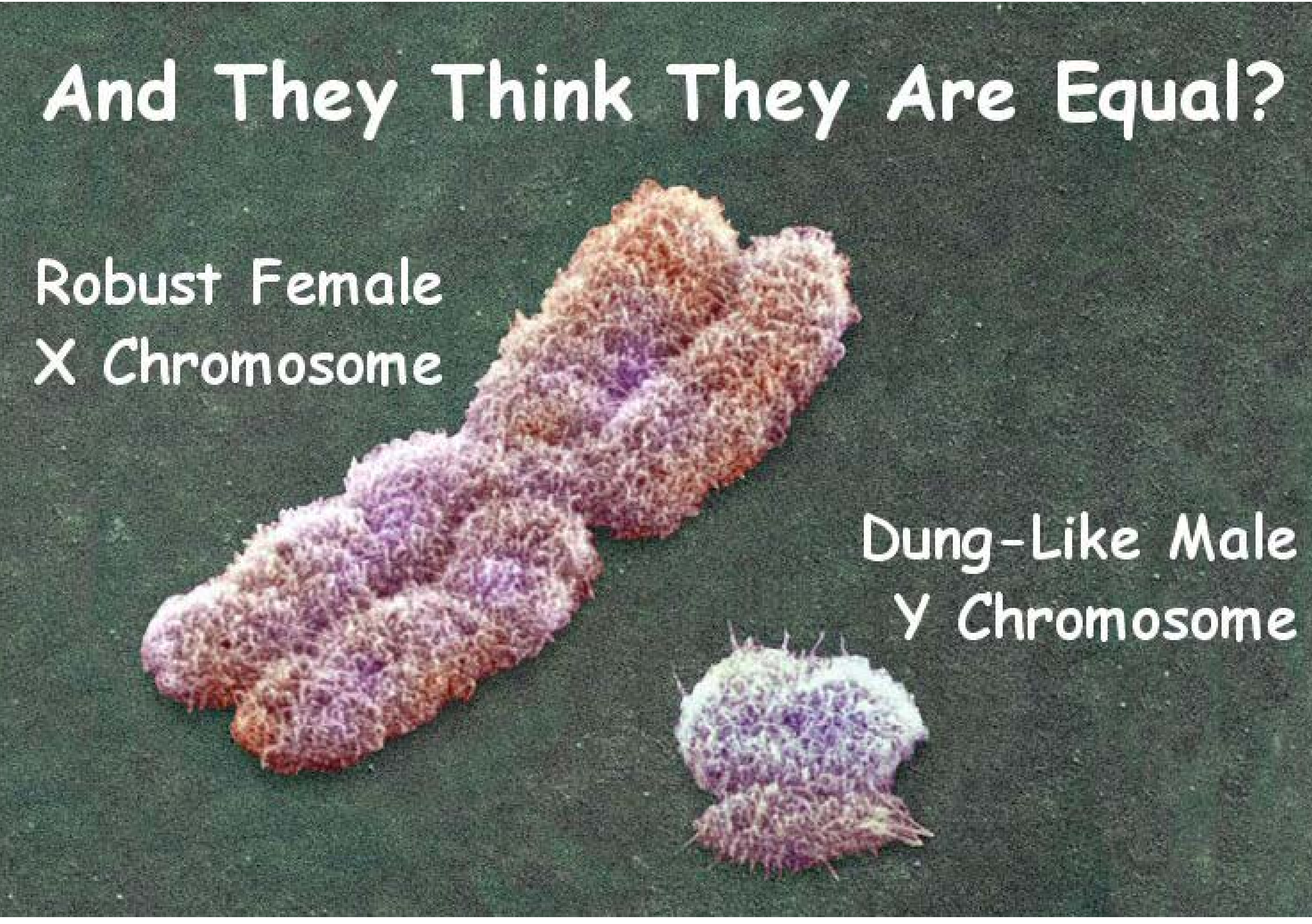
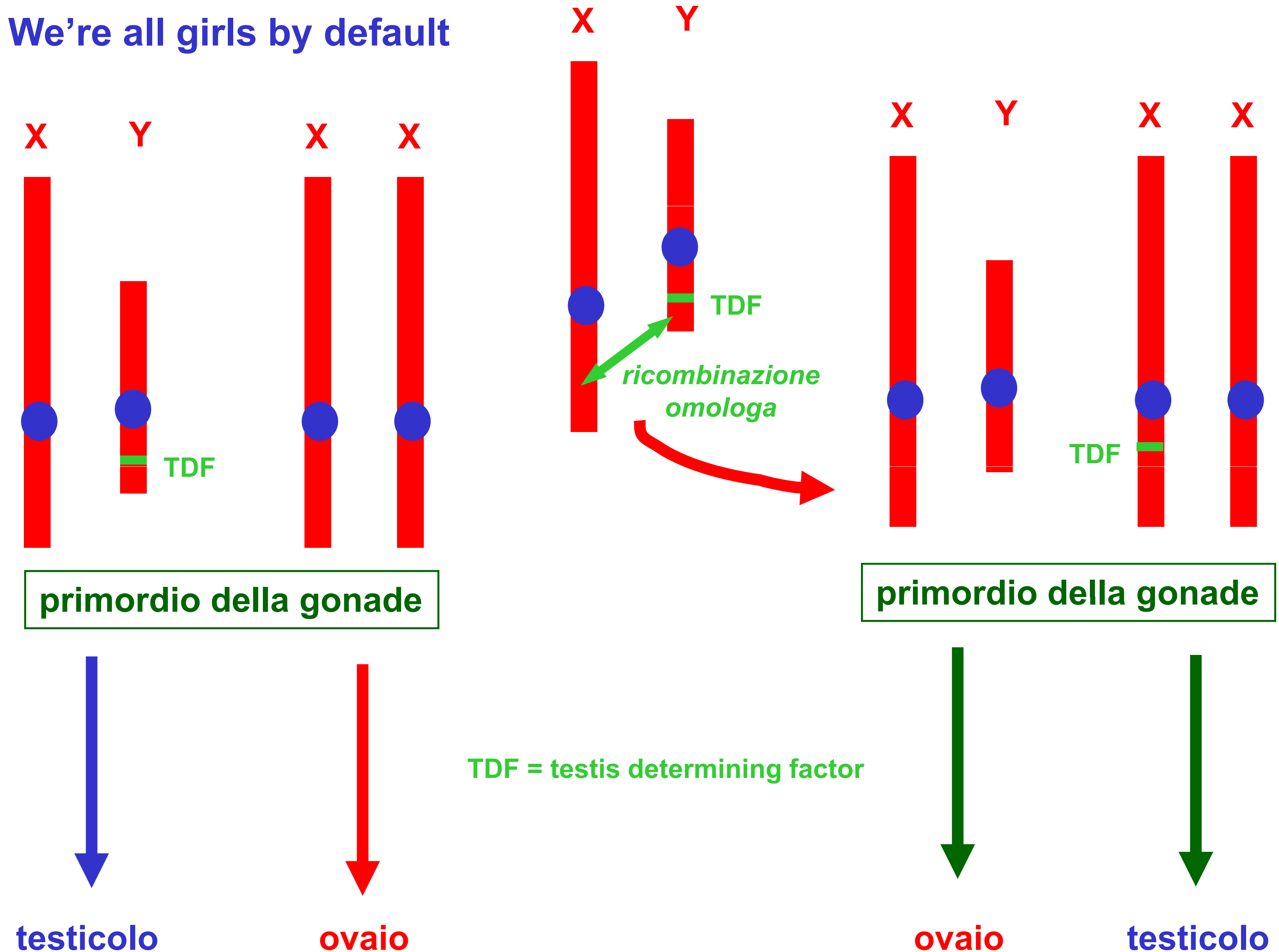

And They Think They Are Equal?
Robust Female
X Chromosome
Dung-Like Male
Y Chromosome

We're all girls by default

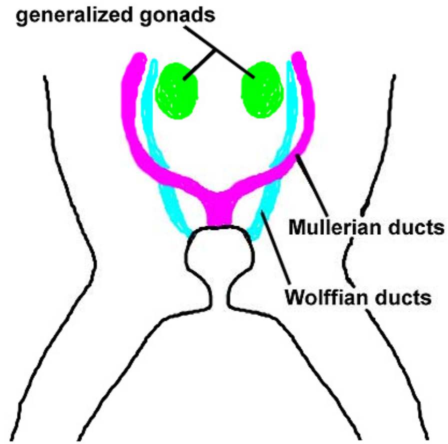


testicolo

testosterone — MIH

Dotto di Wolff — Dotto di Muller

Apparato sessuale maschile — Apparato sessuale femminile



testicolo

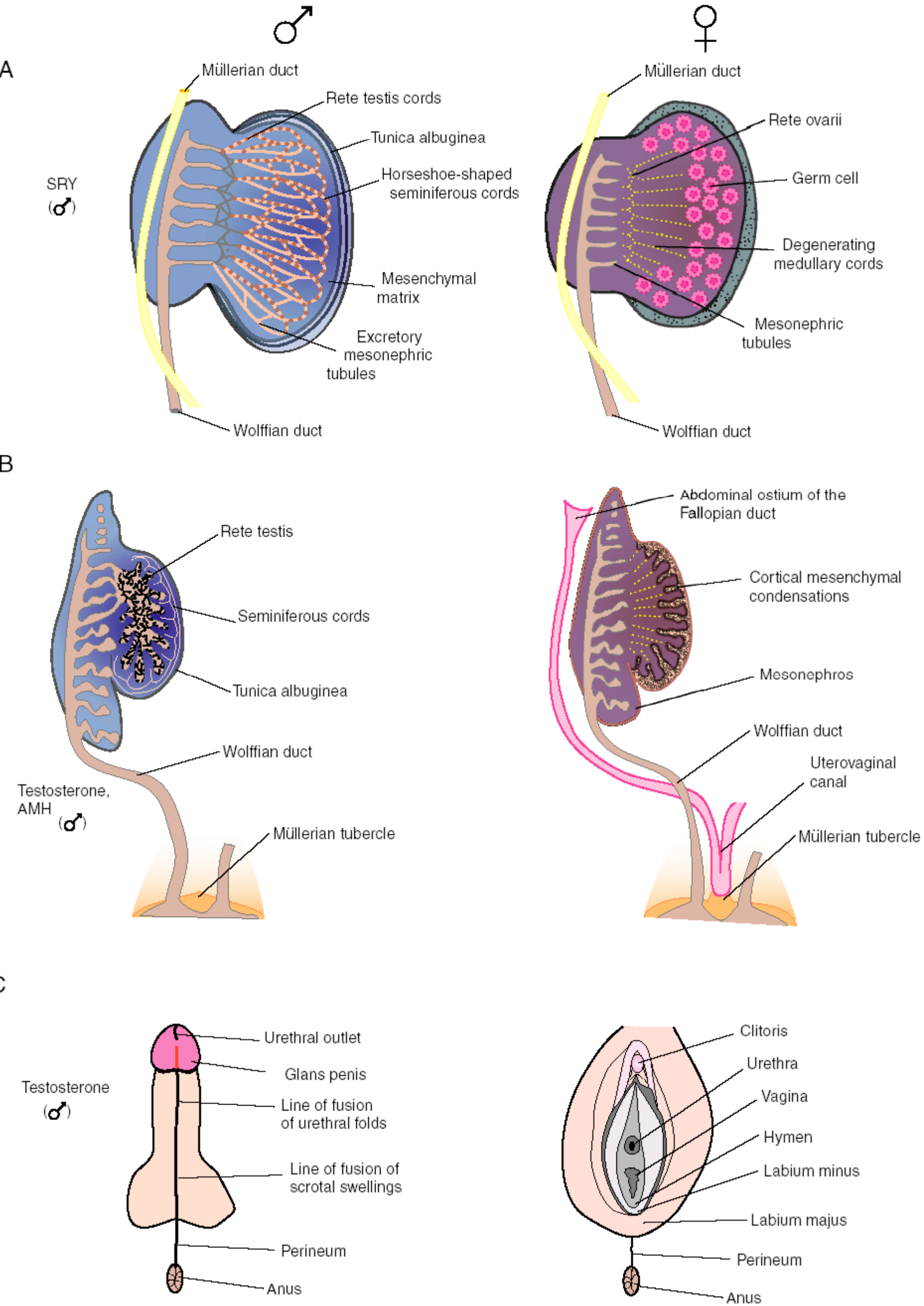
testosterone
DHT

Primordio dei genitali esterni

Genitali esterni maschili — Genitali esterni femminili

MIH = mullerian duct inhibiting hormone

DHT = diidrotesterone



primordio della gonade
struttura unica bipotente

Induzione in senso maschile da TDF (cromosoma Y)

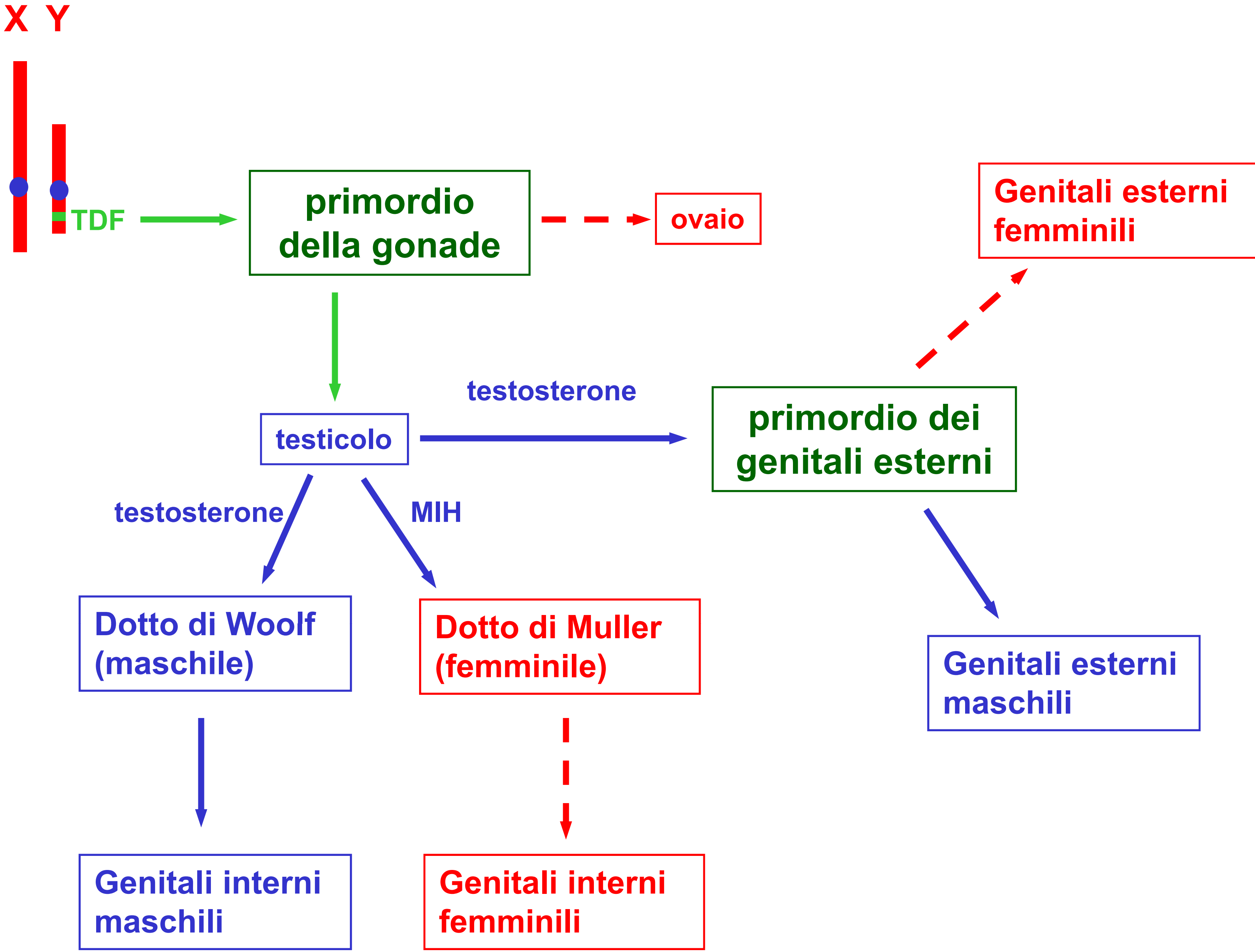
primordi dei genitali interni
due strutture unipotenti

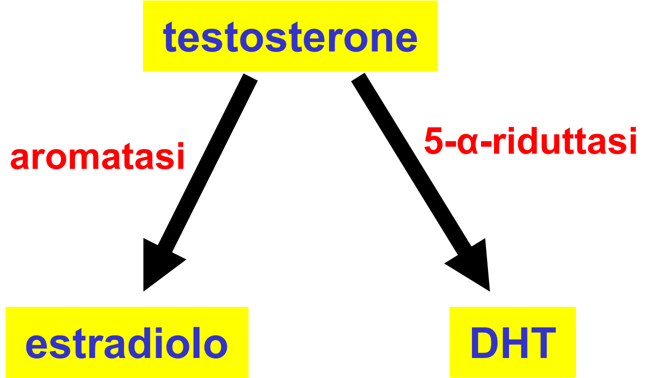
Dotto di Woolf (maschile)
Dotto di Muller (femminile)

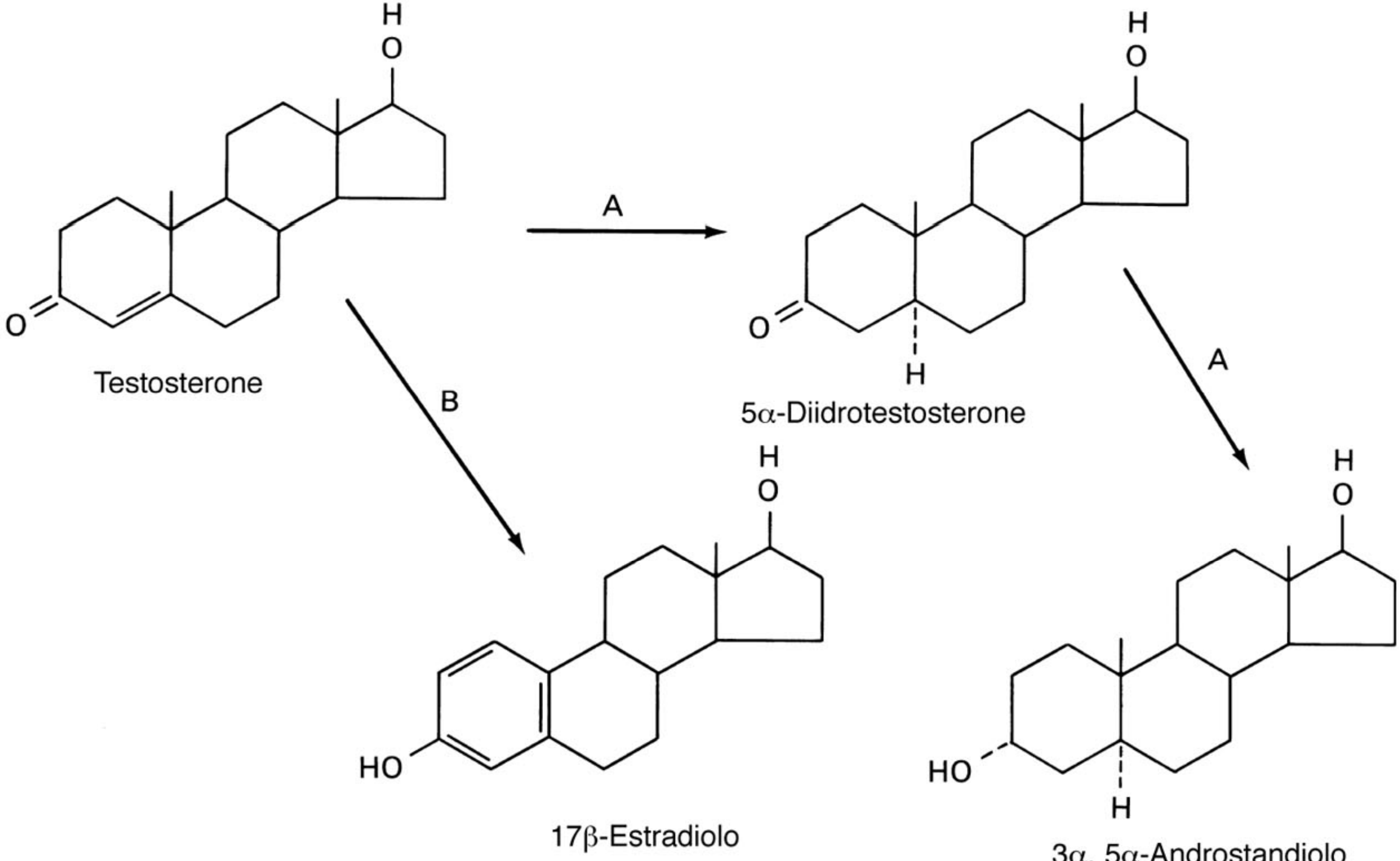
La gonade maschile (testicolo) produce due ormoni, che determinano lo sviluppo in senso maschile:
Testosterone (DHT): promuove lo sviluppo del dotto di Woolf
MIH (anti-Muller hormone): inibisce lo sviluppo del dotto di Muller

primordio dei genitali esterni
struttura unica bipotente

Induzione in senso maschile da Testosterone


X Y
TDF
primordio della gonade
ovaio
Genitali esterni femminili
testicolo
testosterone
primordio dei genitali esterni
testosterone
MIH
Dotto di Woolf (maschile)
Dotto di Muller (femminile)
Genitali esterni maschili
Genitali interni maschili
Genitali interni femminili


testosterone
aromatasi
5-α-riduttasi
estradiolo
DHT

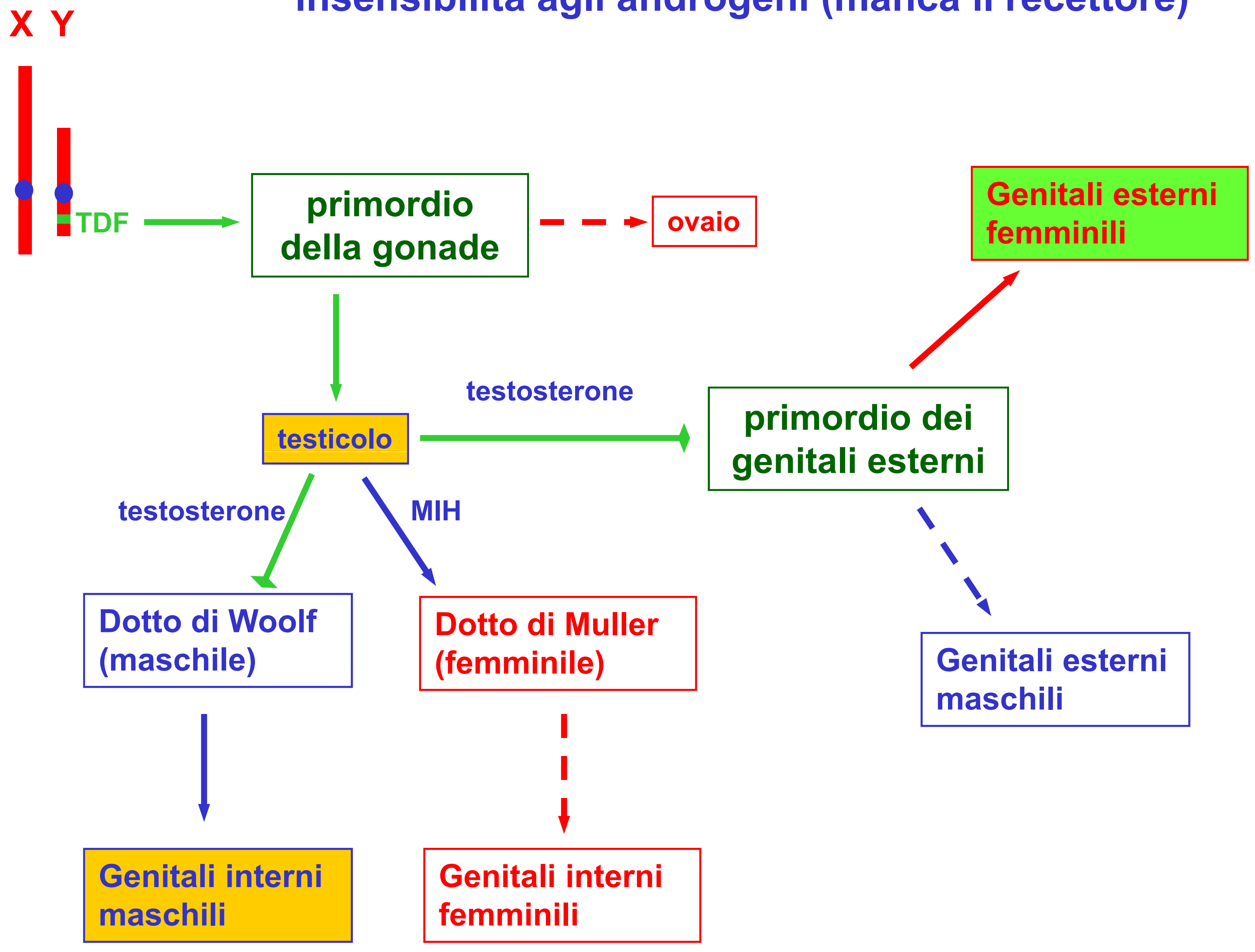

Testosterone
A
5α-Diidrotestosterone
B
A
17β-Estradiolo
3α, 5α-Androstandiolo

freemartinism

A joining of the placental membranes occurs at about the 40th day of pregnancy, and fluids of the two fetuses are mixed. This causes exchange of blood and antigens carrying characteristics that are unique to each heifers and bulls. When these antigens mix, they affect each other in a way that causes each to develop with some characteristics of the other sex.

