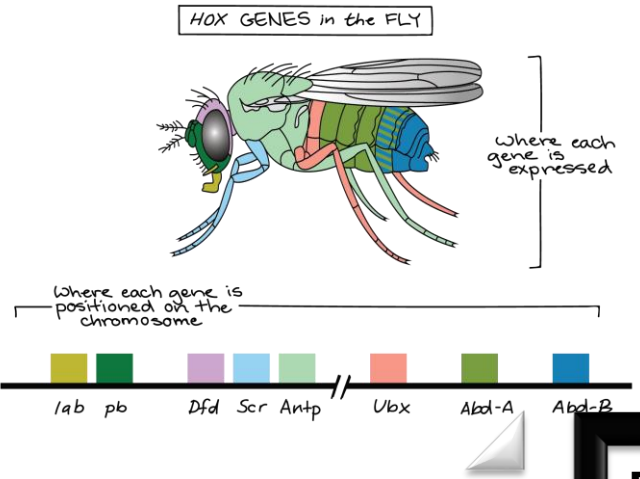
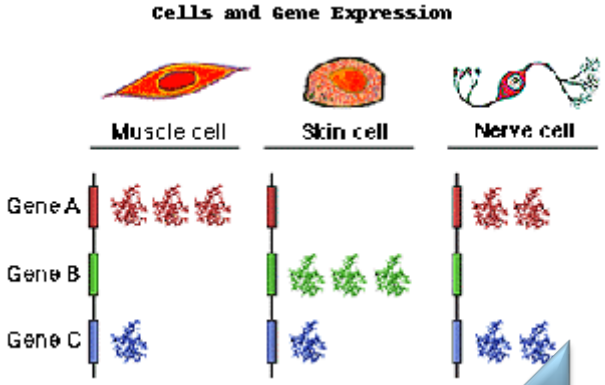
Interacciones durante el desarrollo



Ubicación espacial



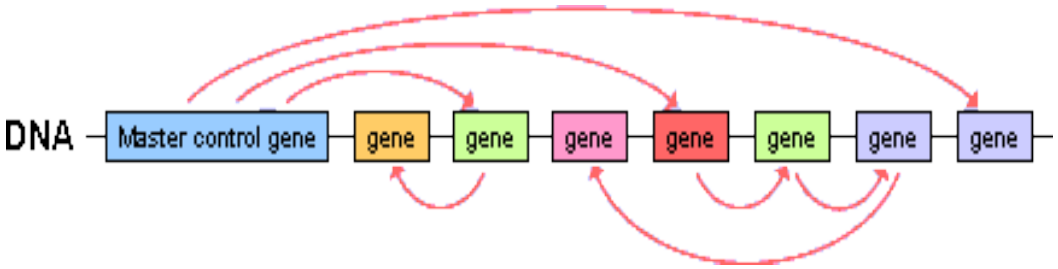
Regulación diferencial de genes específicos por genes maestros

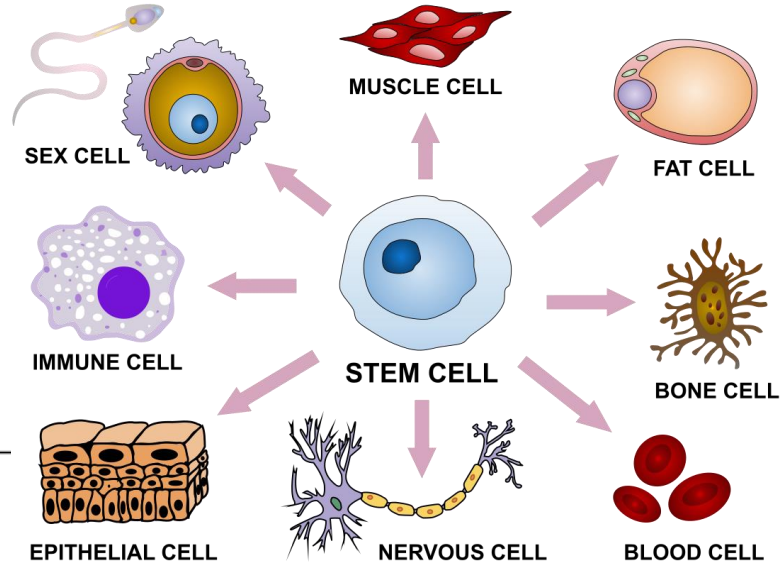
Expresión diferencial de genes específicos