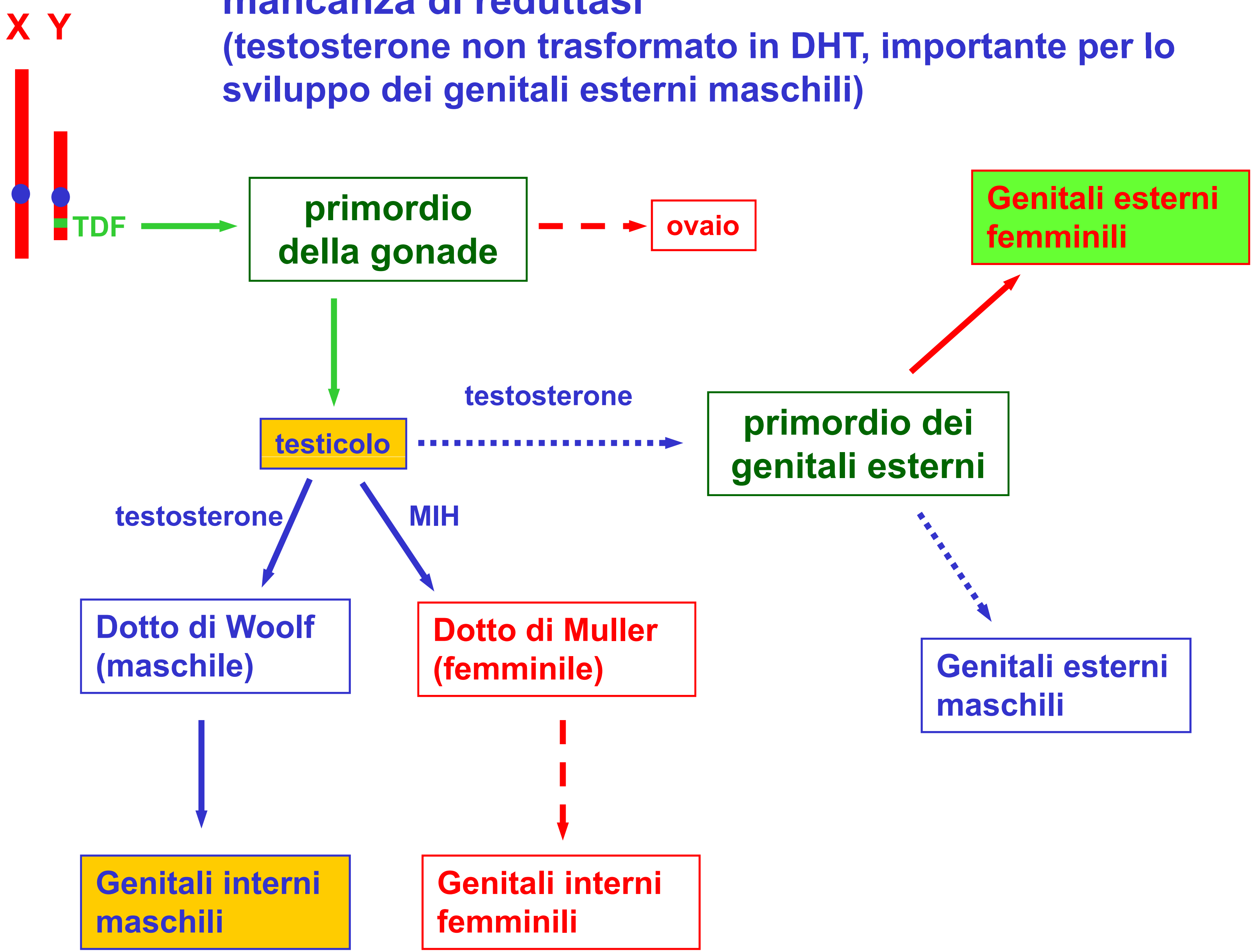
Although the male (bull) twin is only affected by reduced fertility, in over ninety percent of the cases the female (heifer) twin is completely infertile. Because of a transfer of hormones and/or cells, the heifer's reproductive tract is severely underdeveloped, it sometimes contains some elements of a bull's reproductive tract. A freemartin is genetically female, but has many characteristics of a male. The ovaries of the freemartin do not develop correctly, and remain very small. The ovaries of a freemartin do not produce the hormones necessary to induce the behavioral signs of heat.

insensibilità agli androgeni (manca il recettore)

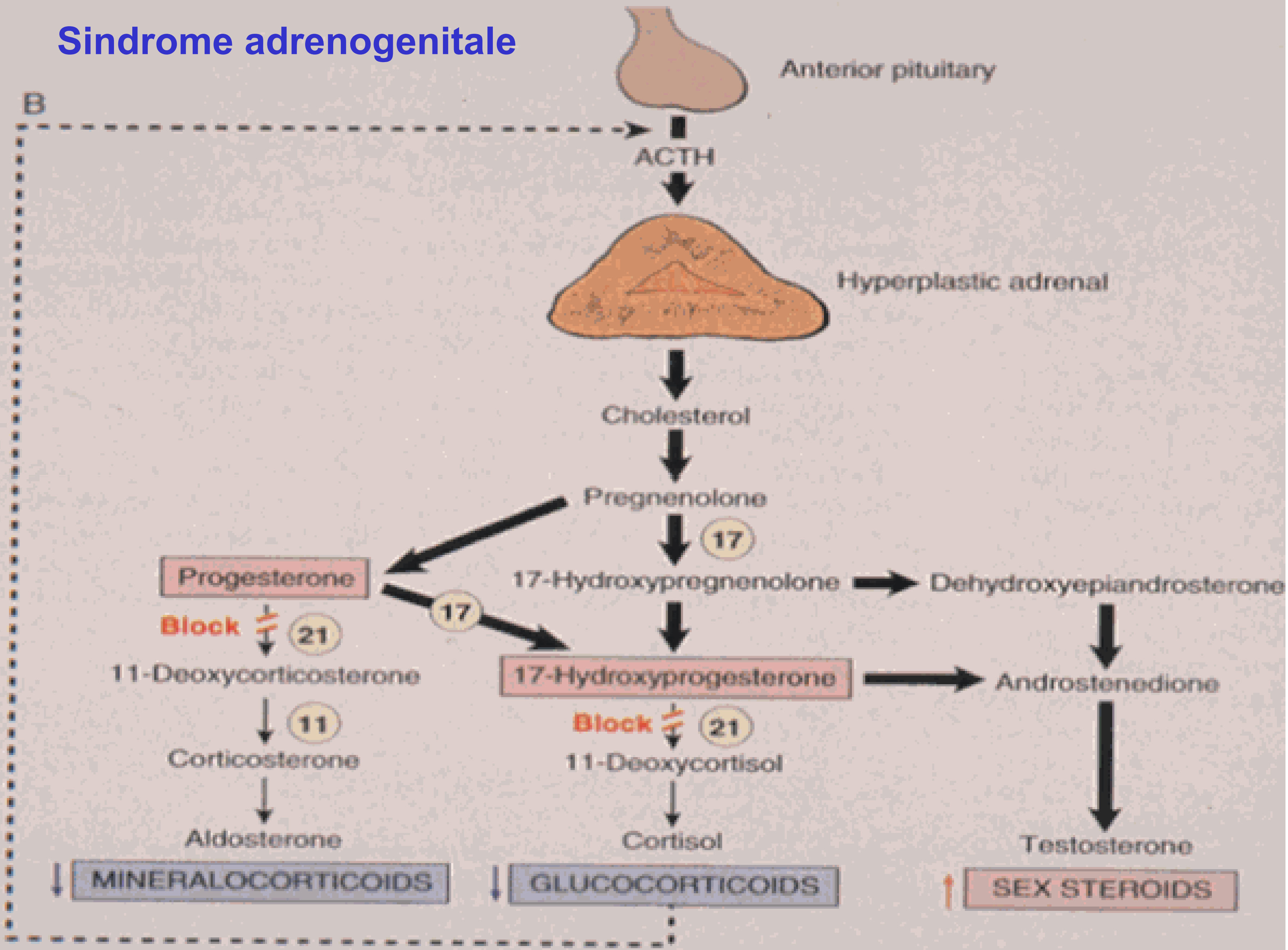


mancanza di reduttasi

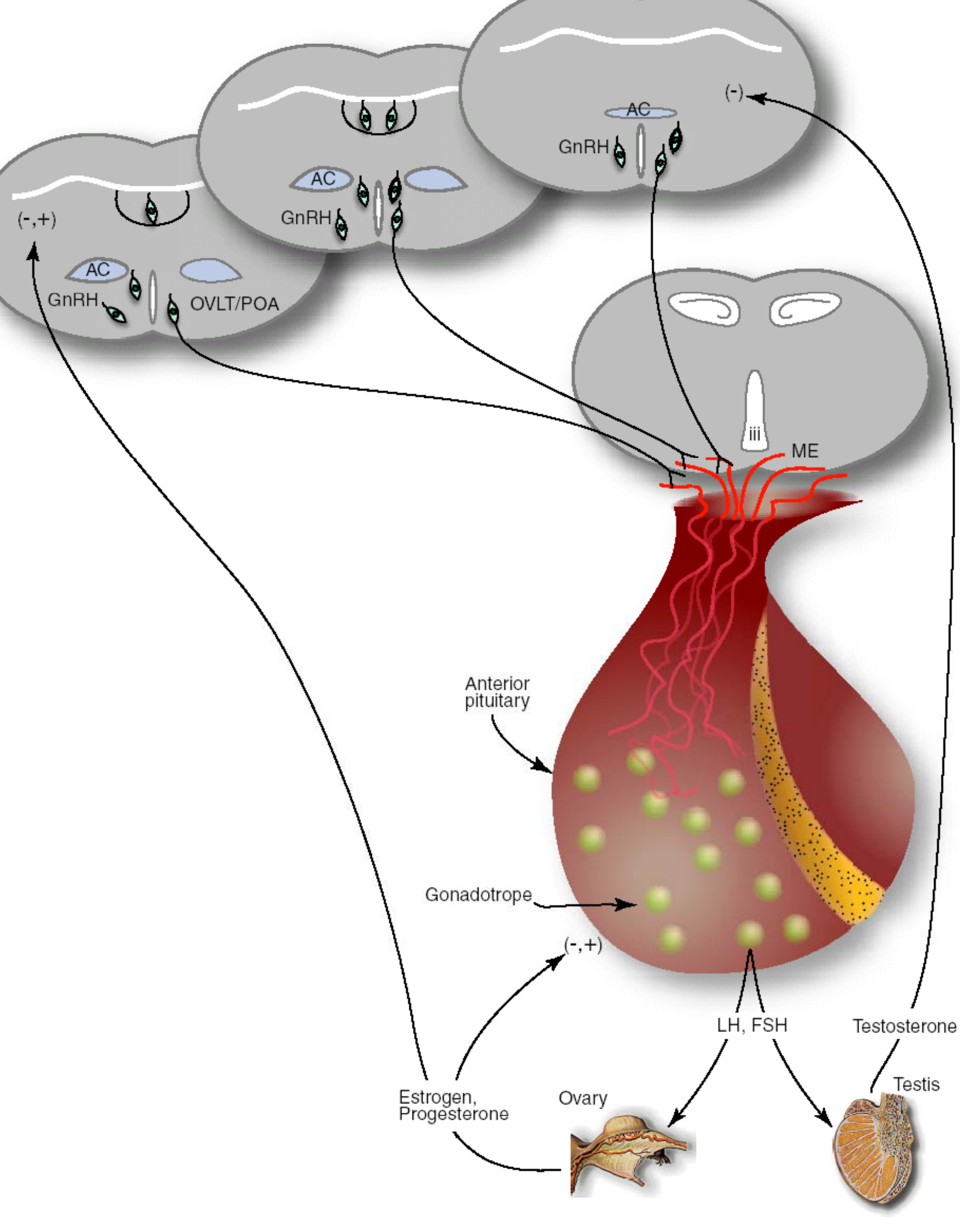
(testosterone non trasformato in DHT, importante per lo sviluppo dei genitali esterni maschili)



Sindrome adrenogenitale



	Insensibilità agli androgeni	Mancanza di 5-α-riduttasi	Sindrome adreno-genitale congenita
Sesso genotipico	XY	XY	XX
Difetto	Mancanza di recettori per gli androgeni	Mancanza dell'enzima	Mancanza degli enzimi per la sintesi di corticosteroidi
Funzione gonadica	Testicolo normale	Testicolo normale	Ovaio normale
Apparenza dei genitali			
alla nascita	Femmina	Femmina	Virilizzazione variabile
dopo la pubertà	Femmina	Virilizzazione variabile	Virilizzazione variabile (femmina se corretto chirurgicamente o con cortisolo)
Organi sessuali interni	Derivati Wolff (maschili)	Derivati Wolff (maschili)	Derivati Muller (femminili)
Identità psicosessuale	Femmina	Femmina o maschio	Femmina con segni di mascolinizzazione

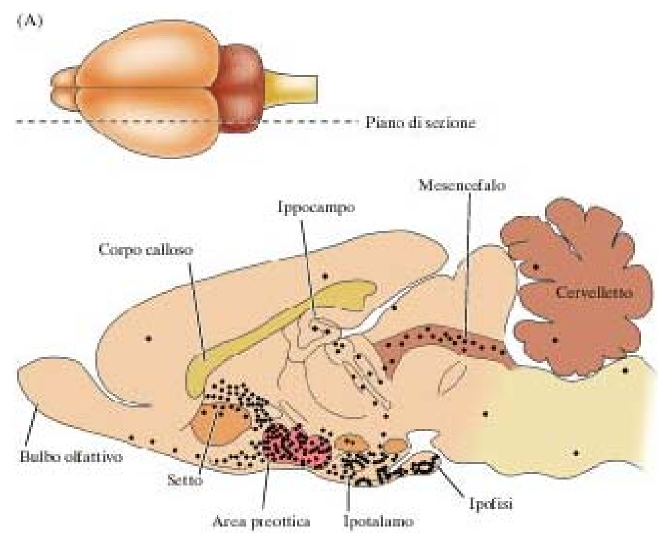


effetti degli ormoni sessuali sul SNC e sul comportamento

Di organizzazione
- **Durante il periodo critico (sviluppo)**
- **Permanenti ed irreversibili**

Di attivazione
- **Nell'adulto (pubertà)**
- **Temporanei e reversibili**

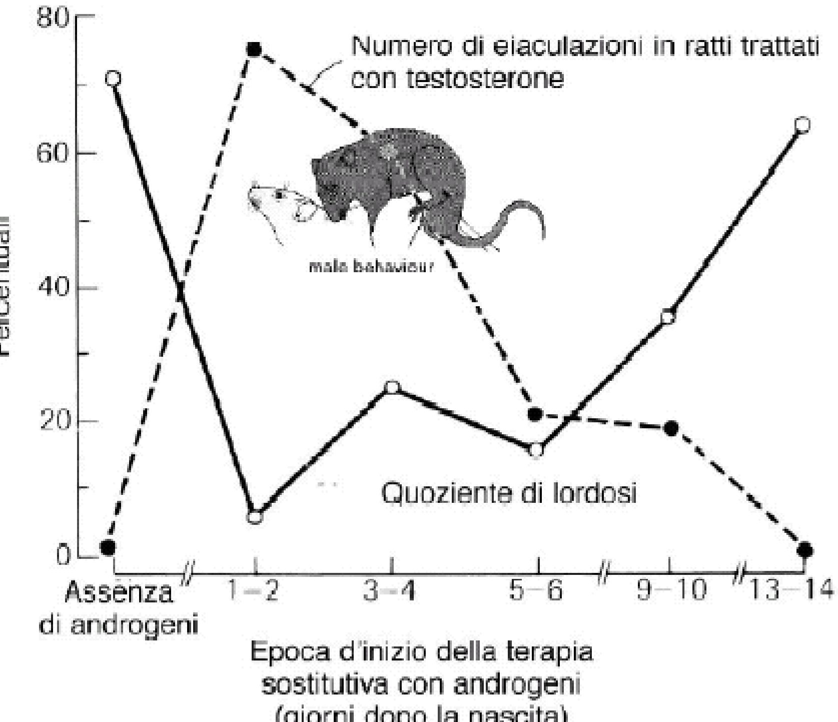
Dimorfismi: differenze di struttura
Diergismi: differenze di funzione



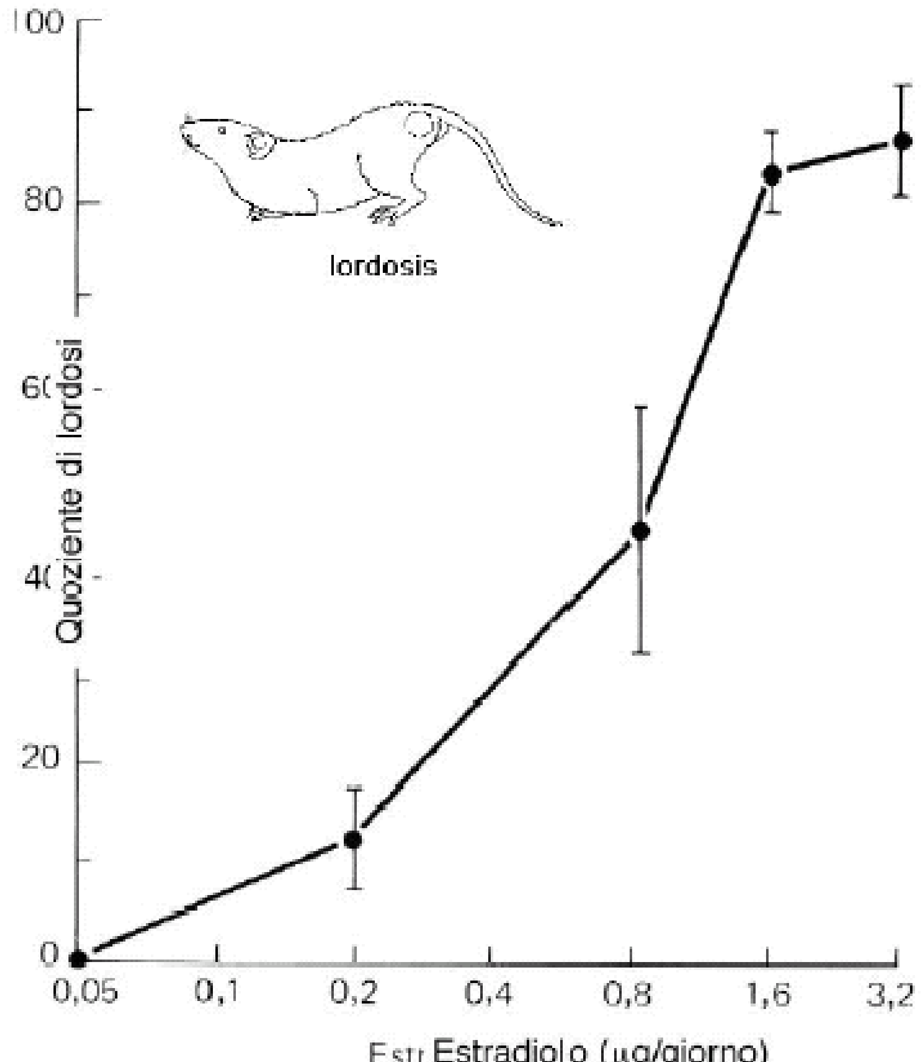
Diergismi comportamentali

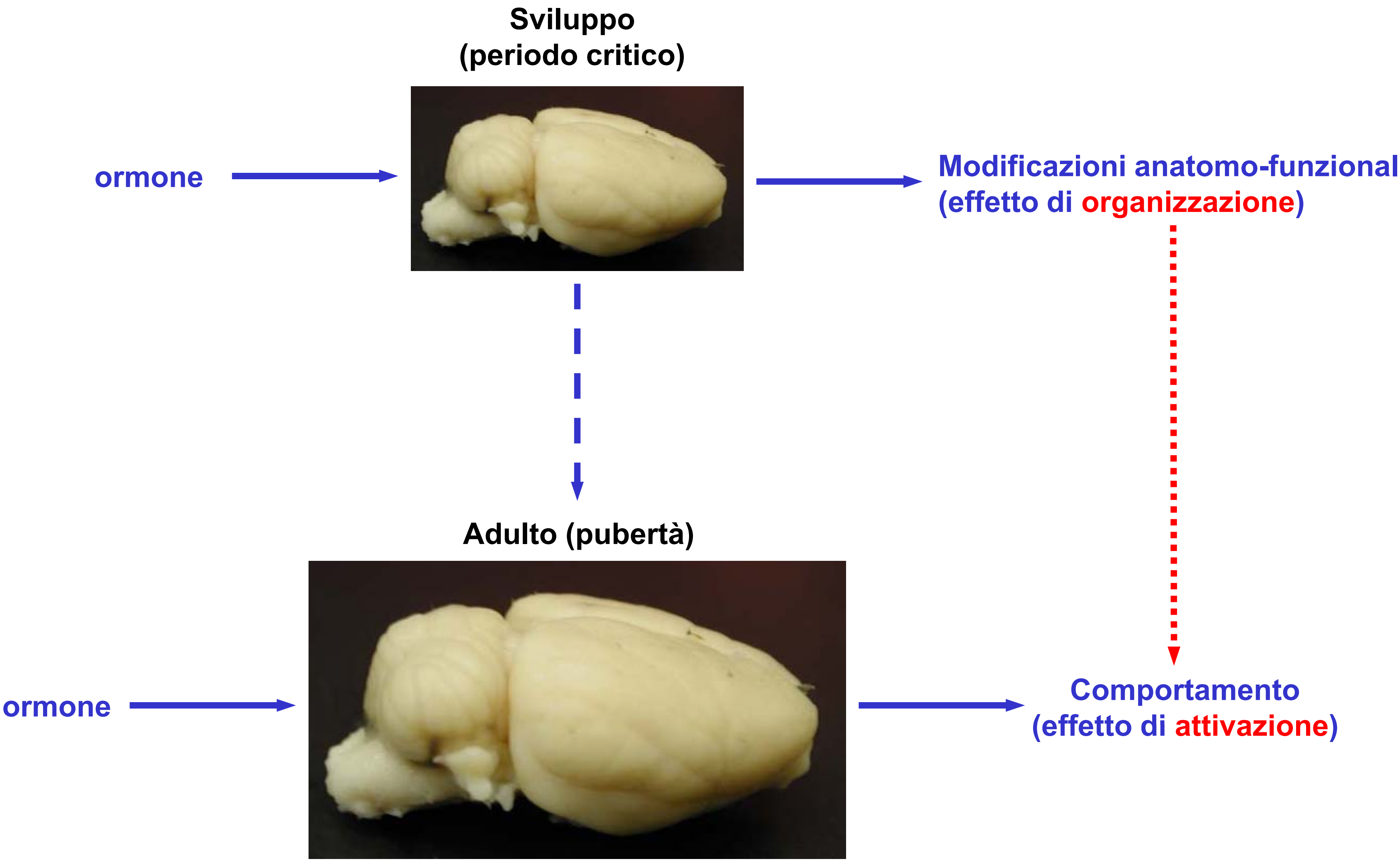
1. Aggressività
2. Cura della prole
3. Comportamento riproduttivo

- Corteggiamento
- Lordosi (F nei mammiferi)
- Copula (M nei mammiferi)



Il comportamento sessuale, maschile o femminile, è in relazione con la quantità di ormone circolante (testosterone o estrogeni).




Sviluppo
(periodo critico)
ormone
Modificazioni anatomo-funzionali
(effetto di organizzazione)
Adulto (pubertà)
ormone
Comportamento
(effetto di attivazione)

maschio

sviluppo

femmina

sviluppo

estosterone

Estroge

bassi live

Modificazione anatomo-funzionale del SNC

mascolinizzazione - femminizzazione

testosterone

Effetto di organizzazione

estrogeni

adulto

adulto

Effetto di attivazione

comportamento sessuale maschile

comportamento sessuale femminile

femmina

sviluppo

testosterone →

testosterone →

← estrogeni

comportamento sessuale maschile

maschio

sviluppo

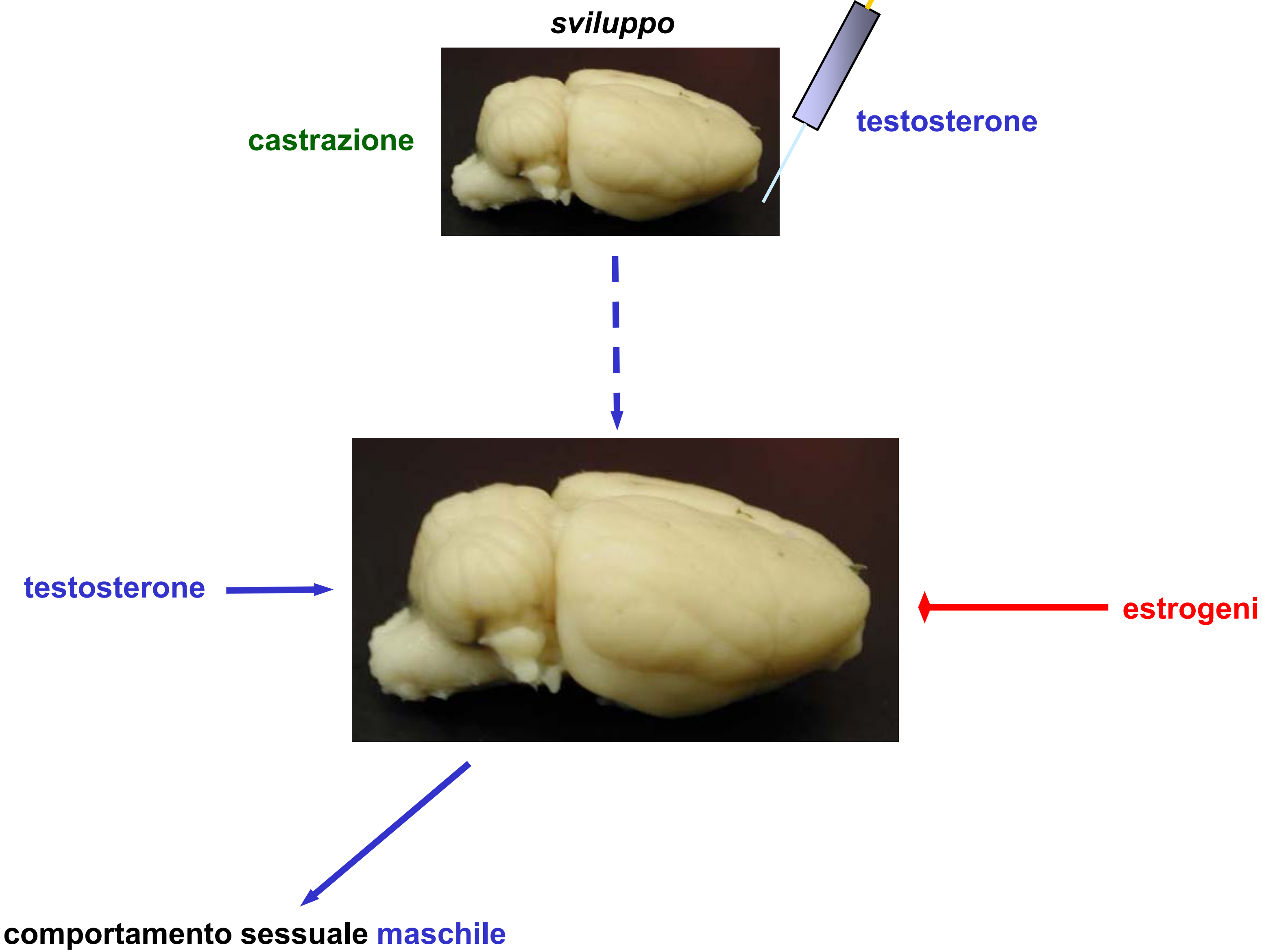
castrazione

testosterone

estrogeni

comportamento sessuale femminile

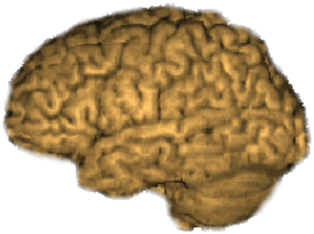
maschio



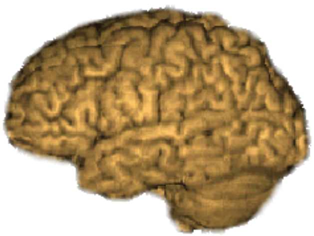
sviluppo
castrazione
testosterone
testosterone
estrogeni
comportamento sessuale maschile

Come agiscono gli ormoni sessuali sullo sviluppo del SNC?

femmina

estradiolo
(bassi livelli) →  **femminizzazione**

maschio

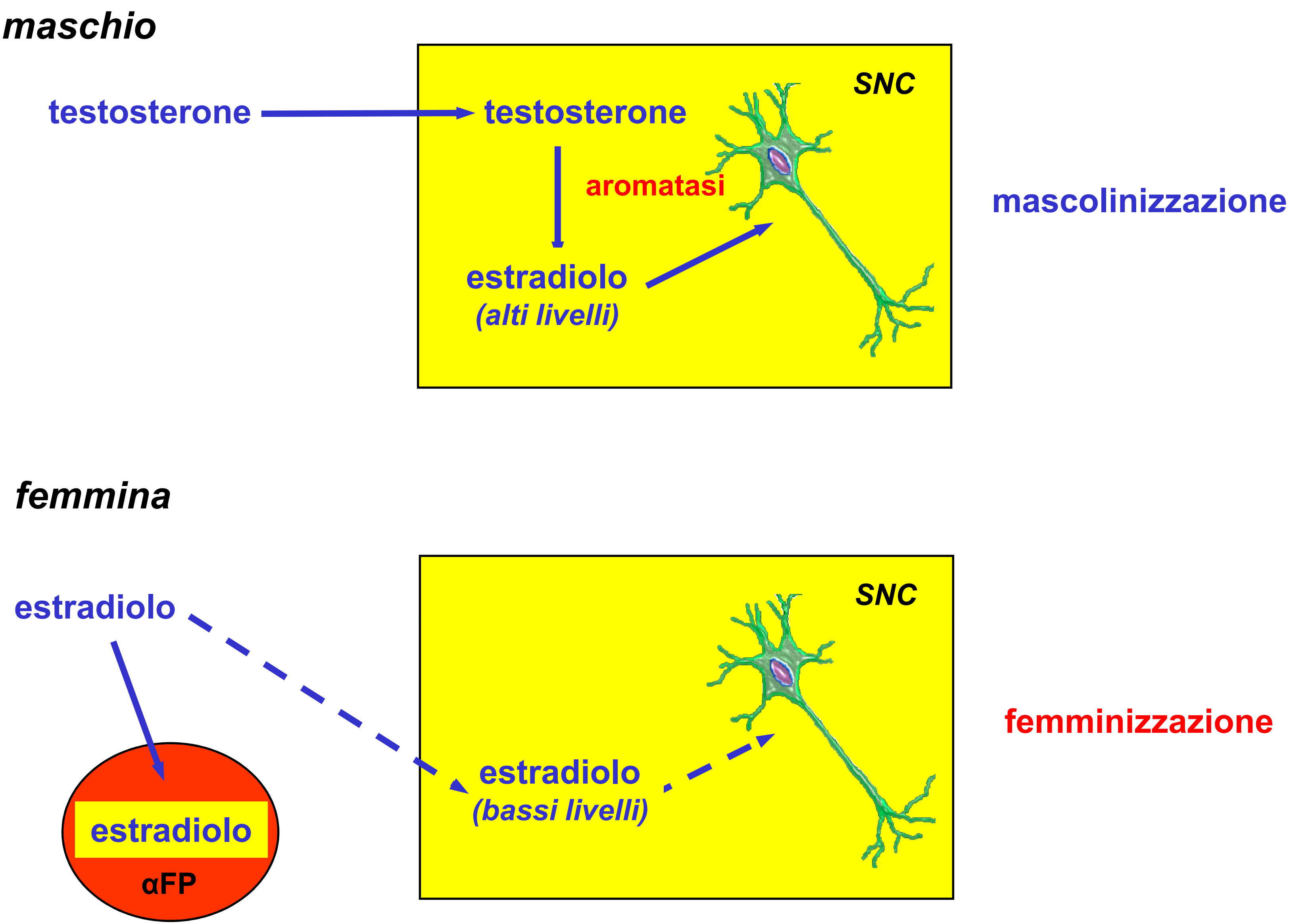
testosterone —aromatasi→ **estradiolo** →  **mascolinizzazione**

Periodo critico

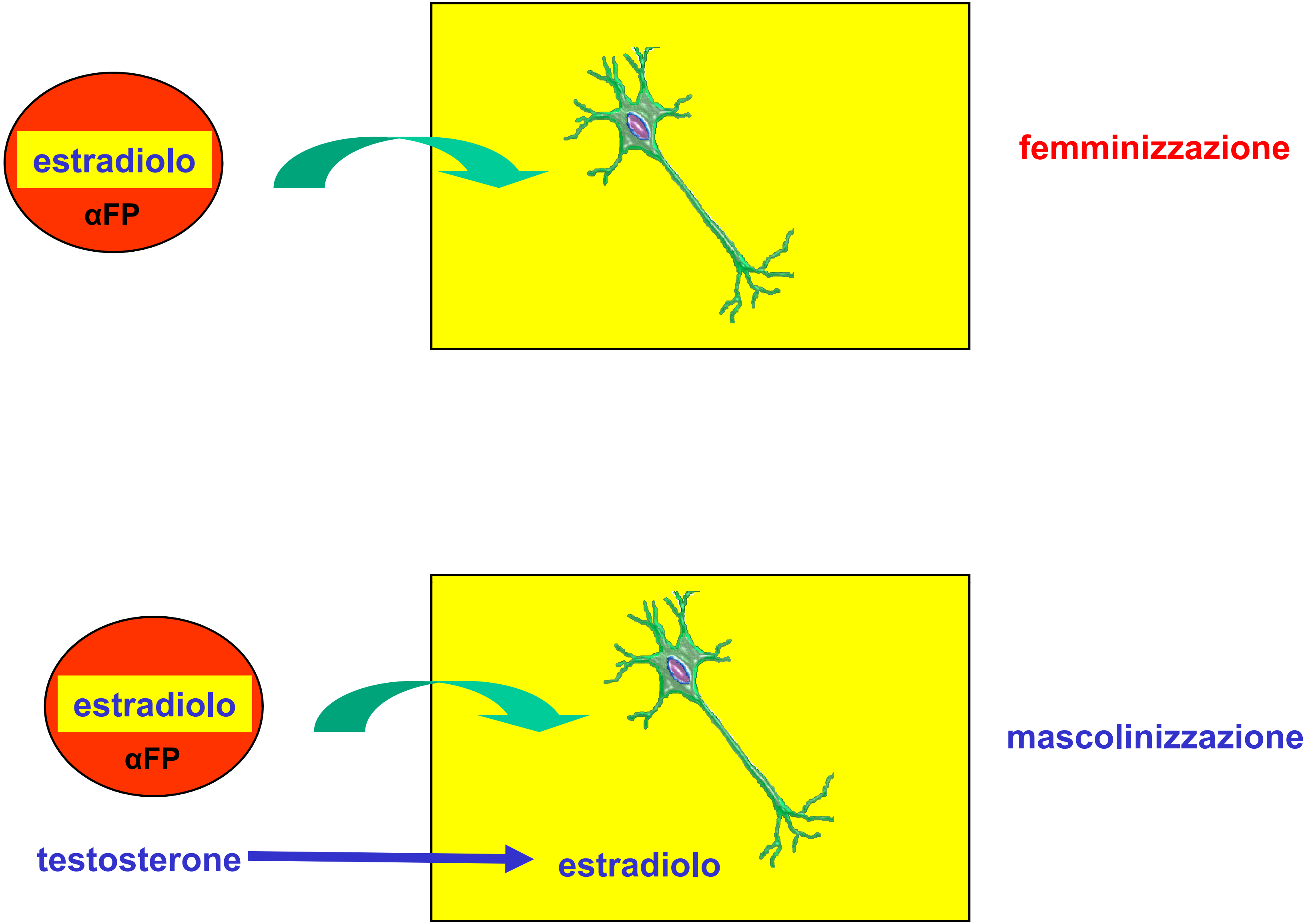
Uomo = 2-5º mese di gestazione
Ratto = pochi giorni prima della nascita

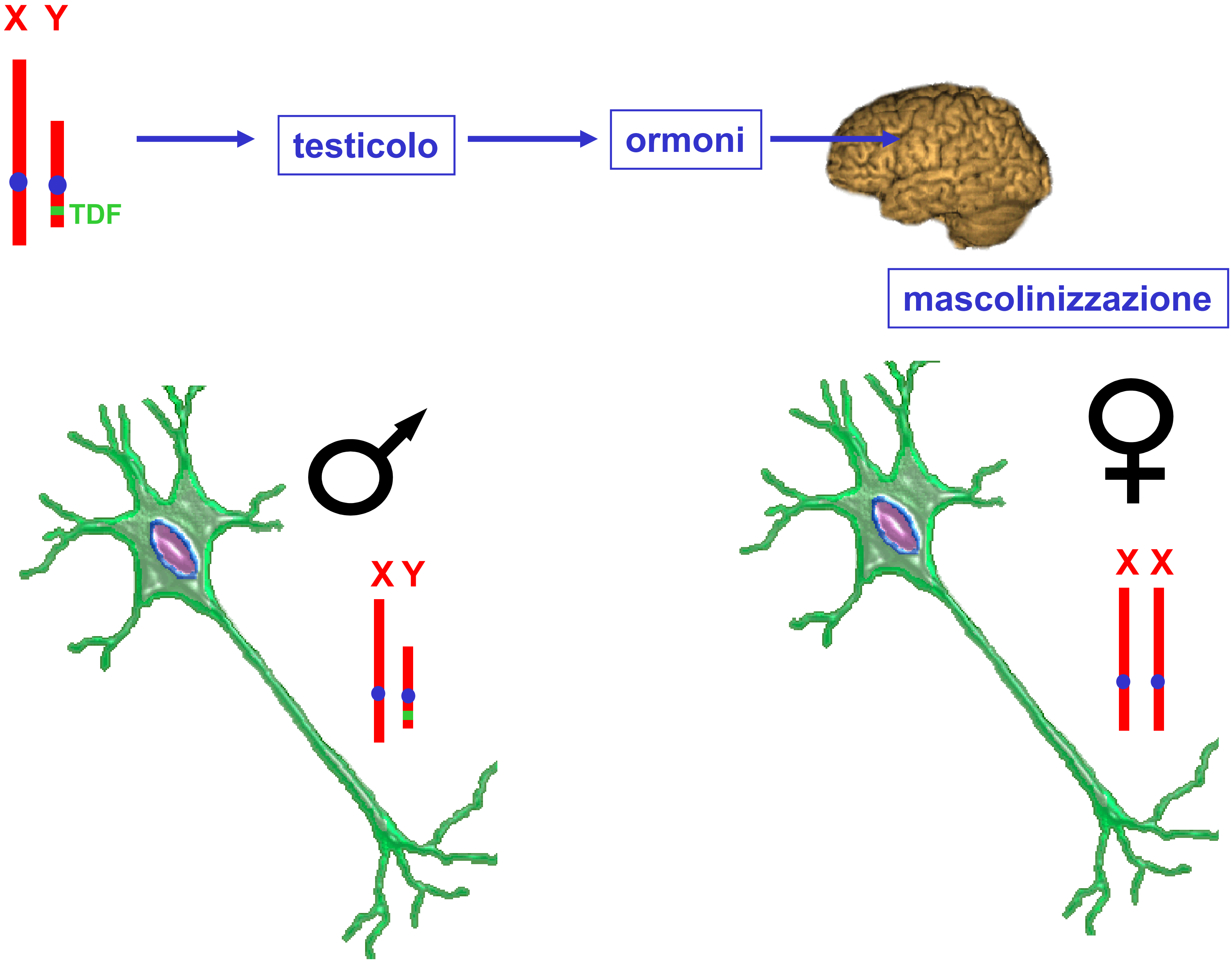
Come fa l'estradiolo (ormone femminile) a mascolinizzare il SNC?

Ipotesi protettiva

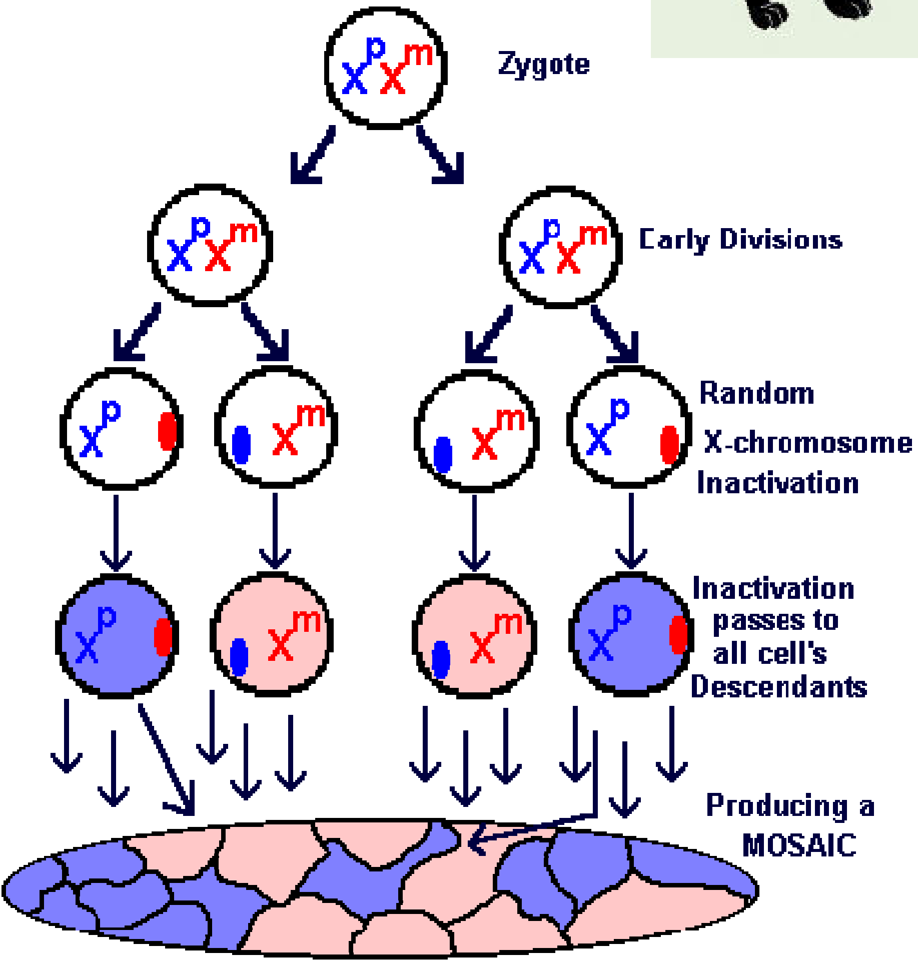


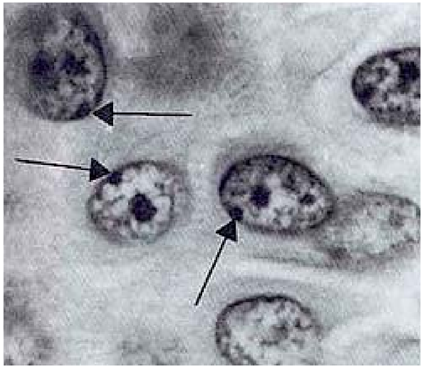
Ipotesi del rilascio




X Y
TDF
testicolo
ormoni
mascolinizzazione
X Y
X X

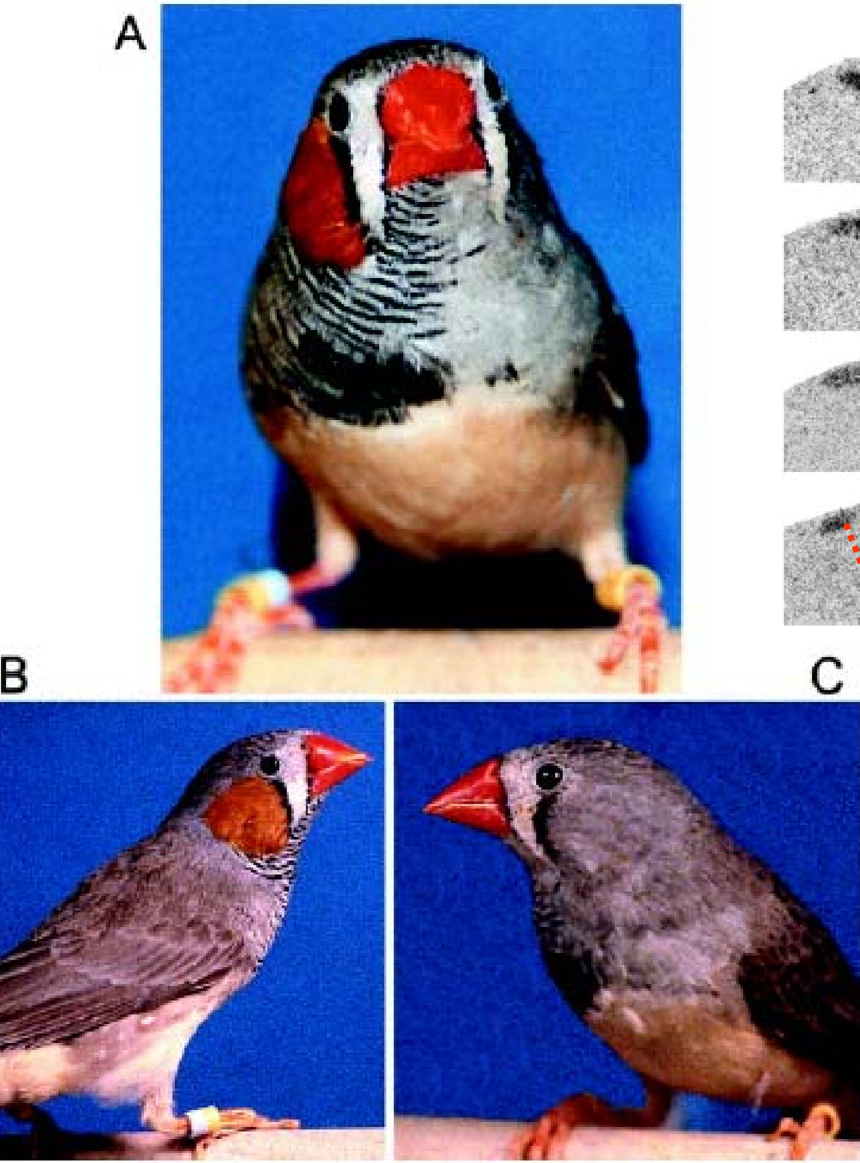
Fenomeno di Mary Lyon

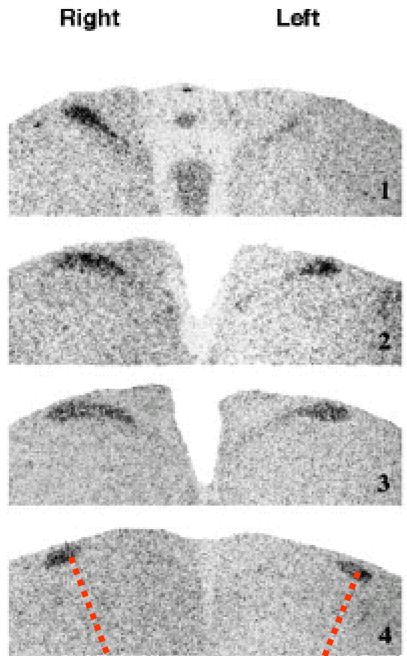




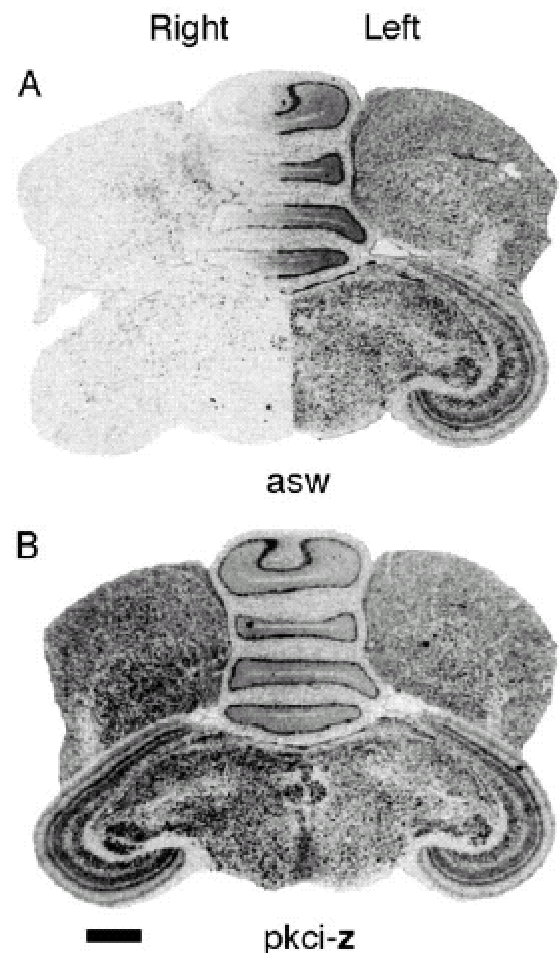
Corpo di Barr

Effetti genetici diretti sul dimorfismo sessuale del sistema nervoso

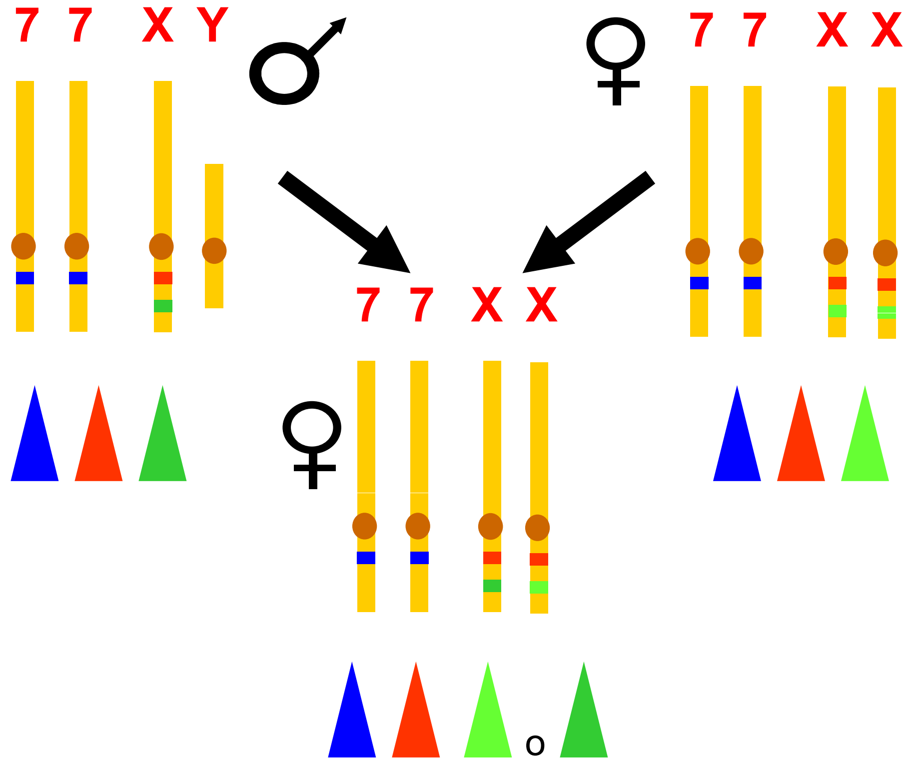




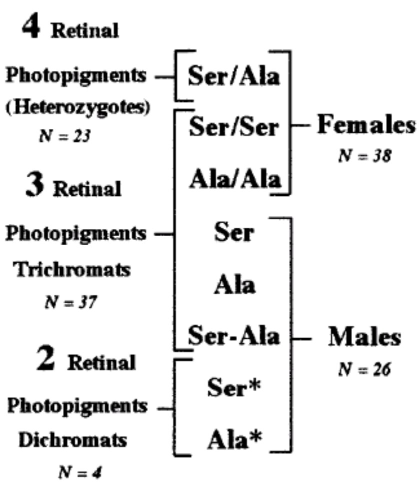
Right = male *ZZ*
Left = female *ZW*



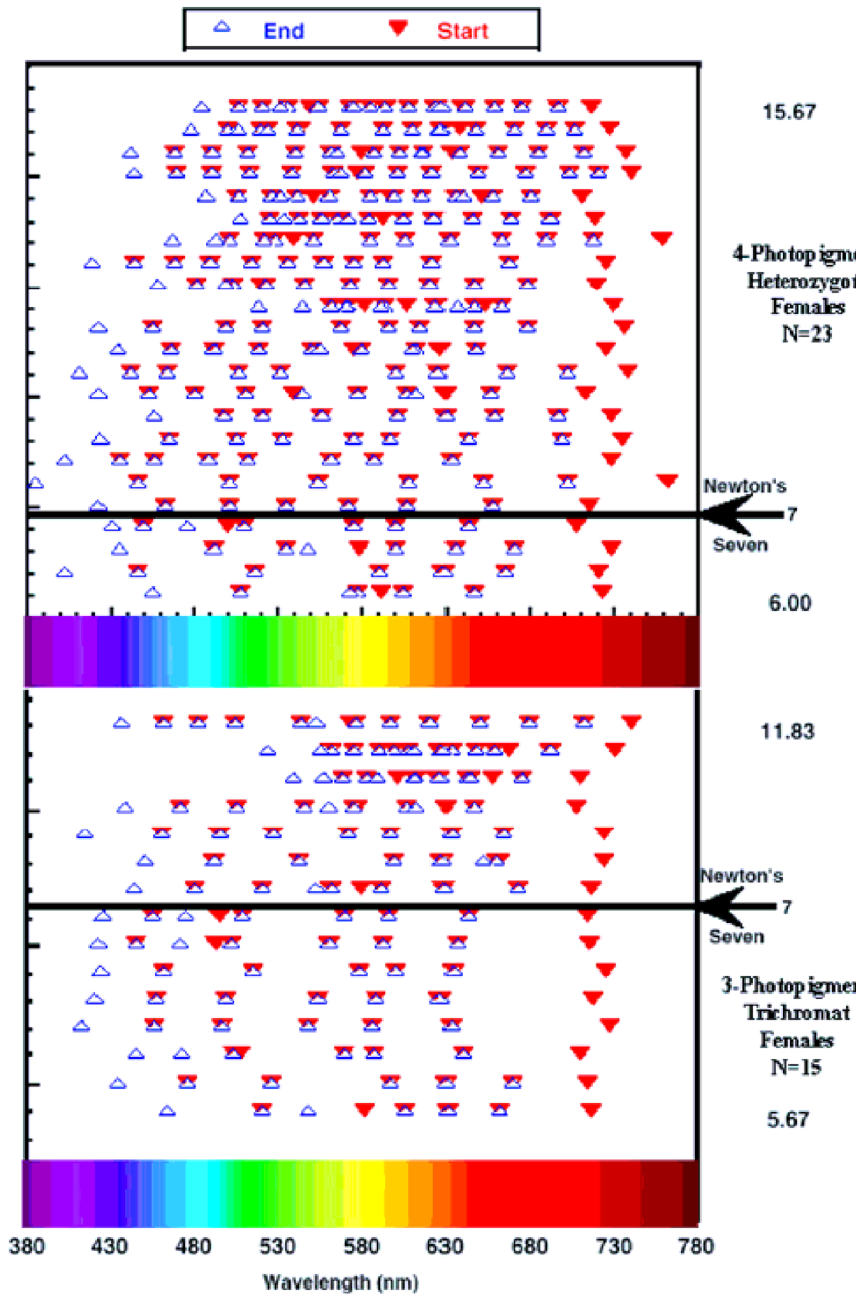
Centro del canto



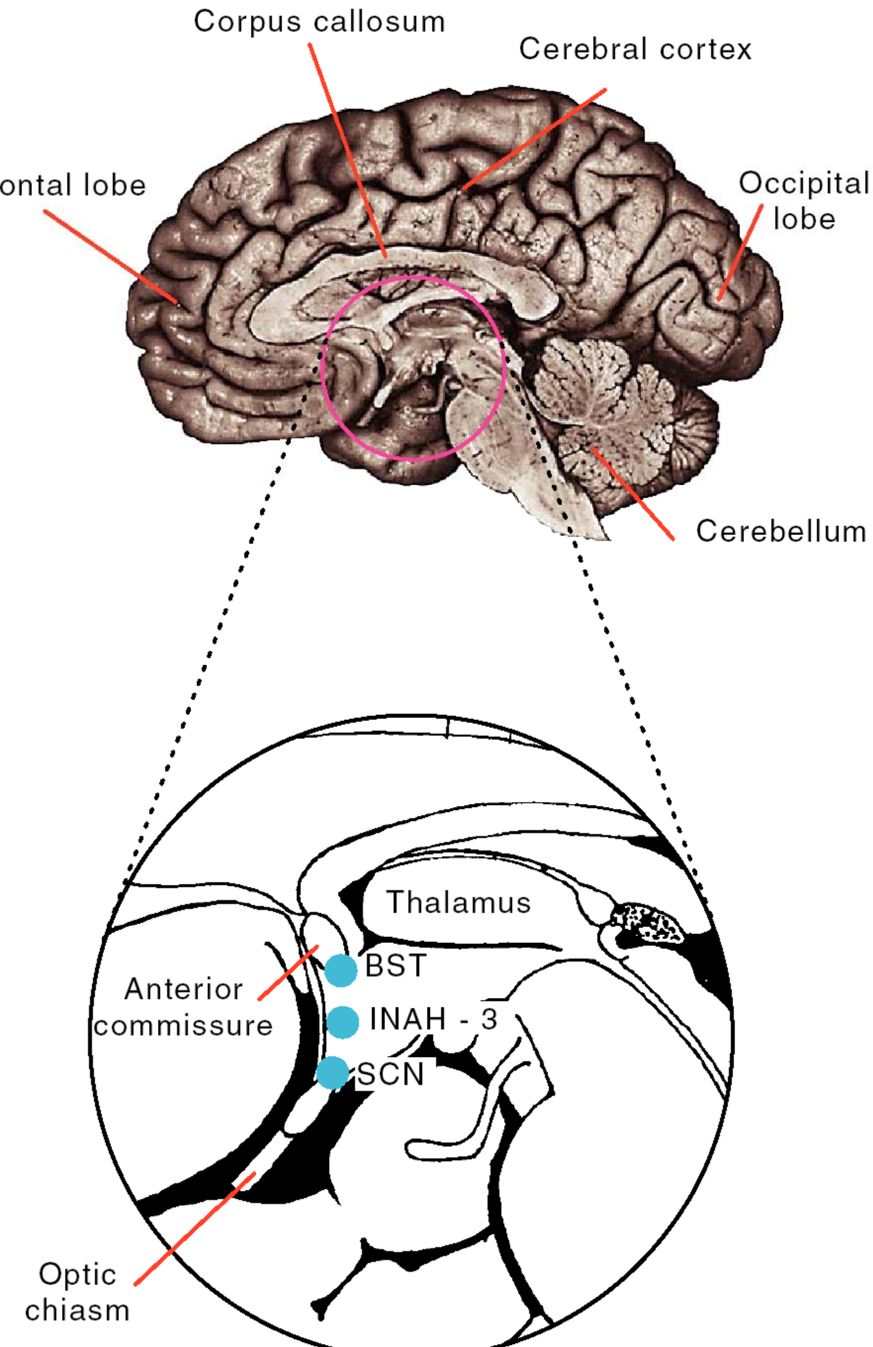
7 7 X Y
♂
♀
7 7 X X
7 7 X X
♀
o



4 Retinal
Photopigments
(Heterozygotes)
N = 23
Ser/Ala
Ser/Ser
Ala/Ala
Females
N = 38
3 Retinal
Photopigments
Trichromats
N = 37
Ser
Ala
Ser-Ala
Males
N = 26
2 Retinal
Photopigments
Dichromats
N = 4
Ser*
Ala*



End
Start
15.67
4-Photopigm
Heterozygot
Females
N=23
Newton's
7
Seven
6.00
11.83
Newton's
7
Seven
3-Photopigmen
Trichromat
Females
N=15
5.67
380
430
480
530
580
630
680
730
780
Wavelength (nm)



Strutture dimorfiche nel SNC umano

Strutture più grandi nel maschio

- **Nucleo della stria terminale**
- **Nuclei interstiziali dell'ipotalamo anteriore (INAH3)**
- **Nucleo dimorfico dell'area preottica (SDN-POA)**
- **Nucleo di Onuf (midollo spinale)**

Strutture più grandi nella femmina

- **Commissura anteriore**
- **Corpo calloso**

Asimmetria maggiore nel maschio

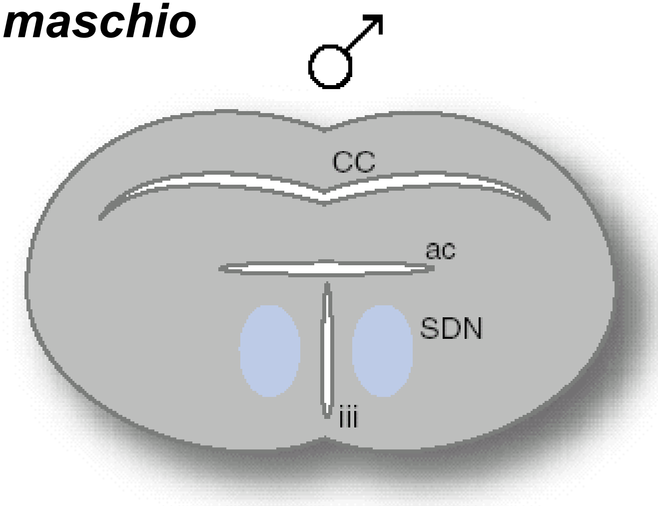
- **Planum temporale**

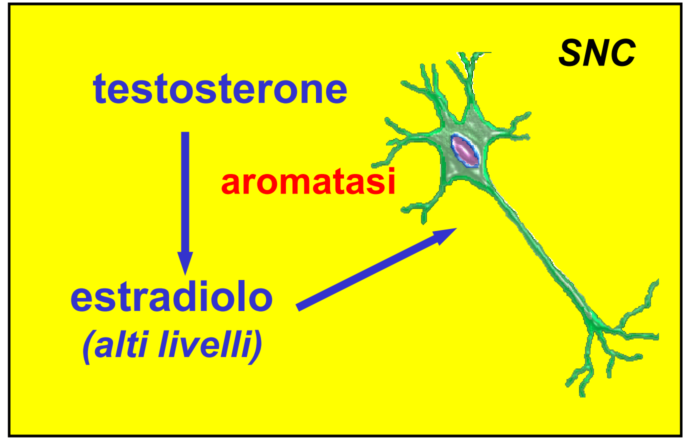
Strutture con forma diversa

- **Splenio del corpo calloso**
- **Nucleo soprachiasmatico (ipotalamo)**

SDN-POA è 5 volte più grande nel maschio che nella femmina

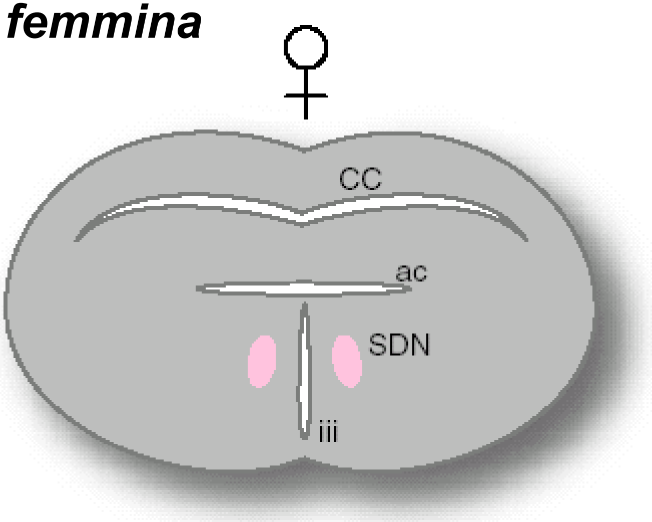
maschio

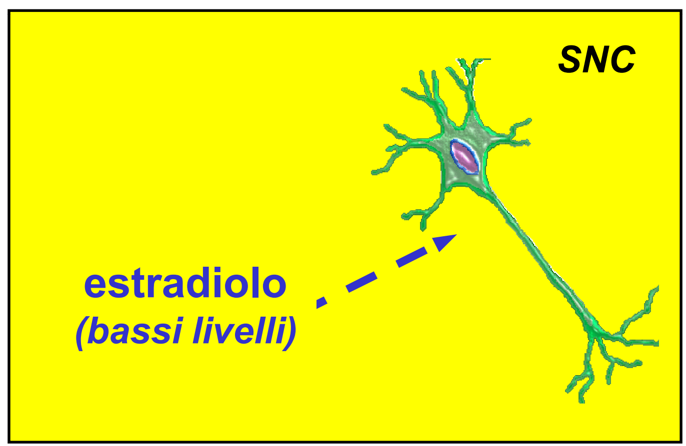




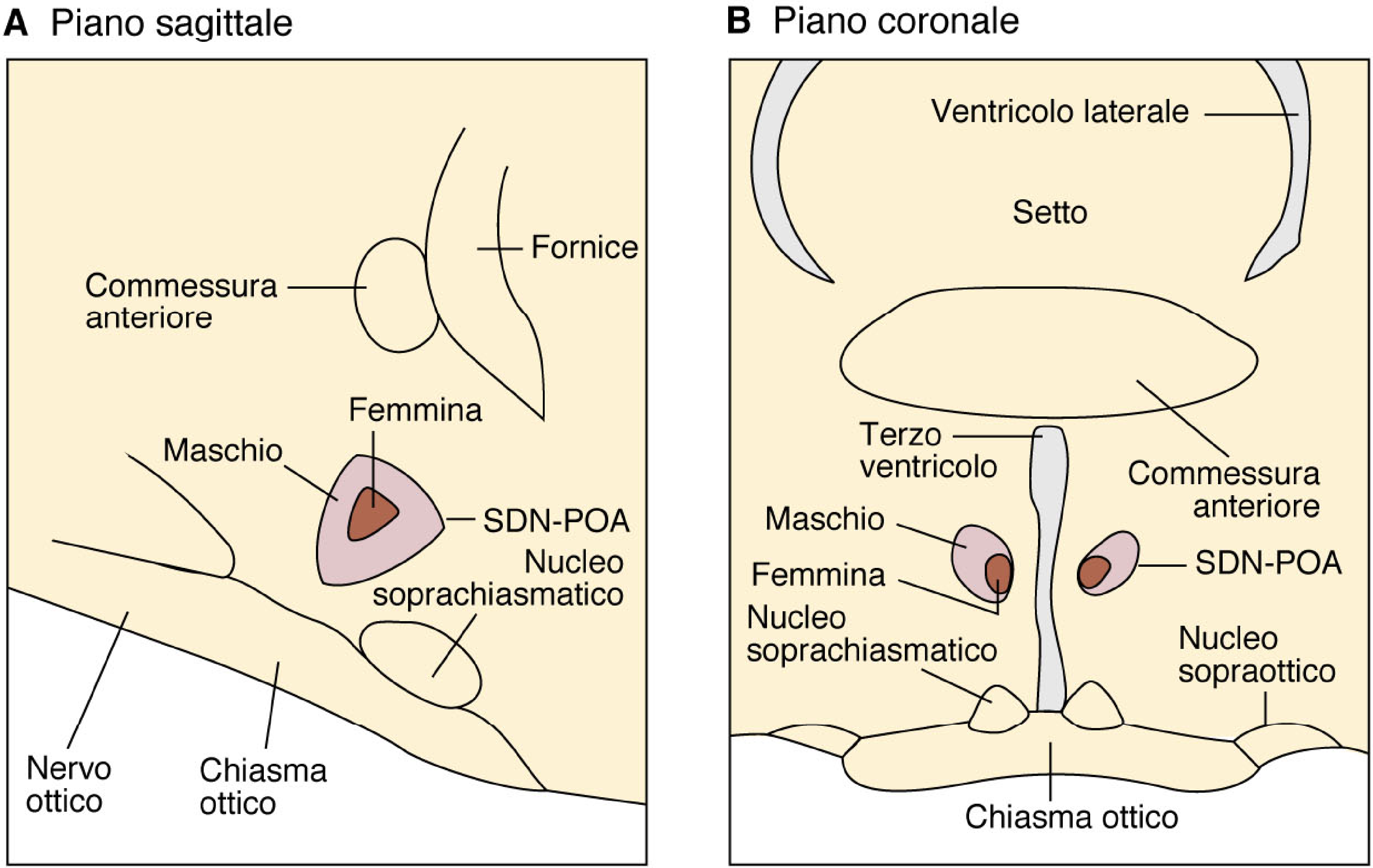
sopravvivenza
(mascolinizzazione

femmina

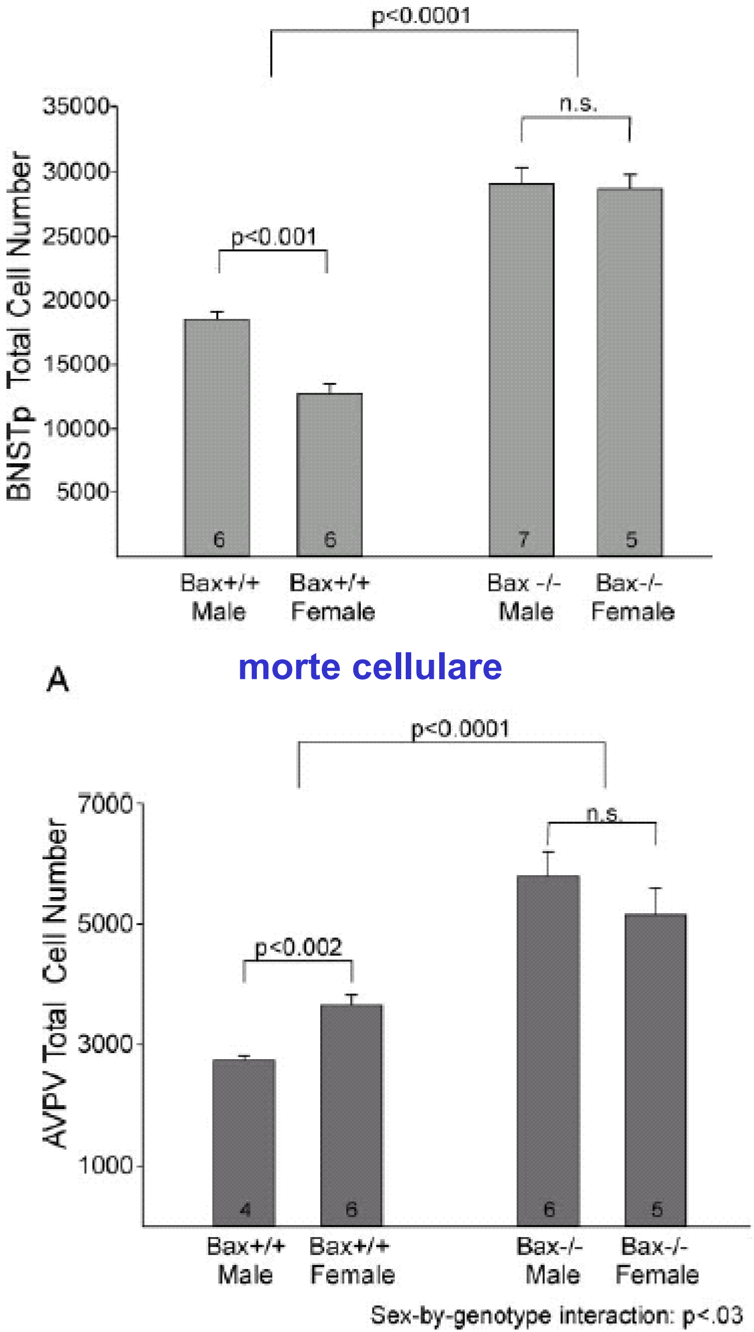




apoptosi
(femminizzazione)

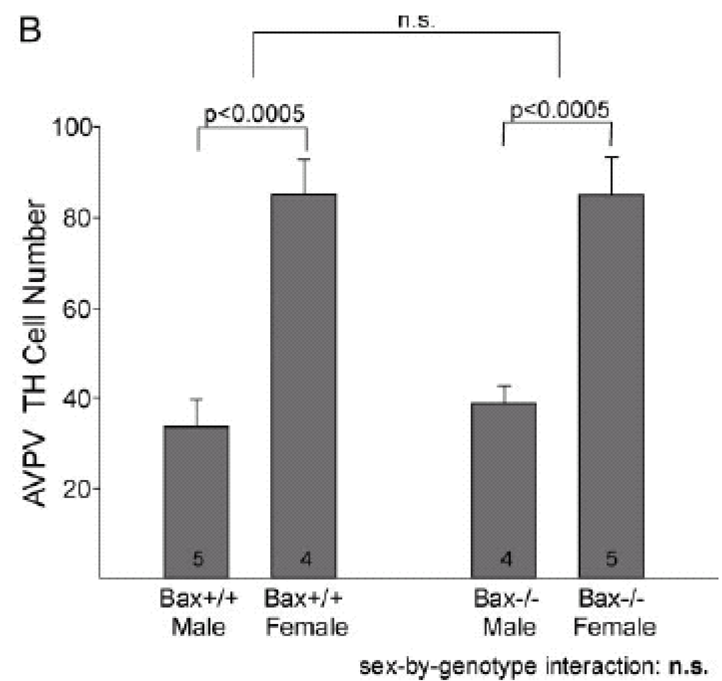

A Piano sagittale
Fornice
Commessura anteriore
Femmina
Maschio
SDN-POA
Nucleo soprachiasmatico
Nervo ottico
Chiasma ottico
B Piano coronale
Ventricolo laterale
Setto
Terzo ventricolo
Commessura anteriore
Maschio
SDN-POA
Femmina
Nucleo soprachiasmatico
Nucleo sopraottico
Chiasma ottico

Eterogeneità dei meccanismi d'azione nel dimorfismo sessuale indotto da ormoni

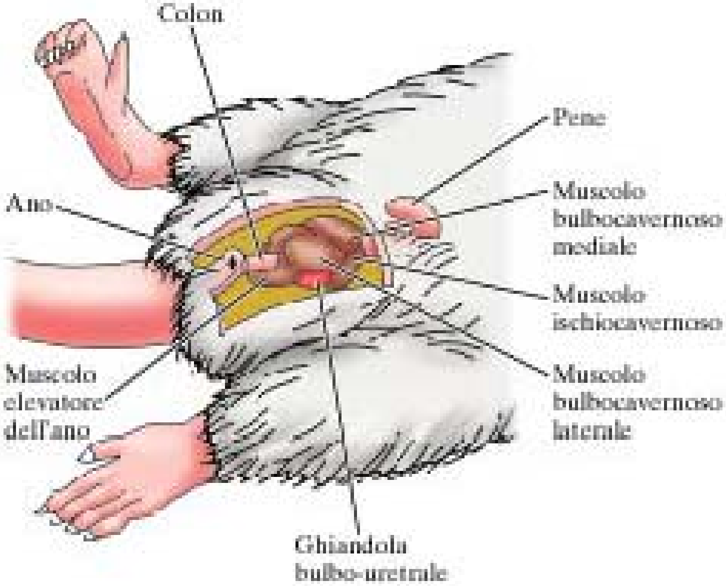


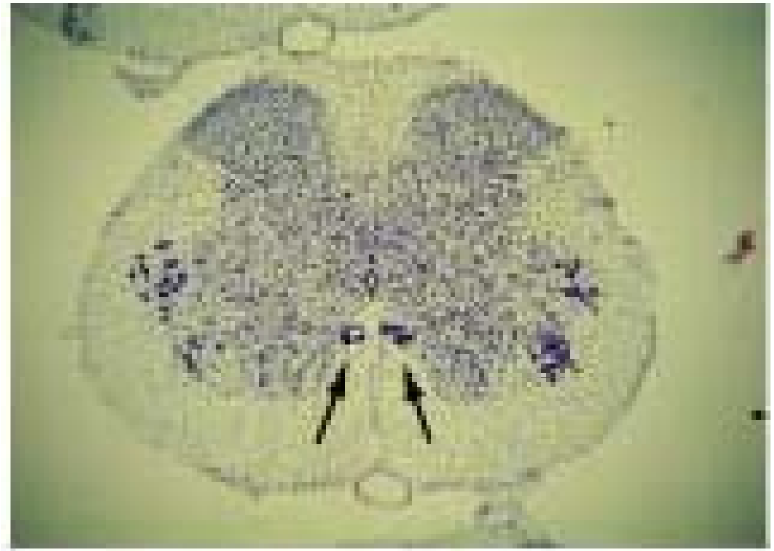
morte cellulare

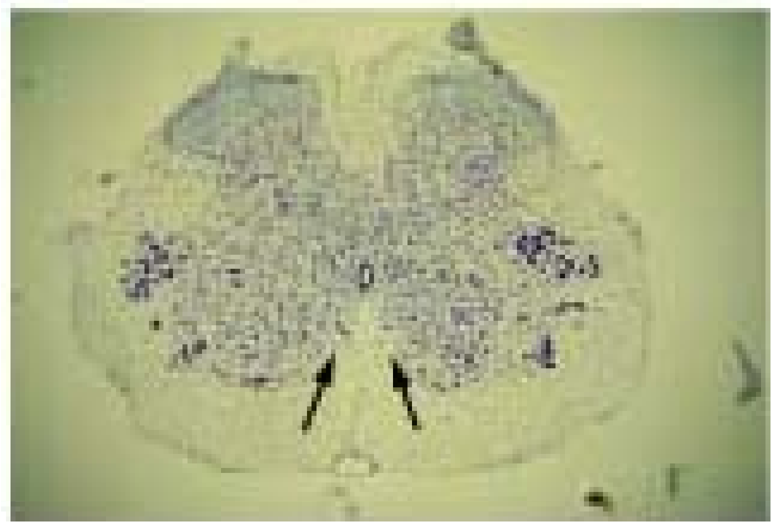
espressione genica



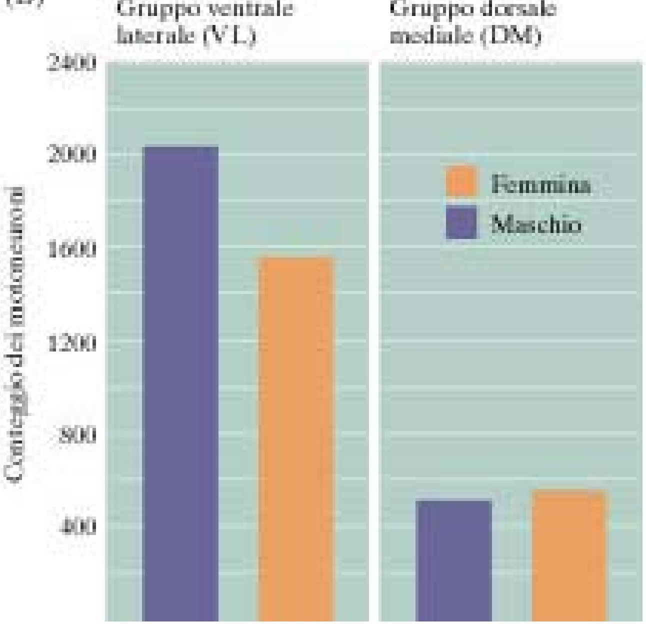
(A) Pelvi di ratto maschio

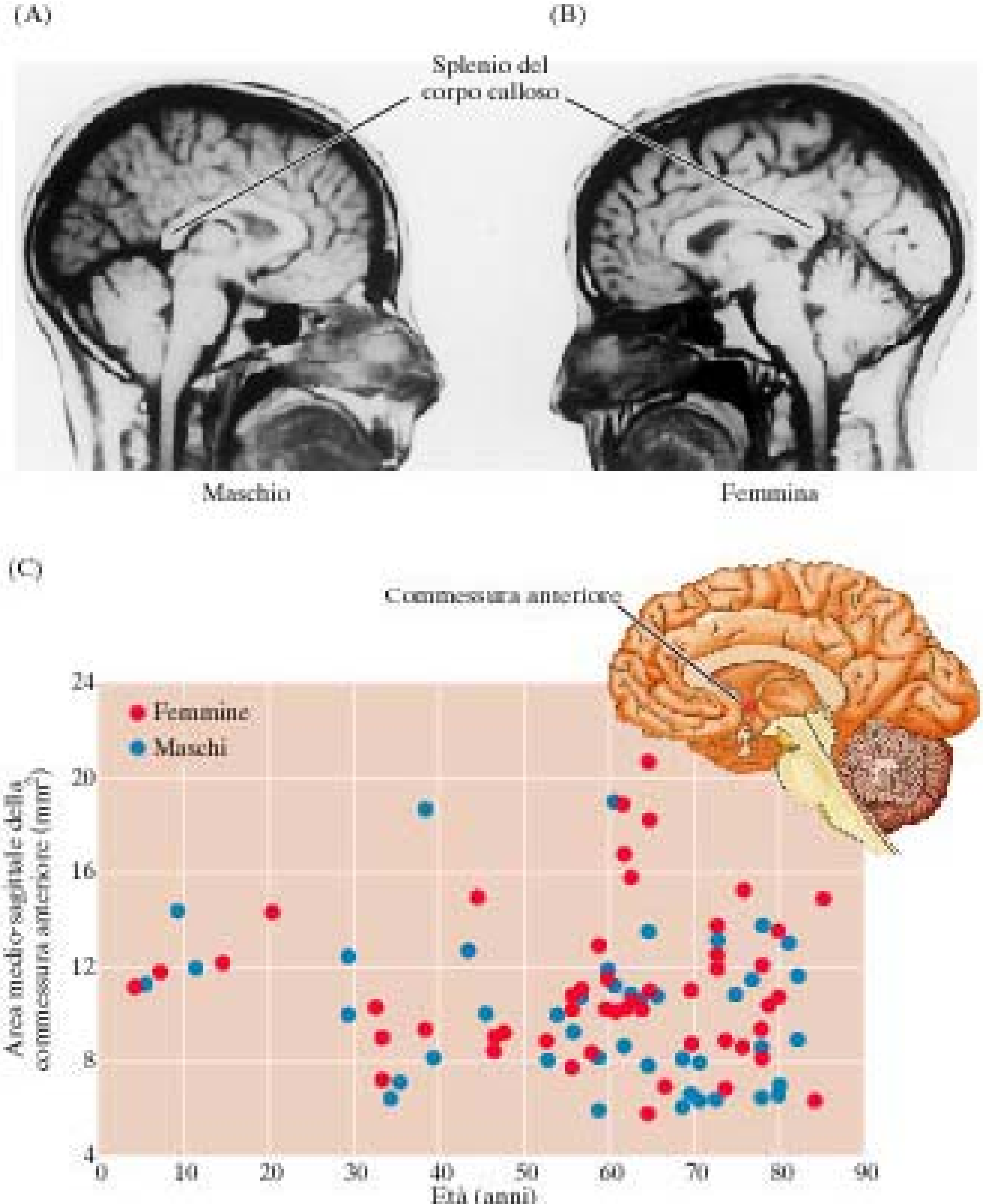




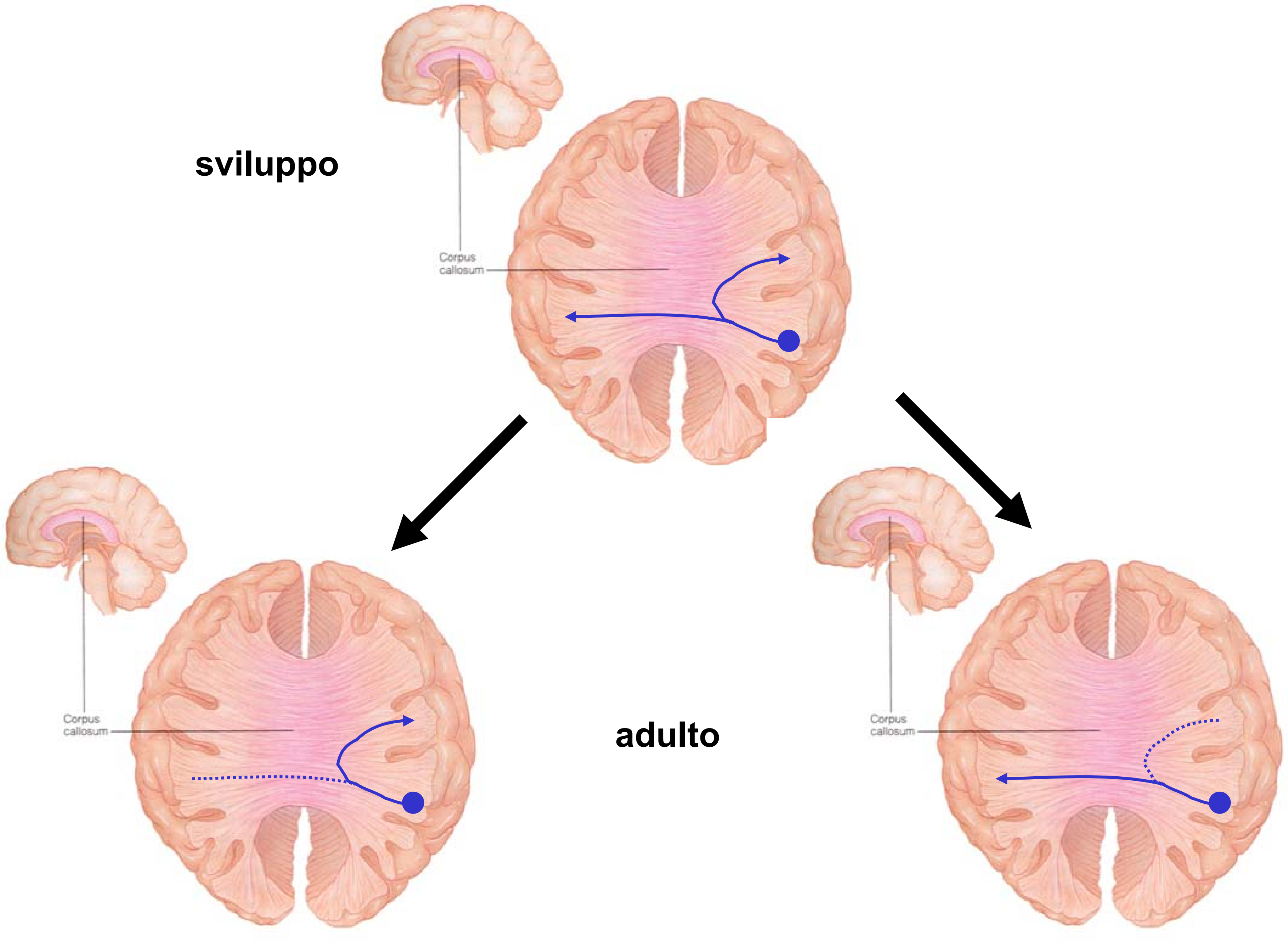


(D)



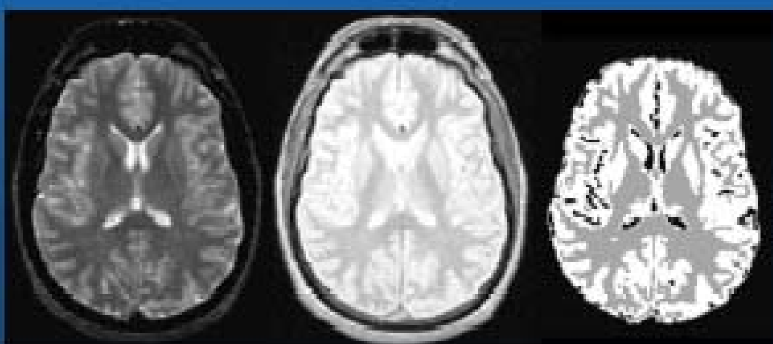


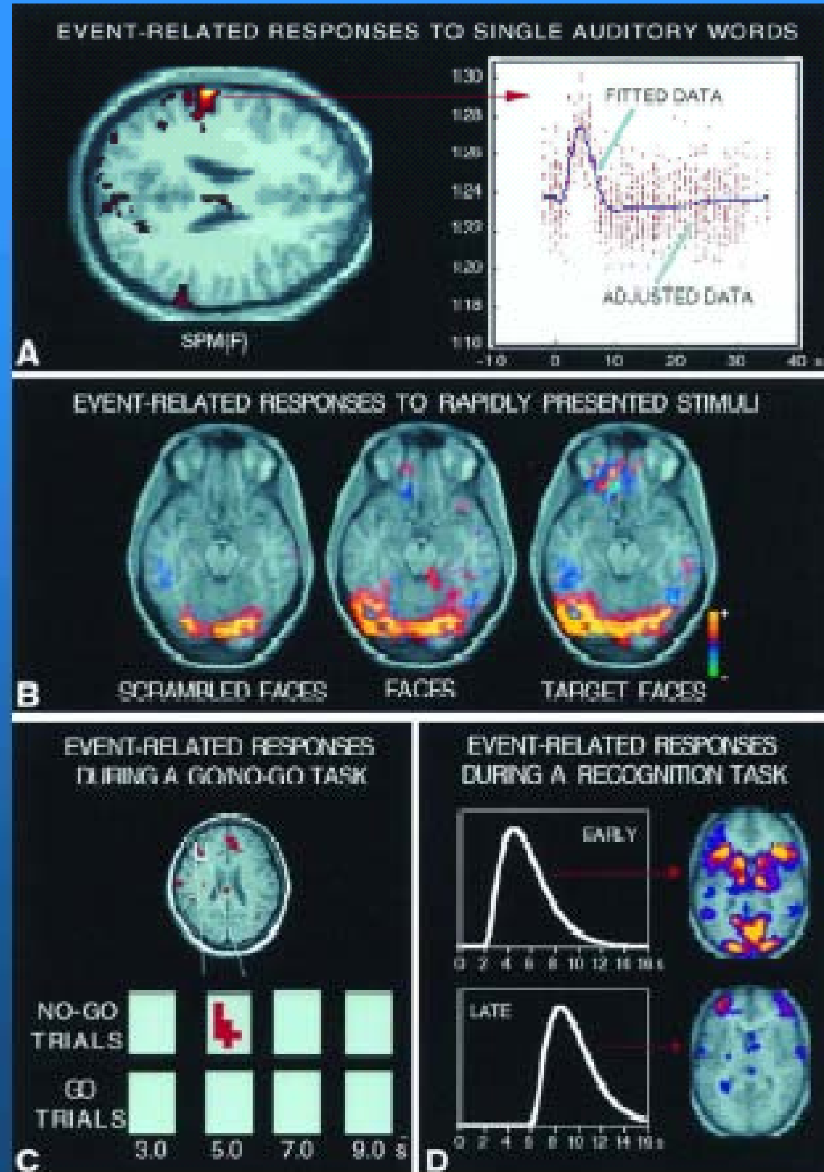
(A)
(B)
Splenio del corpo calloso
Maschio
Femmina
(C)
Commessura anteriore
Femmine
Maschi
Area medio-sagittale della commessura anteriore (mm²)
Età (anni)
4
8
12
16
20
24
0
10
20
30
40
50
60
70
80
90


sviluppo
Corpus callosum
Corpus callosum
adulto
Corpus callosum

Metodi di indagine

- Esame autoptico
- EEG
- TAC
- PET
- MRI - fMRI





Dolore

- Donne più sensibili agli stimoli nocicettivi
- Oppioidi più efficaci nelle donne che negli uomini

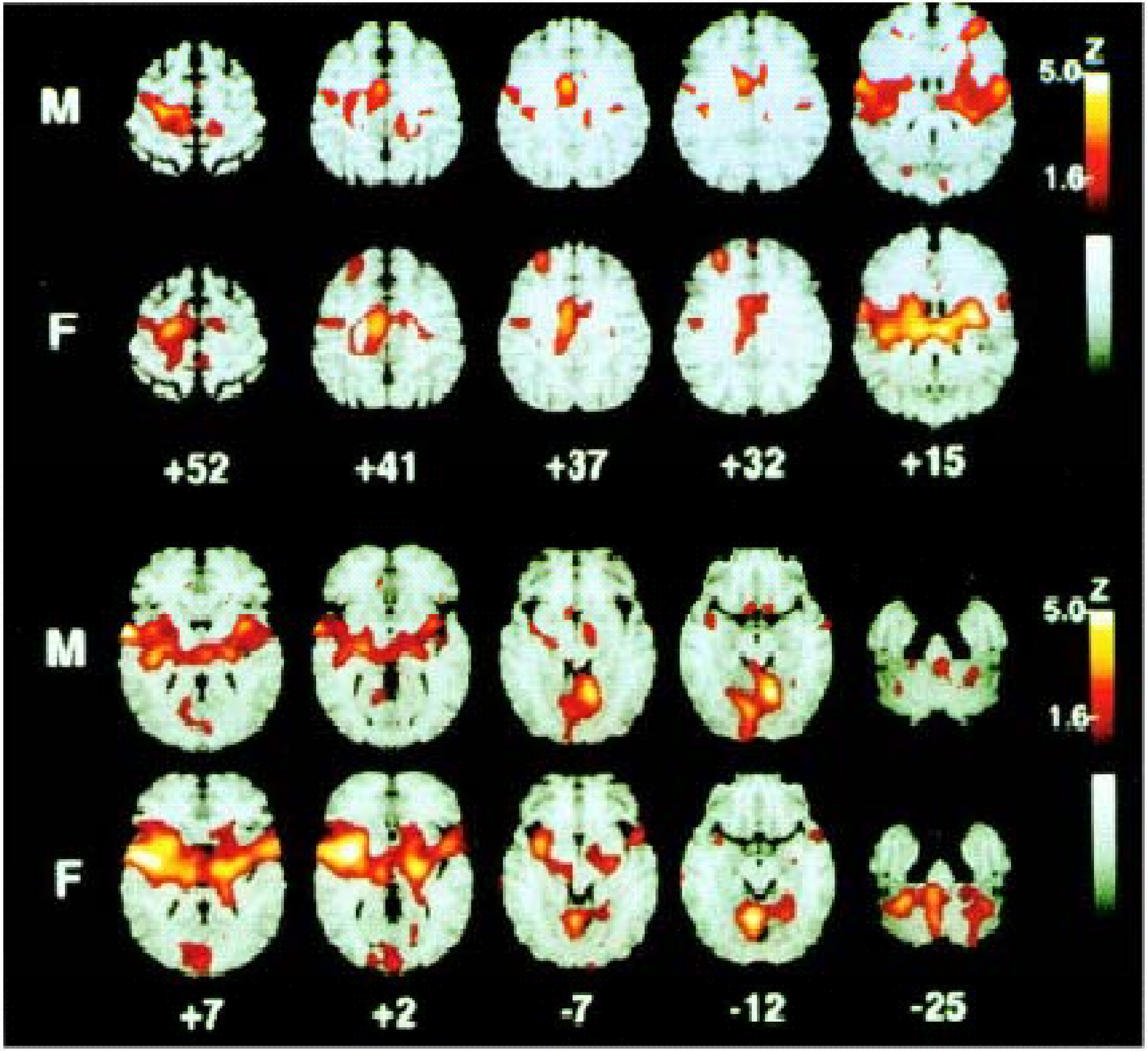
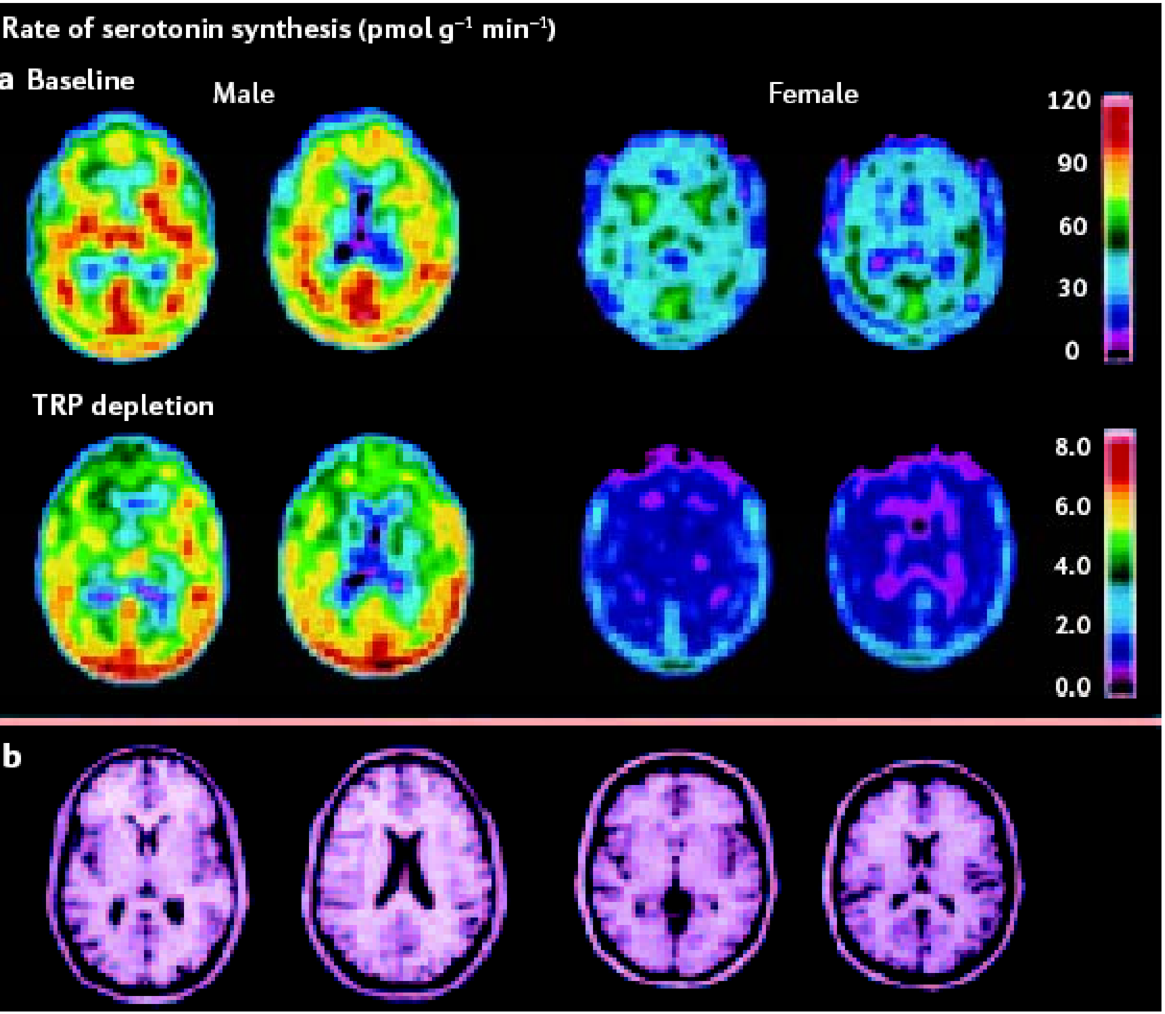
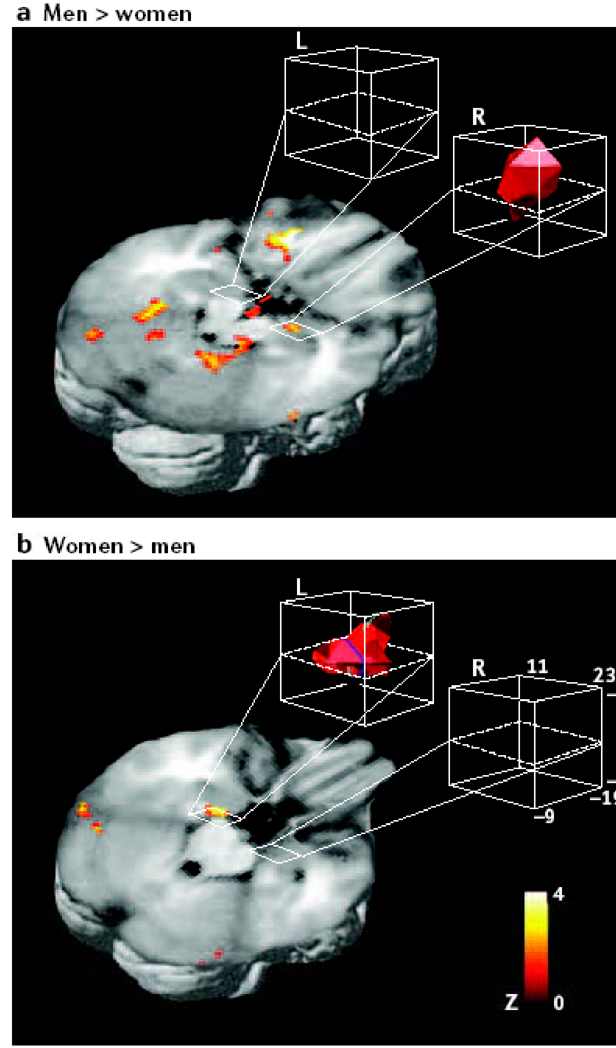


Fig. 5. Differenze sessuali nella risposta cerebrale ad uno stimolo dolorifico di natura termica applicato sulla faccia volare dell'avambraccio. Si noti l'attivazione di aree diverse nei due sessi e la diversa estensione ed attivazione delle strutture (maggiore nelle donne). Da Casey, 1999.


Rate of serotonin synthesis (pmol g⁻¹ min⁻¹)
a Baseline
Male
Female
120
90
60
30
0
TRP depletion
8.0
6.0
4.0
2.0
0.0
b


a Men > women
L
R
b Women > men
L
R
11
23
−9
−19
4
Z
0

Linguaggio

- Aree del linguaggio più grandi in femmine
- lateralizzazione maggiore nei soggetti maschi e nei destrimani
- dislessia più nei maschi e associata a microdigenesia

Capacità cognitive

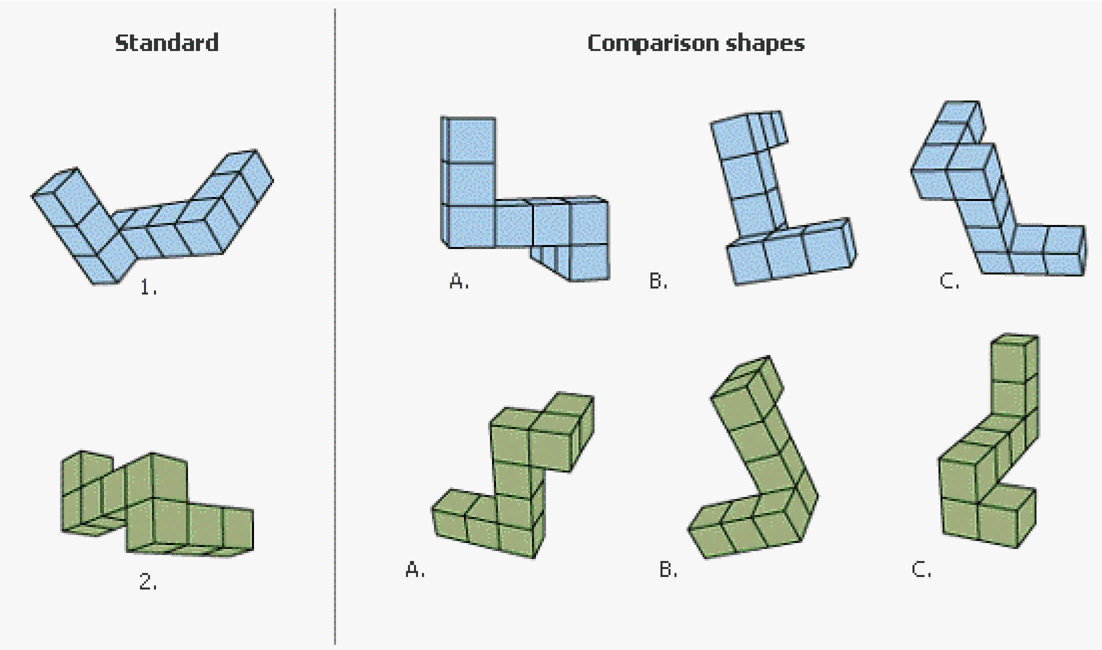
- Equivalenza nei test intellettivi, ma:
  - maschi migliori performance logico-matematiche, pilotaggio, orientamento spaziale
  - femmine migliori capacità linguistiche , memoria verbale, lavori di precisione

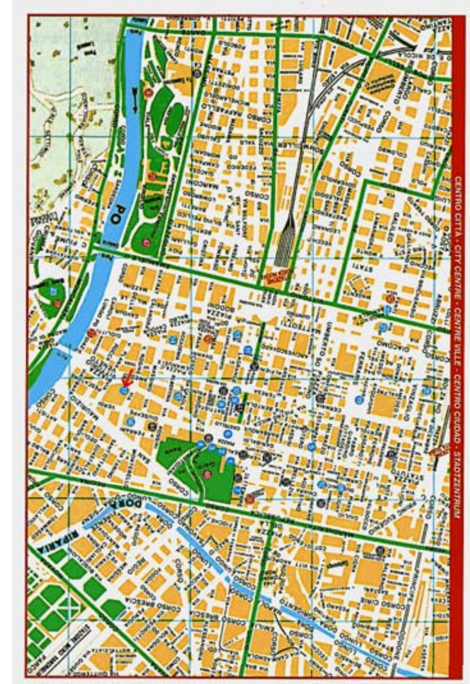
Table I. Some abilities favouring men and women, respectively

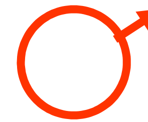
PROBLEM-SOLVING TASKS FAVOURING MEN	PROBLEM-SOLVING TASKS FAVOURING WOMEN
SPATIAL ORIENTATION – making a correction for a change in orientation of an object, e.g., "mental rotation"	**OBJECT LOCATION MEMORY** – recall of the location of objects in an array
VISUALIZATION – determining how a depicted object will appear when manipulated, e.g. folded	**PERCEPTUAL SPEED** – rapid identif- ication of matching or designated items
LINE ORIENTATION – matching the slope of a line	**VERBAL MEMORY** – recall of a story, paragraph or list of unrelated words
MATHEMATICAL REASONING – solving a novel mathematical problem	**NUMERICAL CALCULATION** – adding, subtracting, etc., of given numbers
THROWING ACCURACY – hitting a distant target	**DEXTERITY** – manual tasks involving precision

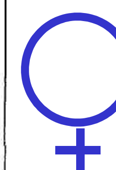
Table II. Prepubertal sex differences in cognitive and motor function.

AUTHOR/ YEAR	AGES	FINDINGS
Rosser *et al.*, 1984	4–5	Boys better at spatial rotation
Vederhus & Krekling, 1996	9	Boys better on spatial tasks
Lunn, 1997	3–4	Boys better on targeting
Levine *et al.*, 1999	5–6	Boys better on spatial transformations, mazes
Denckla & Rudel, 1974	5–11	Girls faster at colour naming
Ingram, 1975	3–5	Girls better at copying hand postures
McGuinness *et al.*, 1990	7–10	Girls better memory for words


Standard
Comparison shapes
1.
A.
B.
C.
2.
A.
B.
C.







schizofrenia

- Incidenza maggiore nelle femmine
- eziologia ancora ignota ma riscontro di alterazioni a livello encefalico
- Nelle donne significativa assenza della massa intermedia del talamo

Morbo di Alzheimer

- Maggiore incidenza in soggetti di sesso femminile forse legata alla brusca diminuzione di estrogeni circolanti
- terapia ormonale sostituiva non migliora i sintomi in fase conclamata, ma ritarda insorgenza della malattia se attuata in fase precoce

Morbo di Parkinson

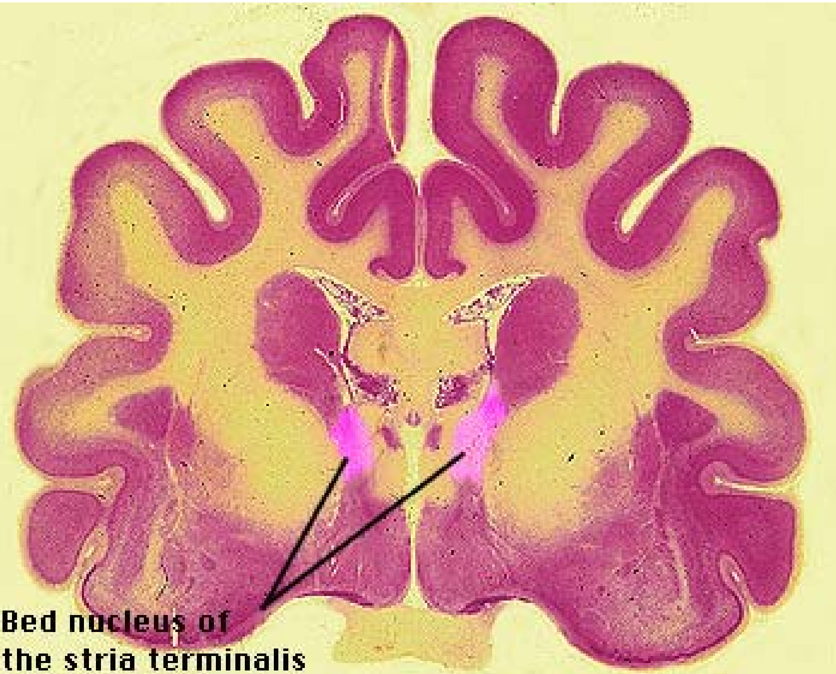
- Eziologia sconosciuta (genetica? tossica?)
- incidenza maggiore nei soggetti maschi
- mediante PET individuate zone della corteccia frontale dimorfiche

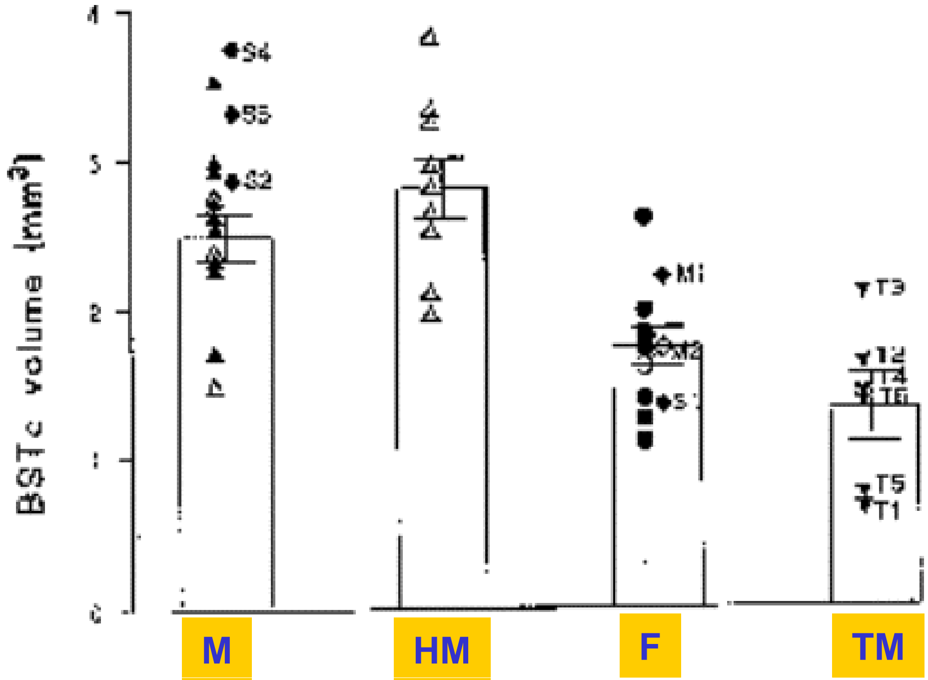
Dimorfismo ed orientamento sessuale

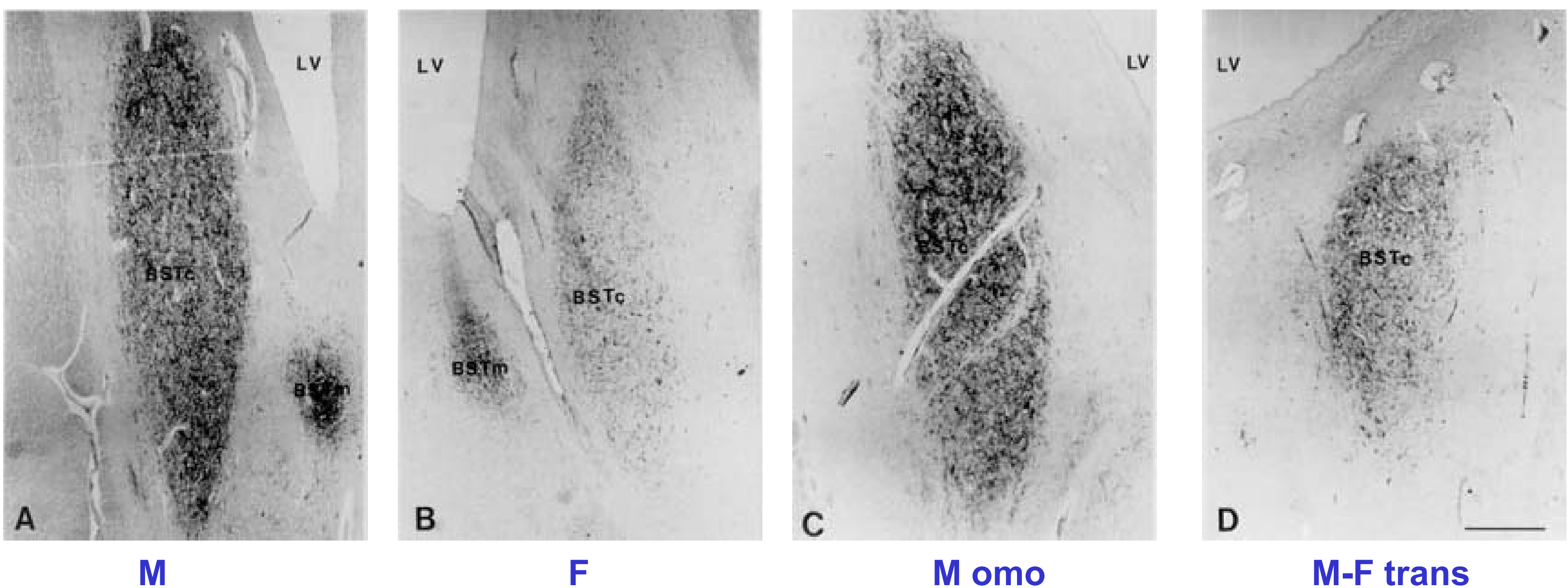
Problemi metodologici per le indagini nell'uomo

- Non è possibile allestire gruppi sperimentali omogenei
- Difficoltà nel ricostruire la "storia clinica" dei soggetti di studio
- Presenza di patologie neurologiche o altre (AIDS)
- I reperti autoptici hanno condizioni diverse a seconda delle modalità di prelievo e conservazione

Negli animali da esperimento l'esposizione agli ormoni dell'altro sesso durante il periodo critico modifica il comportamento sessuale ed induce interesse per partners dello stesso sesso
Tuttavia, in questi casi sono indotte profonde modificazioni anatomiche che non si ritrovano negli omosessuali umani


Bed nucleus of
the stria terminalis

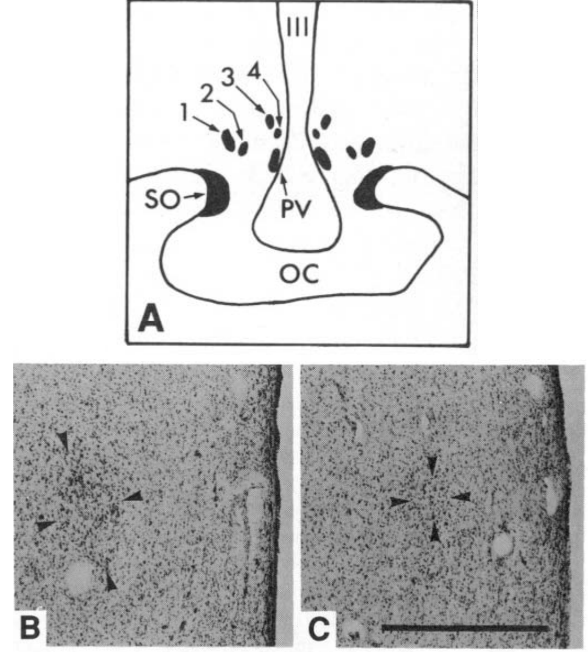

BSTc volume (mm³)
S4
S5
S2
M1
S1
T3
T2
T4
T5
T1
M
HM
F
TM

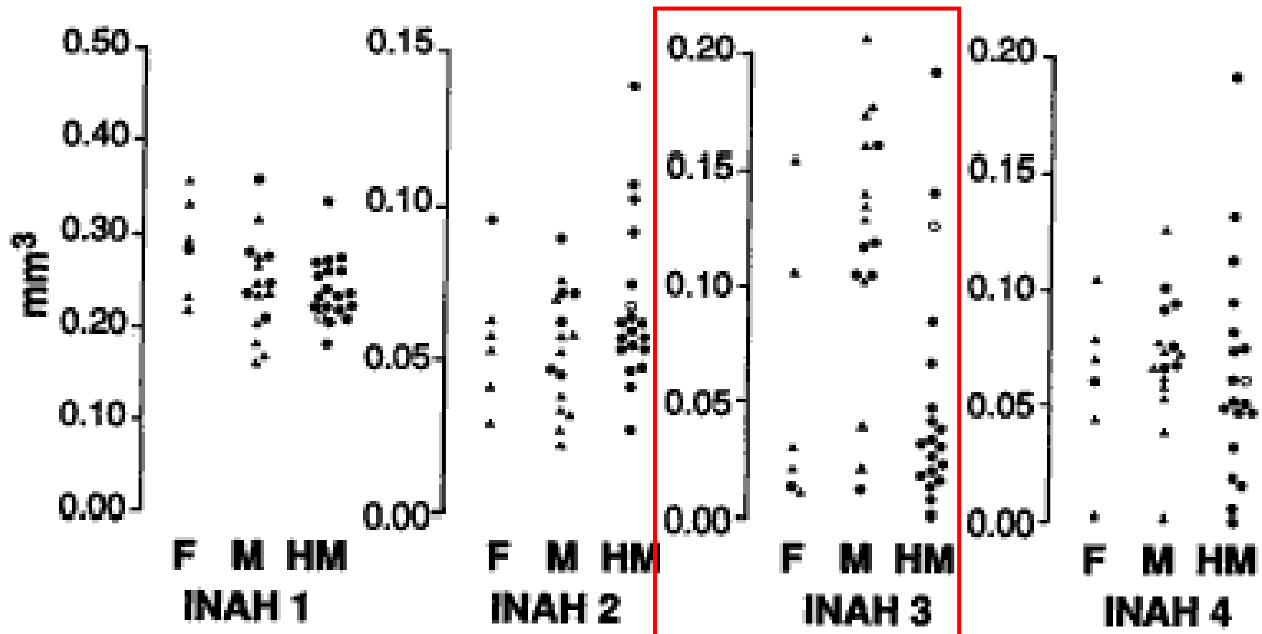

LV
BSTc
BSTm
A
B
C
D
M
F
M omo
M-F trans

A Difference in Hypothalamic Structure Between Heterosexual and Homosexual Men

SIMON LEVAY

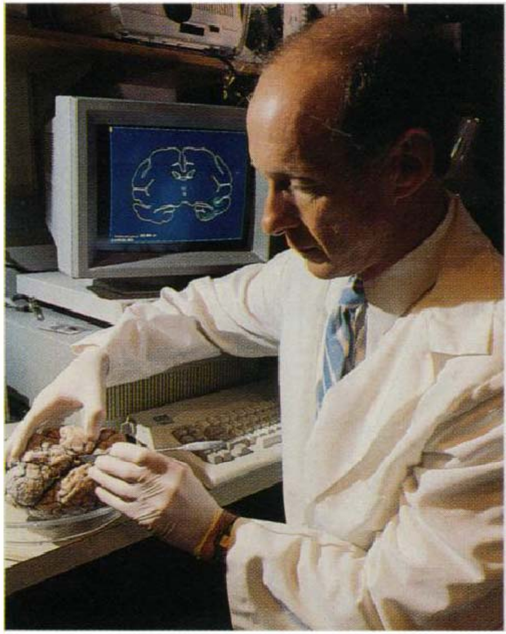
The anterior hypothalamus of the brain participates in the regulation of male-typical sexual behavior. The volumes of four cell groups in this region [interstitial nuclei of the anterior hypothalamus (INAH) 1, 2, 3, and 4] were measured in postmortem tissue from three subject groups: women, men who were presumed to be heterosexual, and homosexual men. No differences were found between the groups in the volumes of INAH 1, 2, or 4. As has been reported previously, INAH 3 was more than twice as large in the heterosexual men as in the women. It was also, however, more than twice as large in the heterosexual men as in the homosexual men. This finding indicates that INAH is dimorphic with sexual orientation, at least in men, and suggests that sexual orientation has a biological substrate.



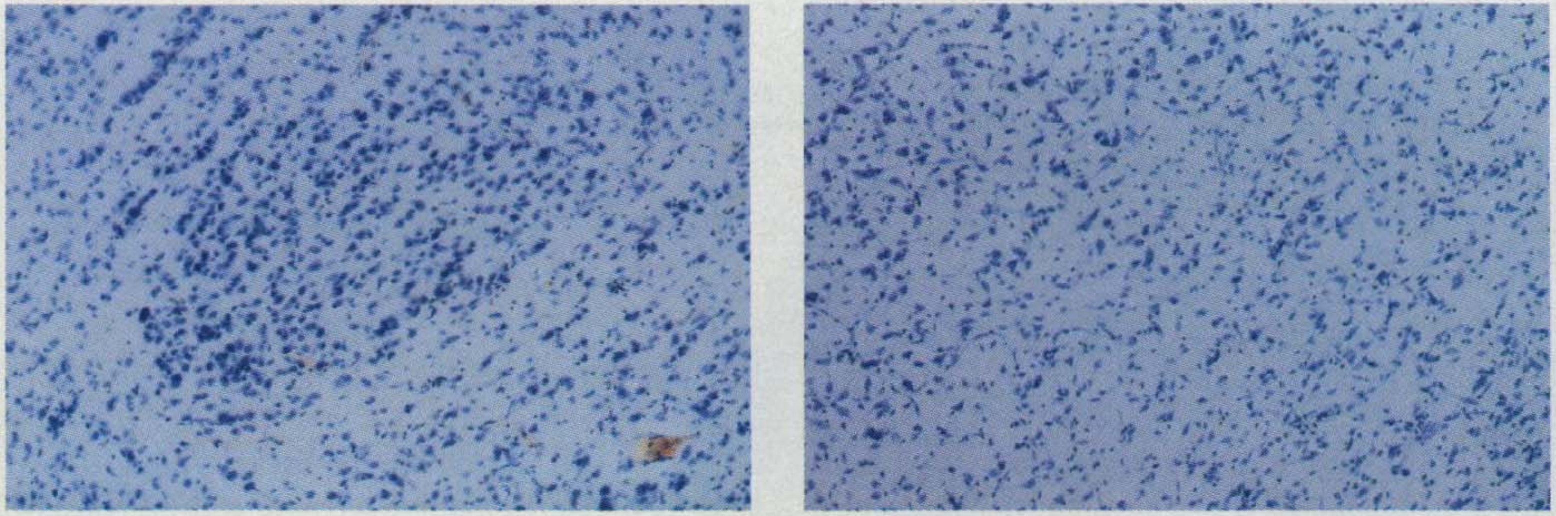


Is Homosexuality Biological?

New work on the hypothalamus suggests the answer may be yes. But that's only part of a broader debate over gender differences and the brain.



Marc Lieberman



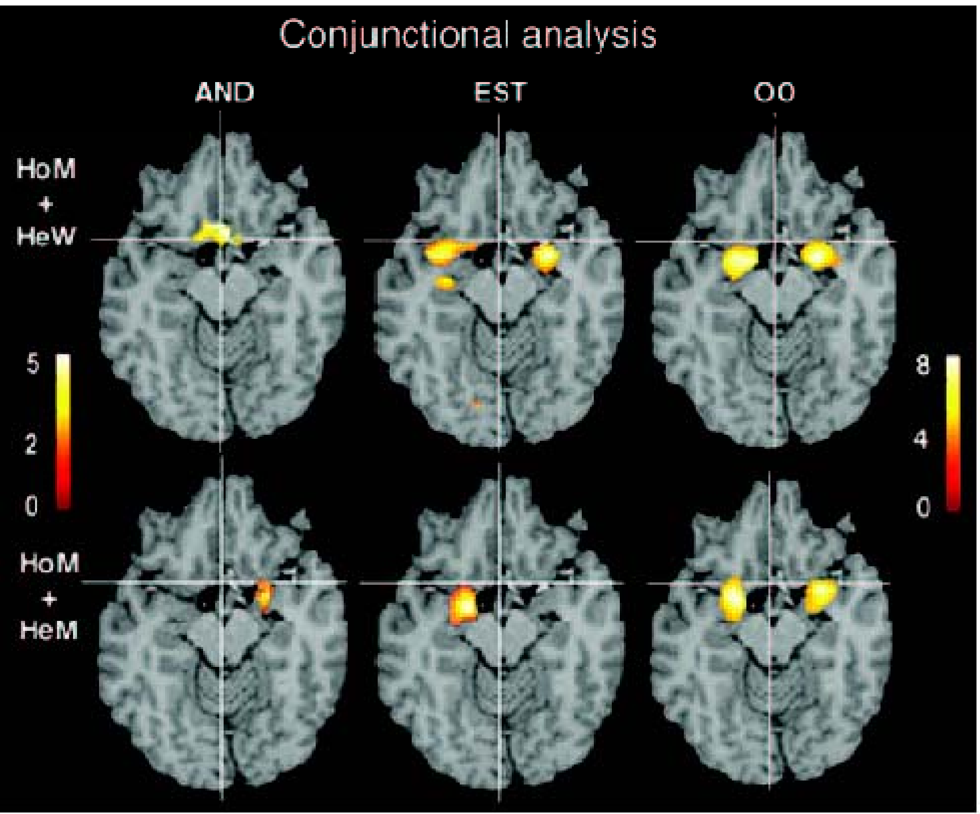
Missing cells. *Oval collection of cells in hypothalamus from heterosexual man* (left) *are absent in homosexual man* (right).

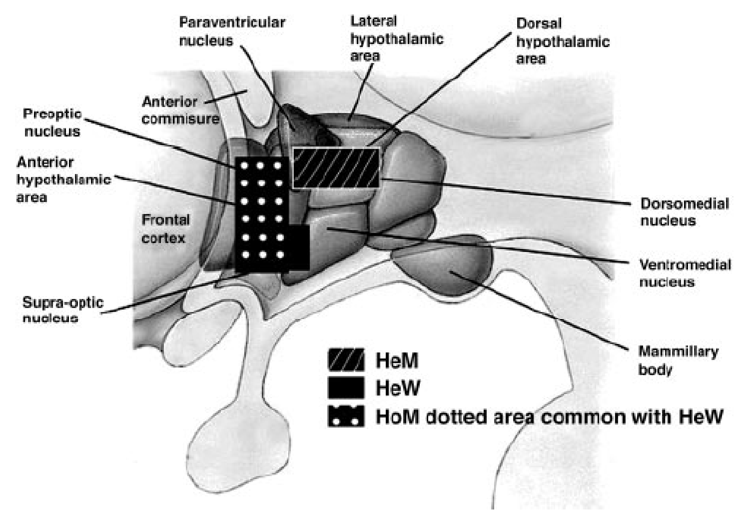
Brain response to putative pheromones in homosexual men

Ivanka Savic*†‡, Hans Berglund§, and Per Lindström*

Departments of *Clinical Neuroscience and §Medicine, Karolinska University Hospital, 171 76 Stockholm, Sweden; and †Department of Neuroscience, Center for Gender-Related Medicine, Karolinska Institute, 171 77 Stockholm, Sweden

Edited by Jan-Åke Gustafsson, Karolinska Institute, Huddinge, Sweden, and approved April 4, 2005 (received for review October 27, 2004)



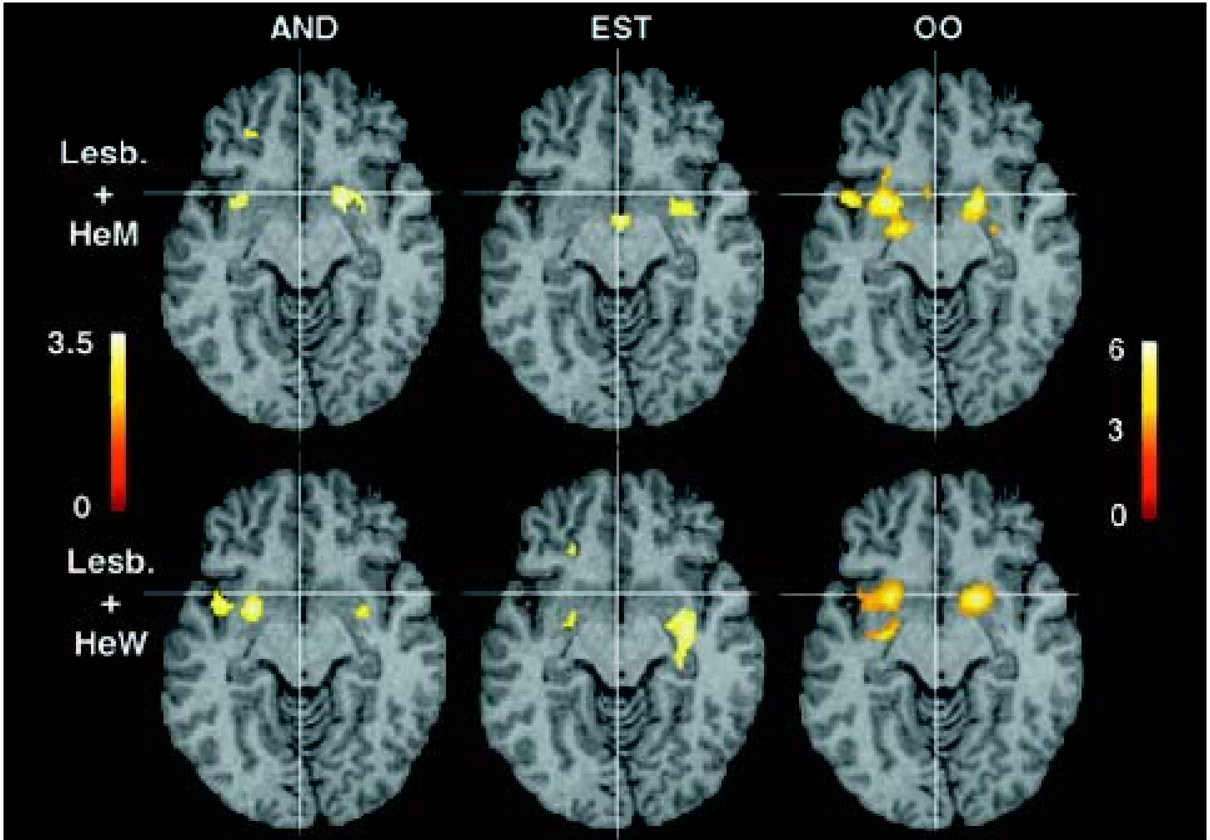


Brain response to putative pheromones in lesbian women

Hans Berglund*, Per Lindström†, and Ivanka Savic†‡

*Department of Medicine, and †Stockholm Brain Institute, Department of Clinical Neuroscience, Karolinska University Hospital, Karolinska Institutet, 171 76 Stockholm, Sweden

Edited by Jan-Åke Gustafsson, Karolinska Institutet, Huddinge, Sweden, and approved March 11, 2006 (received for review January 13, 2006)



Studi genetici

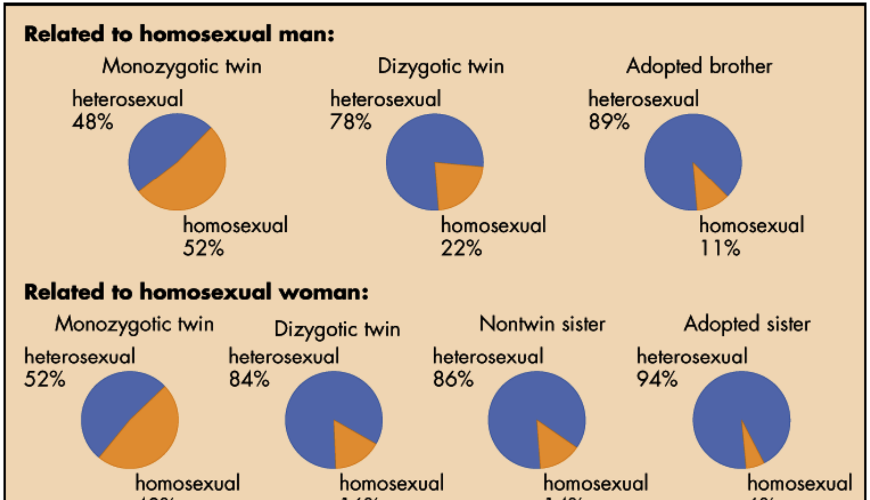
% orientamento omosessuale nella popolazione normale = 2-10% (m 4-5%)

occurrence of homosexuality among brothers

- 52% of identical (monozygotic) twins of homosexual men
- 22% of fraternal (dizygotic) twins
- 9% of the non-twin brothers
- 11% of adoptive brothers of homosexual men were likewise homosexual

occurrence of homosexuality among sisters

- 48% of identical (monozygotic) twins of homosexual women
- 16% of fraternal (dizygotic) twins were likewise homosexual
- 6% of adoptive sisters of homosexual women were likewise homosexual

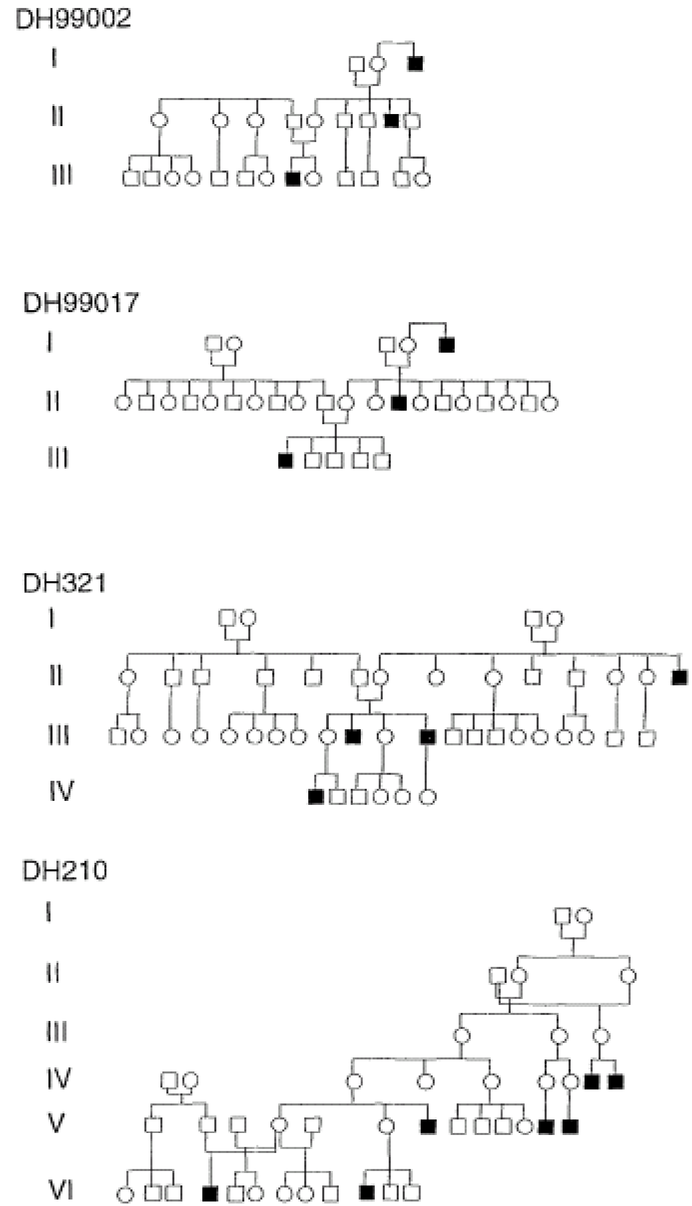


A Linkage Between DNA Markers on the X Chromosome and Male Sexual Orientation

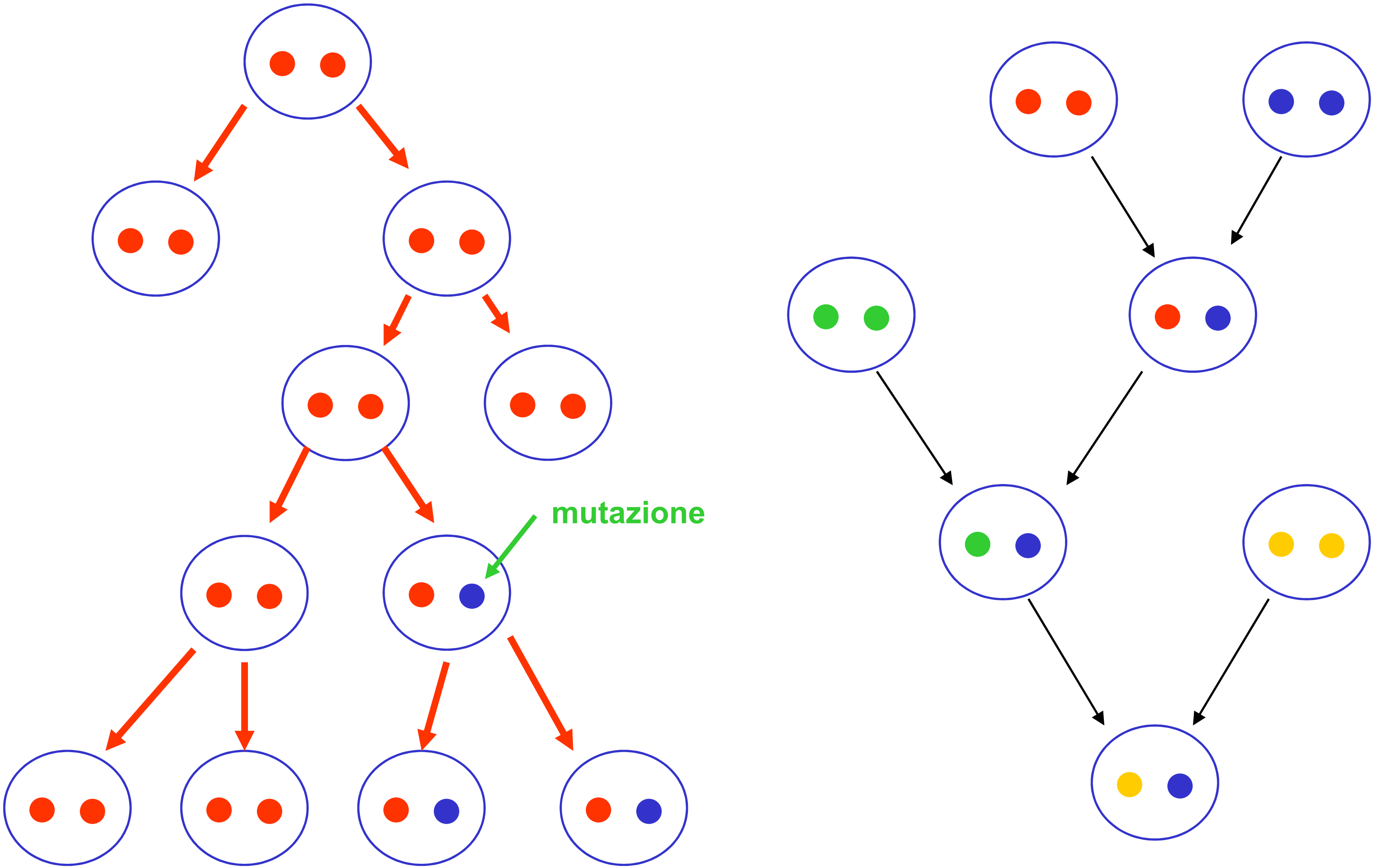
Dean H. Hamer, Stella Hu, Victoria L. Magnuson, Nan Hu, Angela M. L. Pattatucci

The role of genetics in male sexual orientation was investigated by pedigree and linkage analyses on 114 families of homosexual men. Increased rates of same-sex orientation were found in the maternal uncles and male cousins of these subjects, but not in their fathers or paternal relatives, suggesting the possibility of sex-linked transmission in a portion of the population. DNA linkage analysis of a selected group of 40 families in which there were two gay brothers and no indication of nonmaternal transmission revealed a correlation between homosexual orientation and the inheritance of polymorphic markers on the X chromosome in approximately 64 percent of the sib-pairs tested. The linkage to markers on Xq28, the subtelomeric region of the long arm of the sex chromosome, had a multipoint lod score of 4.0 ($P = 10^{-5}$), indicating a statistical confidence level of more than 99 percent that at least one subtype of male sexual orientation is genetically influenced.

Locus	Location	AL*	HET†	Sib-pairs‡			z_1§	$2\ln L(z_1)$‖	P¶
				[D]	[S]	[–]			
A. .KAL	p22	6	0.77	5	16	14	0.51	0.01	ns
B. .DXS996	p22	11	0.84	7	14	18	≤.5	≤0	ns
C. .DXS992	p	8	0.87	6	13	19	≤.5	≤0	ns
D. .DMD1	p21	9	0.78	3	10	23	≤.5	≤0	ns
E. .DXS993	p11	6	0.80	3	14	17	≤.5	≤0	ns
F. .DXS991	p	8	0.77	8	14	14	0.57	0.61	ns
G. .DXS986	q	10	0.71	7	20	10	0.65	2.11	ns
H. .DXS990	q	7	0.76	4	19	13	0.55	0.25	ns
I. .DXS1105	q	5	0.48	3	20	9	≤.5	≤0	ns
J. .DXS456	q21	10	0.85	8	20	8	0.75	7.95	0.00241
K. .DXS1001	q26	10	0.82	8	16	13	0.60	1.09	ns
L. .DXS994	q26	5	0.75	7	17	13	0.55	0.26	ns
M. .DXS297	q27	5	0.70	5	21	8	0.71	4.25	0.01963
N. .FMR	q27	17	0.79	6	17	14	0.56	0.45	ns
O. .FRAXA	q27	8	0.72	4	17	13	0.56	0.38	ns
P. .DXS548	q27	6	0.67	7	20	7	0.73	5.21	0.01123
Q. .GABRA3	q28	4	0.35	2	23	3	0.74	2.39	ns
R. .DXS52	**q28**	**12**	**0.79**	**9**	**22**	**6**	**0.81**	**11.83**	**0.00029**
S. .G6PD	**q28**	**2**	**0.36**	**4**	**24**	**2**	**0.85**	**6.38**	**0.00577**
T. .F8C	**q28**	**2**	**0.41**	**5**	**24**	**3**	**0.82**	**6.56**	**0.00522**
U. .DXS1108	**q28**	**6**	**0.71**	**8**	**22**	**4**	**0.85**	**12.87**	**0.00017**
V. .DXYS154#	**q28**	**10**	**0.71**	**8**	**22**	**5**	**0.83**	**12.84**	**0.00017**
R/S/T/U/V	**q28**		**0.99**	**12**	**21**	**7**	**0.82**	**18.14**	**0.00001**



Vantaggio evoluzionistico della riproduzione sessuata

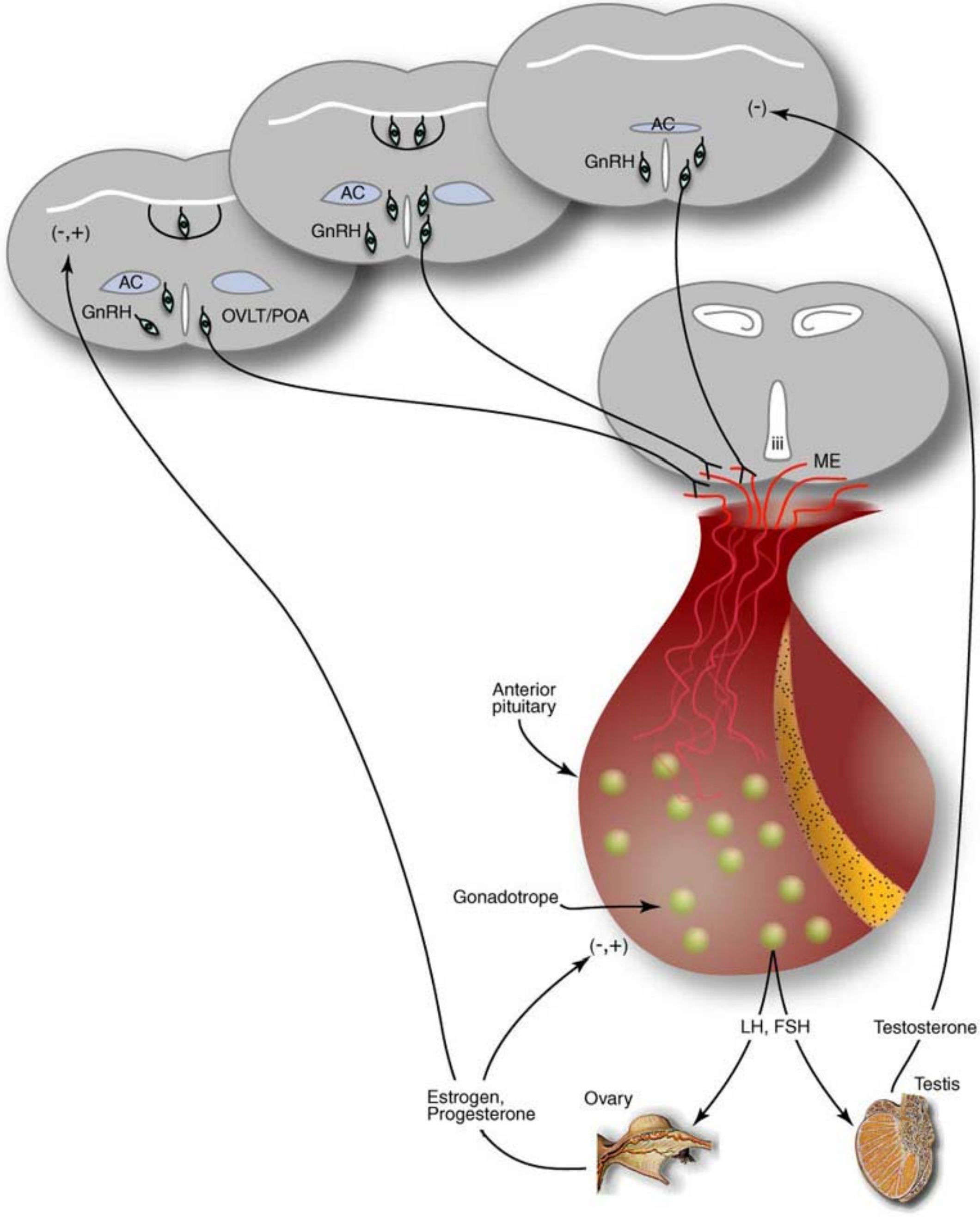


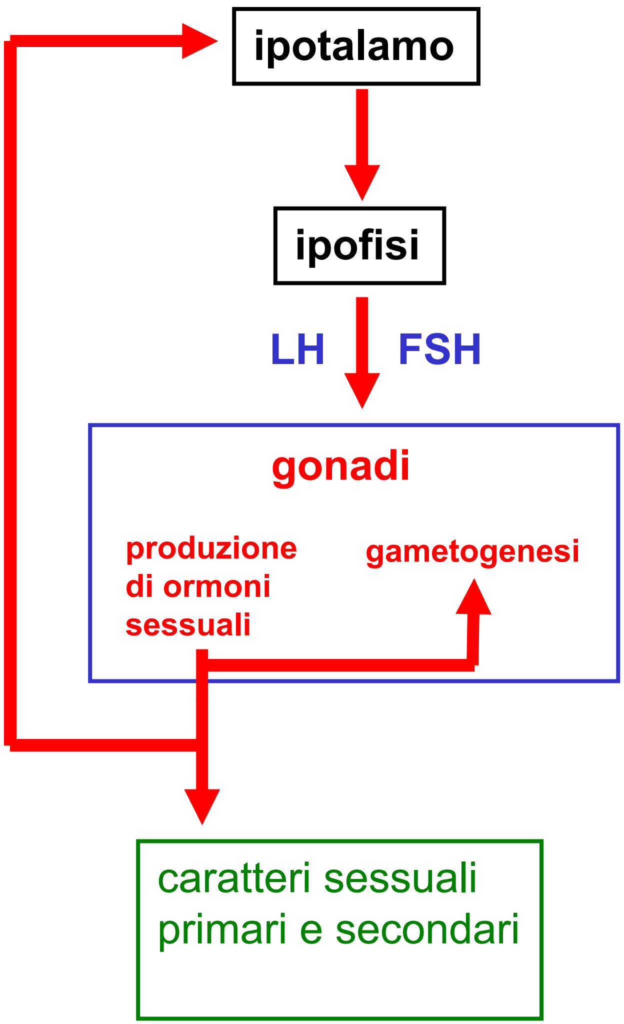
riproduzione asessuata - partenogenesi

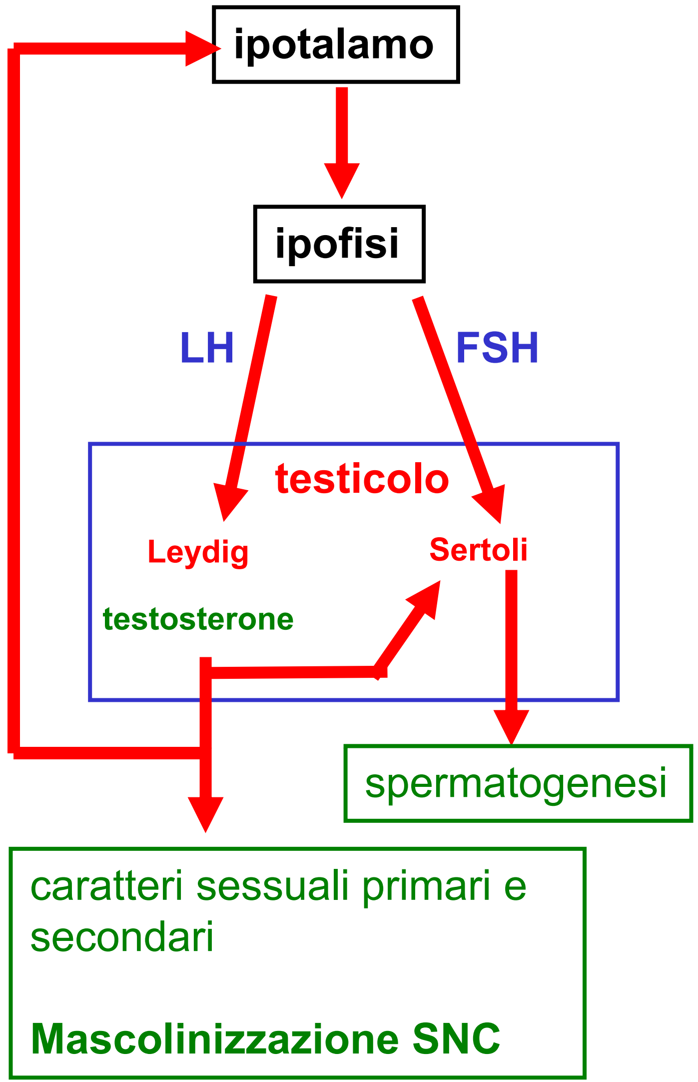
riproduzione sessuata

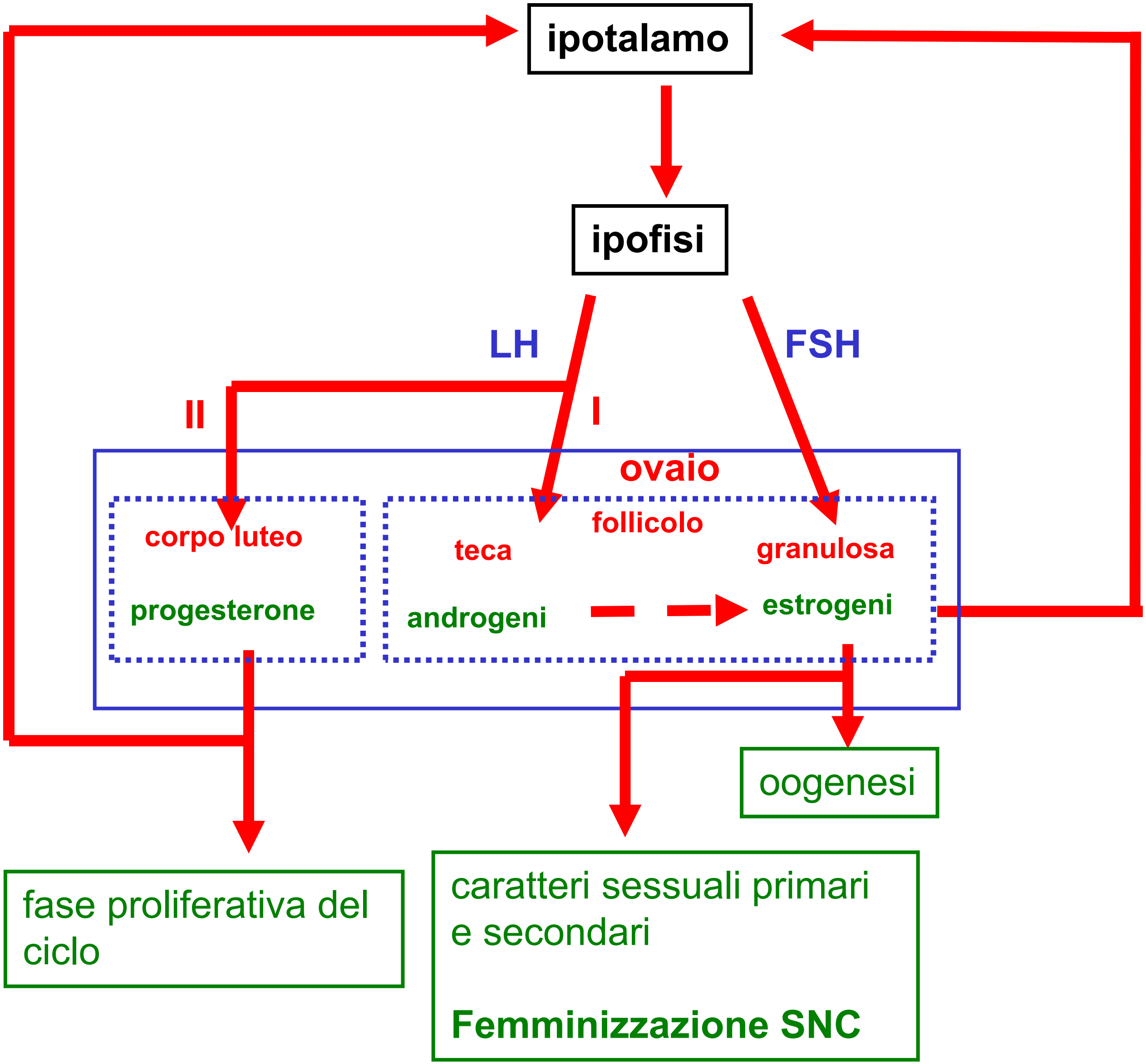
L'ipotalamo controlla la funzione sessuale attraverso le gonadotropine ipofisarie

A loro volta, gli ormoni sessuali agiscono sulla funzione dell'ipotalamo

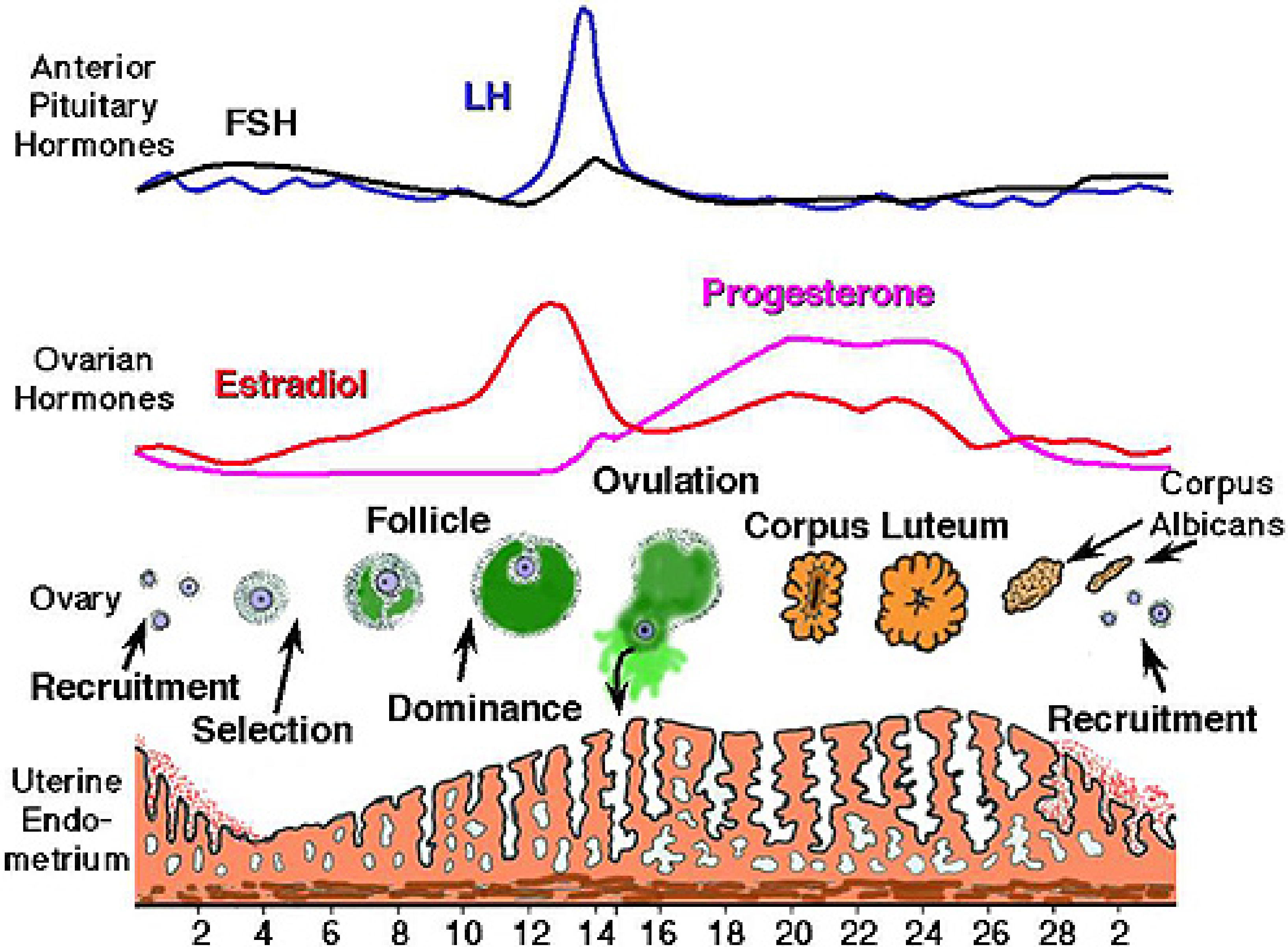



ipotalamo
ipofisi
LH
FSH
gonadi
produzione di ormoni sessuali
gametogenesi
caratteri sessuali primari e secondari

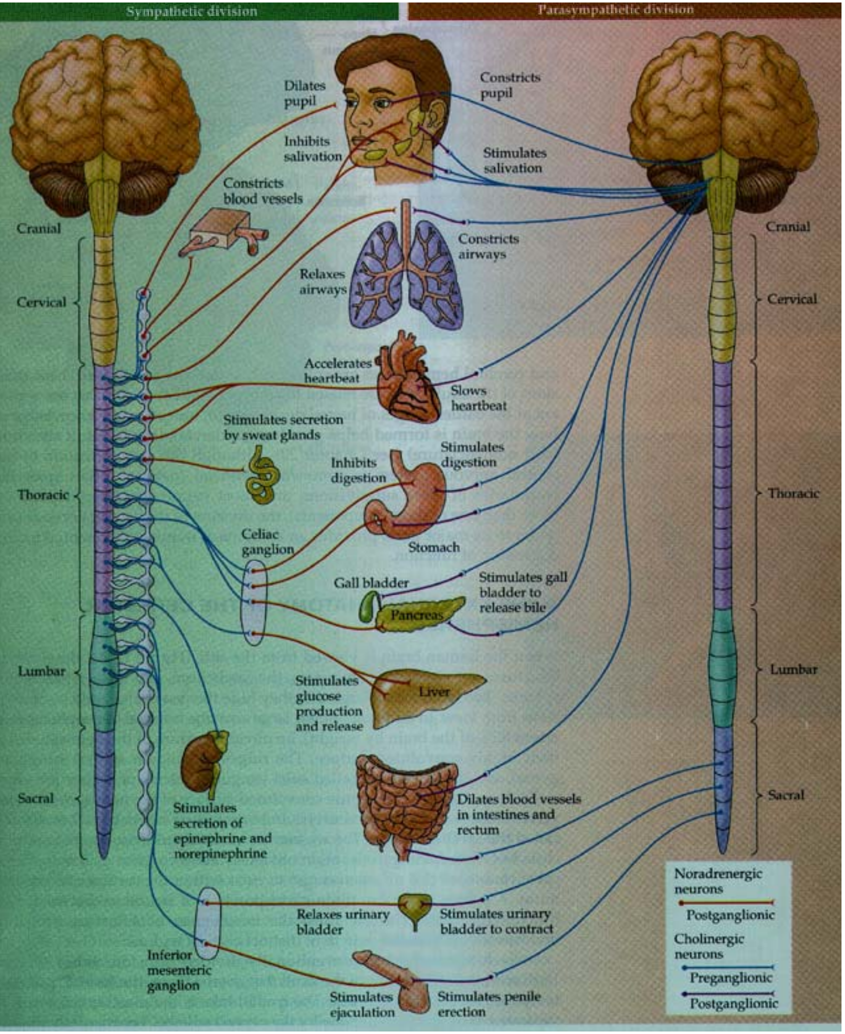

ipotalamo
ipofisi
LH
FSH
testicolo
Leydig
Sertoli
testosterone
spermatogenesi
caratteri sessuali primari e secondari
Mascolinizzazione SNC



ipotalamo
ipofisi
LH
FSH
II
I
ovaio
corpo luteo
progesterone
follicolo
teca
granulosa
androgeni
estrogeni
oogenesi
fase proliferativa del ciclo
caratteri sessuali primari e secondari
Femminizzazione SNC


Anterior
Pituitary
Hormones
FSH
LH
Progesterone
Ovarian
Hormones
Estradiol
Ovulation
Corpus
Albicans
Follicle
Corpus Luteum
Ovary
Recruitment
Selection
Dominance
Recruitment
Uterine
Endo-
metrium
2 4 6 8 10 12 14 16 18 20 22 24 26 28 2

SNA e controllo della funzione sessuale



Stimoli esterni

Stimoli interni

SNA - parasimpatico

Erezione
Congestione/lubrificazione vaginale

copulazione

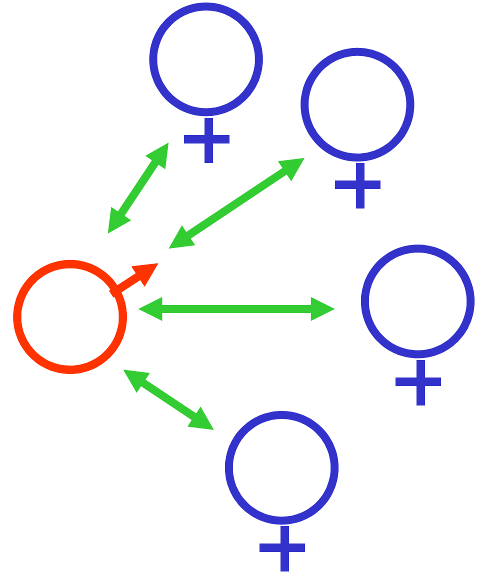
Stimoli sensoriali

SNA - ortosimpatico

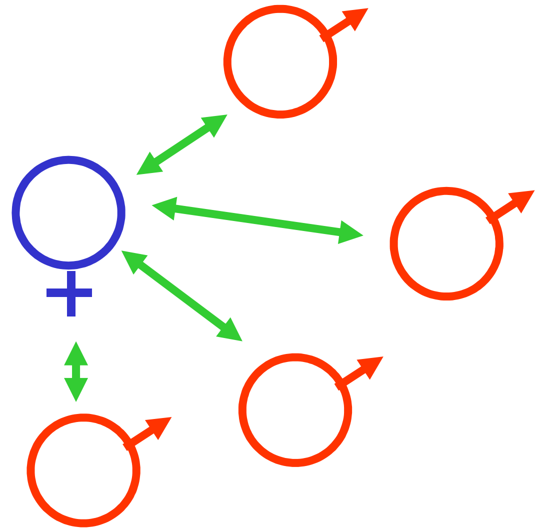
Eiaculazione
Orgasmo femminile

Strategie di accoppiamento nel regno animale

Poliginia
Molto frequente fra i mammiferi (giraffe, oranghi ecc..)
Esempi di rapporto stabile (harem; gorilla, elefanti marini)

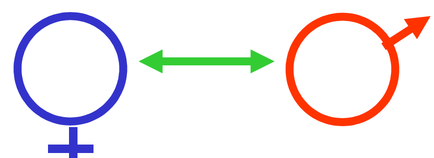


Poliandria
Rara nei vertebrati (ecc.. Falaropo)



Monogamia
90% degli uccelli (cova)
3% dei mammiferi
12% dei primati

Gli umani sono tendenzialmente monogami
Anche nelle società poliginiche, la maggior parte delle coppie sono monogamiche



A causa della competizione per le femmine, la poliginia è associata a:

Maggior differenza di massa corporea fra maschi e femmine (gorilla, leoni marini)
Maggiore differenza nei caratteri sessuali secondari

Altri fattori importanti che determinano le strategie di accoppiamento sono:

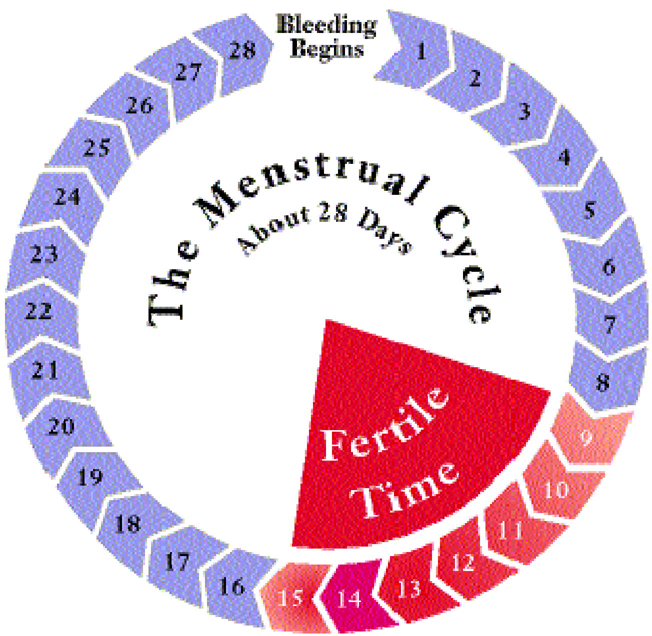
1. La periodicità della recettività della femmina
2. La possibile promiscuità delle femmine (competizione del seme)
3. La partecipazione dei maschi alle cure parentali

Nella nostra specie ci sono due caratteristiche particolari:

- La fertilità femminile non è esteriormente evidente
- L'accoppiamento non avviene in pubblico

Questo perché (teorie):

- Favorire la cooperazione ed evitare la disgregazione sociale
- Tenere il maschio e spingerlo a partecipare alle cure parentali
- Le femmine recettive otterrebbero più facilmente il cibo dai maschi
- L'incertezza della fertilità mantiene stabile la coppia
- L'incertezza della fertilità rende incerta la paternità



Arvicola delle praterie (microtus ochrogaster)

Fortemente sociale e stabilmente monogamo

Maschio e femmina condividono la tana e la cura della prole

Il maschio difende strenuamente la femmina e la prole

Arvicola delle montagne (microtus montanus)

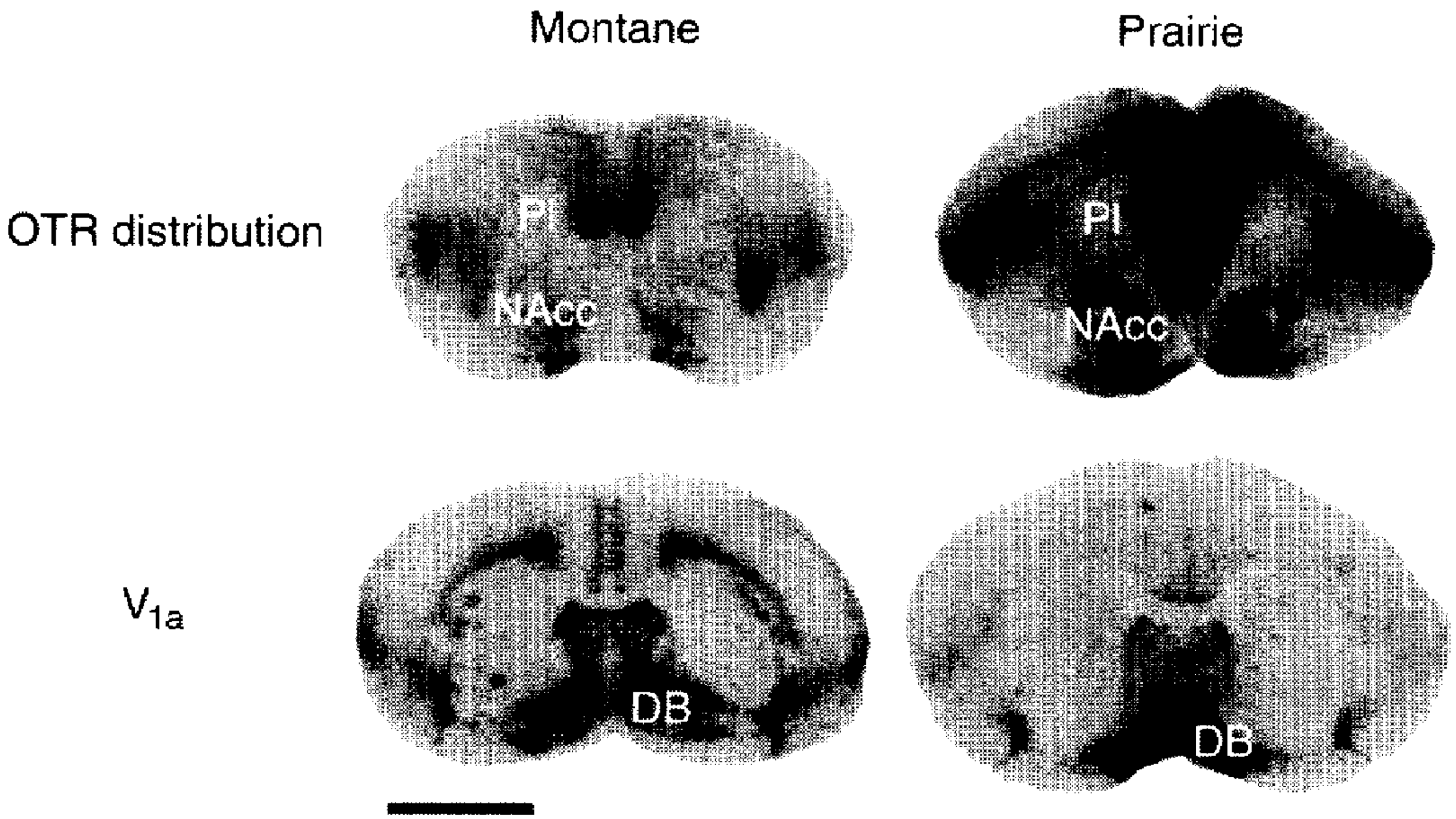
Asociale e promiscuo

Ogni individuo vive isolato in una tana propria

Il maschio non partecipa alla cura della prole

La femmina abbandona i piccoli molto presto

Distribuzione dei recettori per ossitocina e vasopressina nel cervello delle arvicole di montagna e della prateria

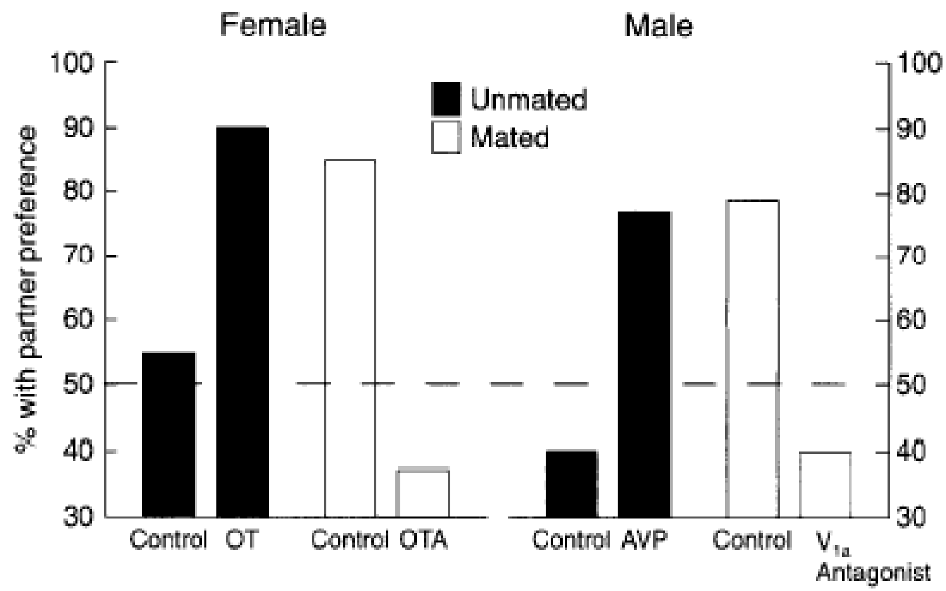


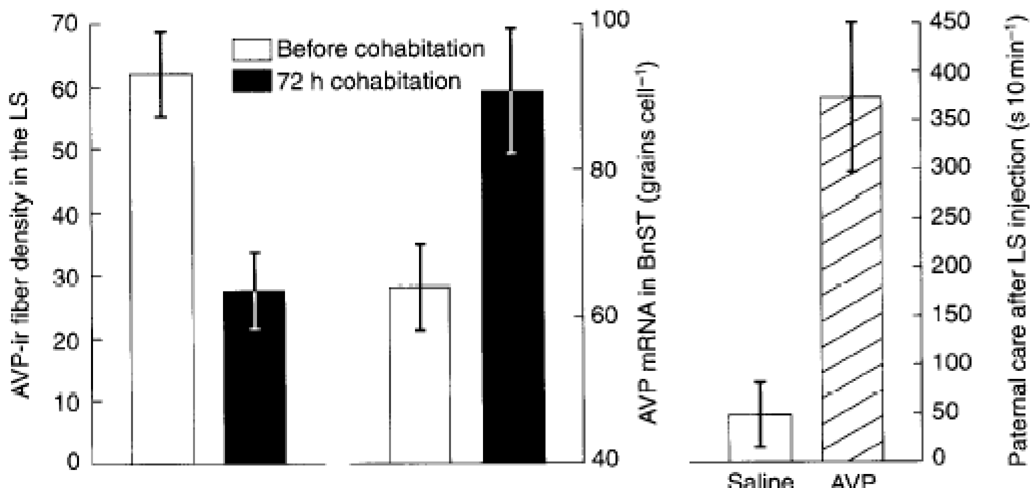
Effetti della somministrazione di ossitocina e vasopressina nel cervello delle arvicole di montagna e della prateria

TABLE 2. Effects of central administration of oxytocin and vasopressin on social behavior

Behavior	Oxytocin	Vasopressin	Refs
Effects in rodents			
Affiliative behavior	+++	?	8
Sexual behavior	+++	?	9,10
Maternal behavior	+++	+	11,12
Social memory	++	+++	13,14
Territorial behavior	?	+++	15
Male aggression	?	+++	16
Effects in monogamous voles			
Partner preference in females	+++	–	17,18
Partner preference in males	–	+++	19
'Selective' aggression	–	+++	19
Paternal care	?	+++	20

+++, marked effect; ++, moderate effect; +, some effect; –, no effect; ?, effect unknown.

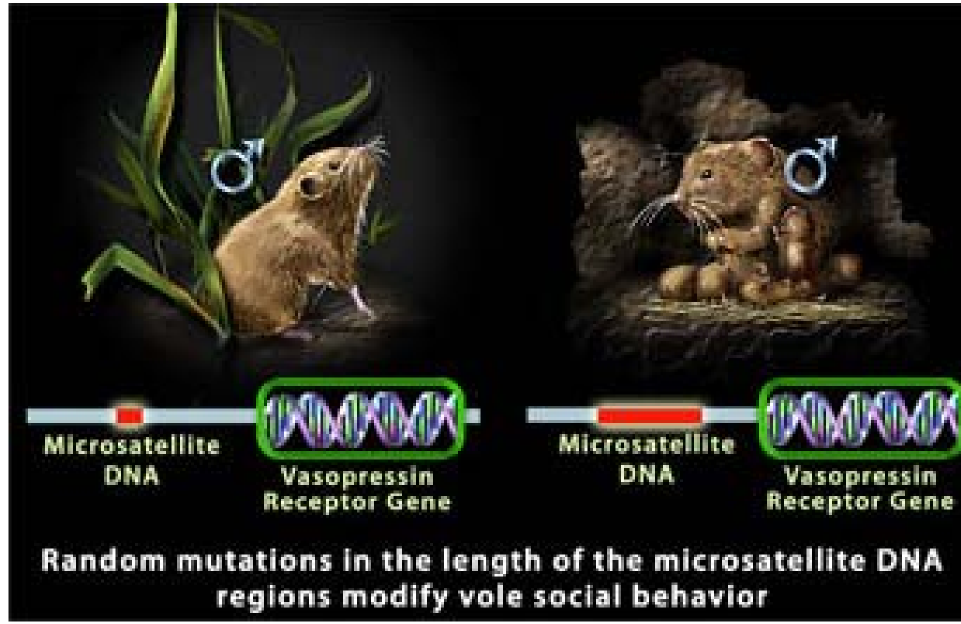


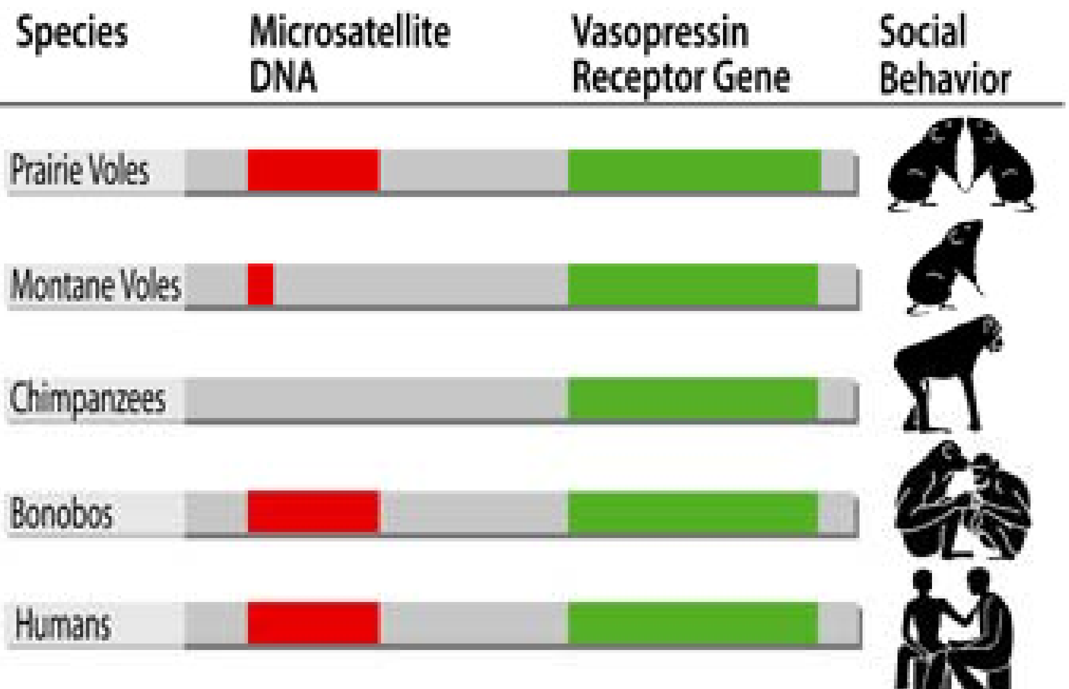


Microsatellite Instability Generates Diversity in Brain and Sociobehavioral Traits

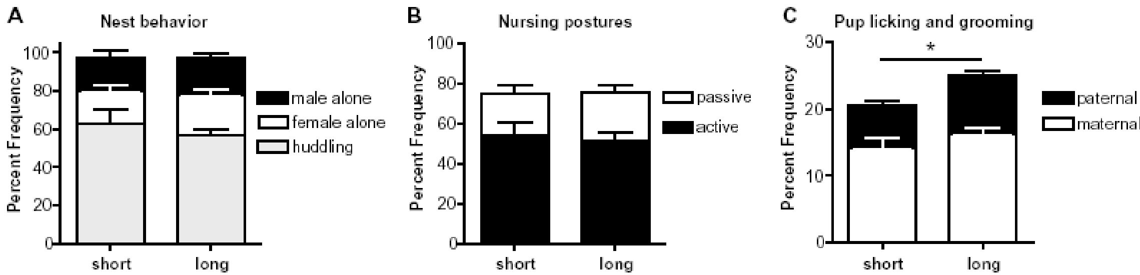
Elizabeth A. D. Hammock and Larry J. Young*

Repetitive microsatellites mutate at relatively high rates and may contribute to the rapid evolution of species-typical traits. We show that individual alleles of a repetitive polymorphic microsatellite in the 5′ region of the prairie vole *vasopressin 1a receptor* (*avpr1a*) gene modify gene expression in vitro. In vivo, we observe that this regulatory polymorphism predicts both individual differences in receptor distribution patterns and socio-behavioral traits. These data suggest that individual differences in gene expression patterns may be conferred via polymorphic microsatellites in the cis-regulatory regions of genes and may contribute to normal variation in behavioral traits.

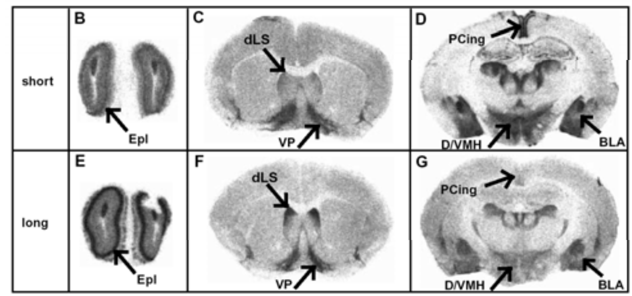




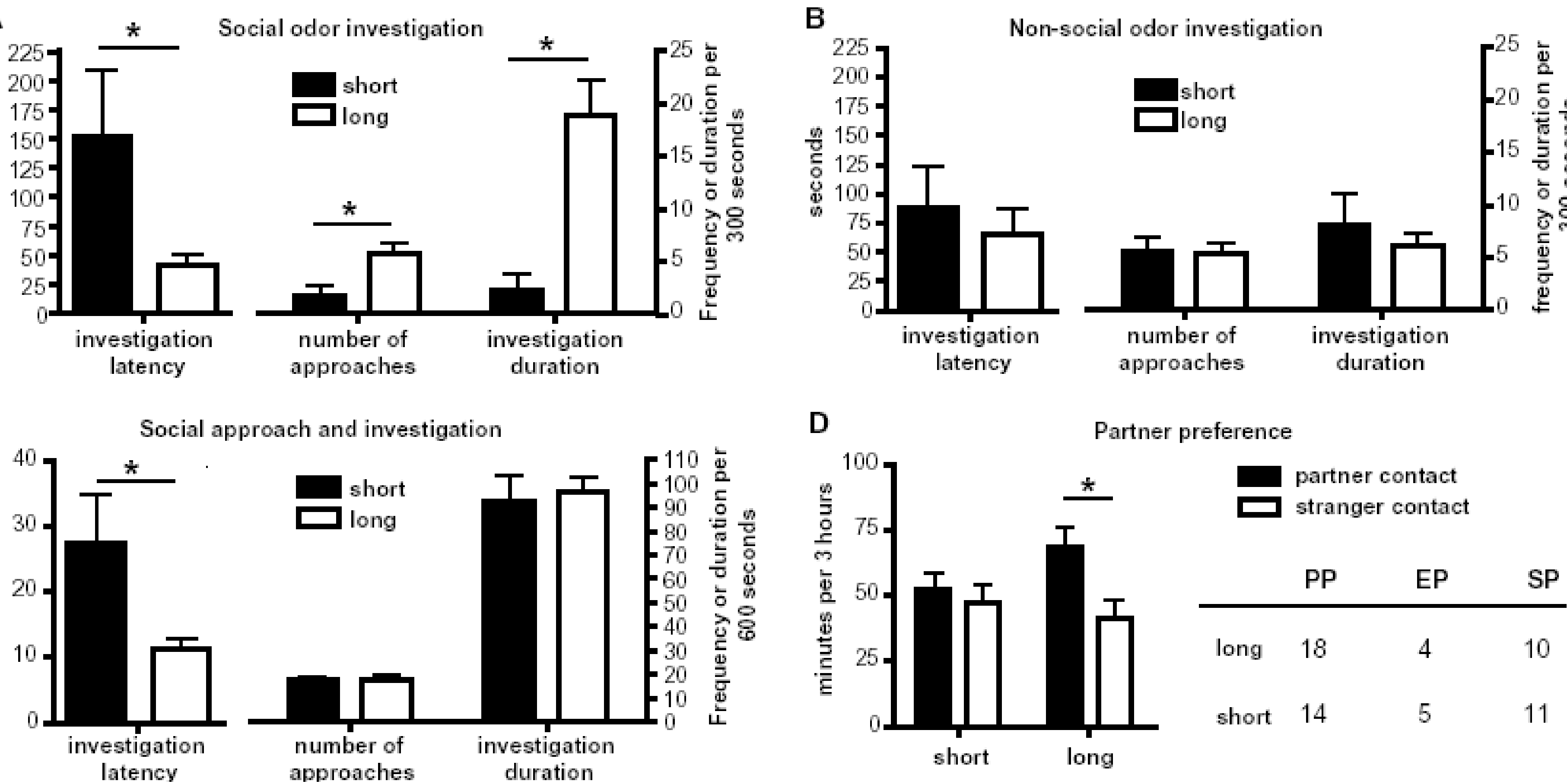
Cure parentali

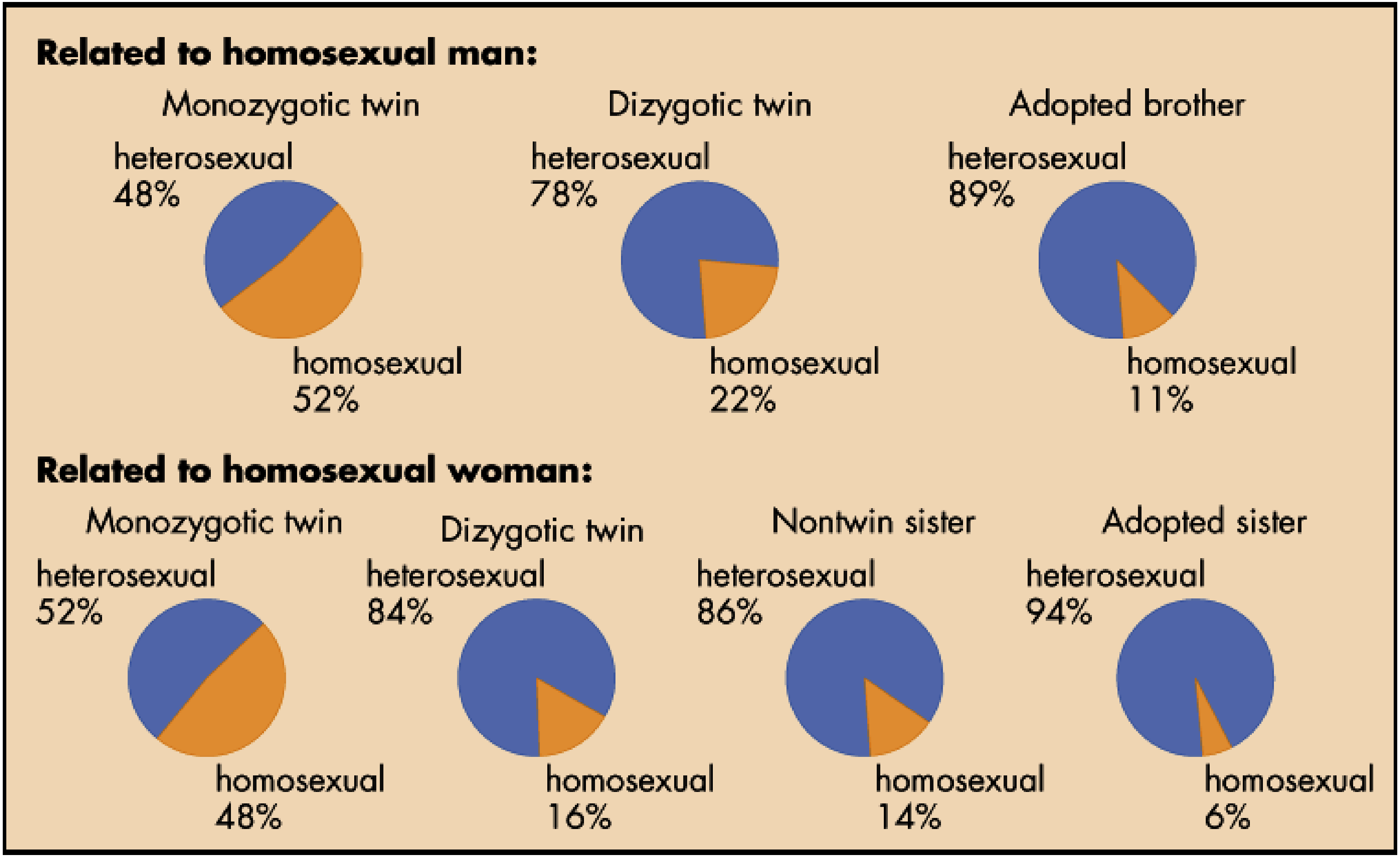


Distribuzione del recettore ADH



Riconoscimento sociale




Related to homosexual man:
Monozygotic twin
heterosexual 48%
homosexual 52%
Dizygotic twin
heterosexual 78%
homosexual 22%
Adopted brother
heterosexual 89%
homosexual 11%
Related to homosexual woman:
Monozygotic twin
heterosexual 52%
homosexual 48%
Dizygotic twin
heterosexual 84%
homosexual 16%
Nontwin sister
heterosexual 86%
homosexual 14%
Adopted sister
heterosexual 94%
homosexual 6%