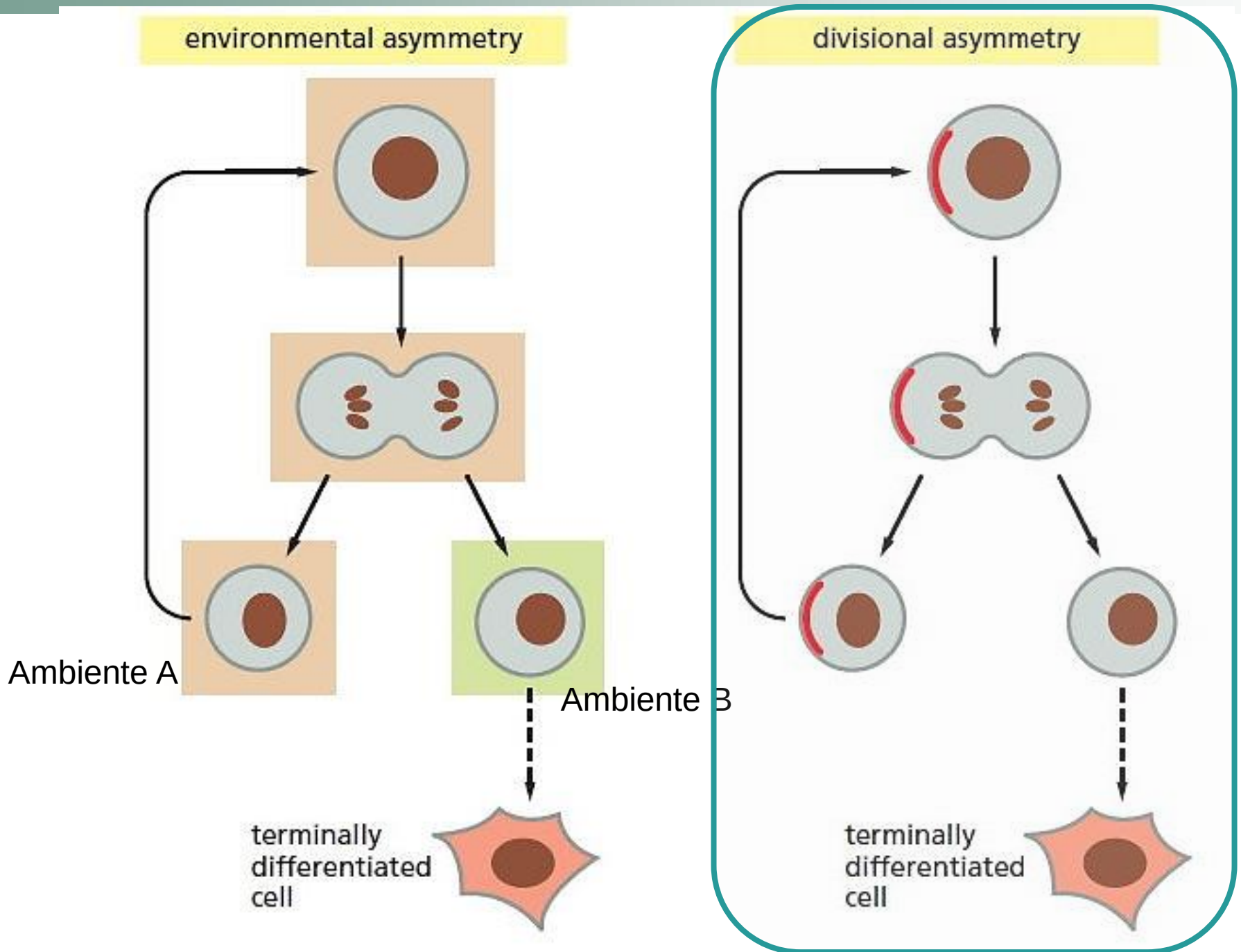
Diferenciación celular

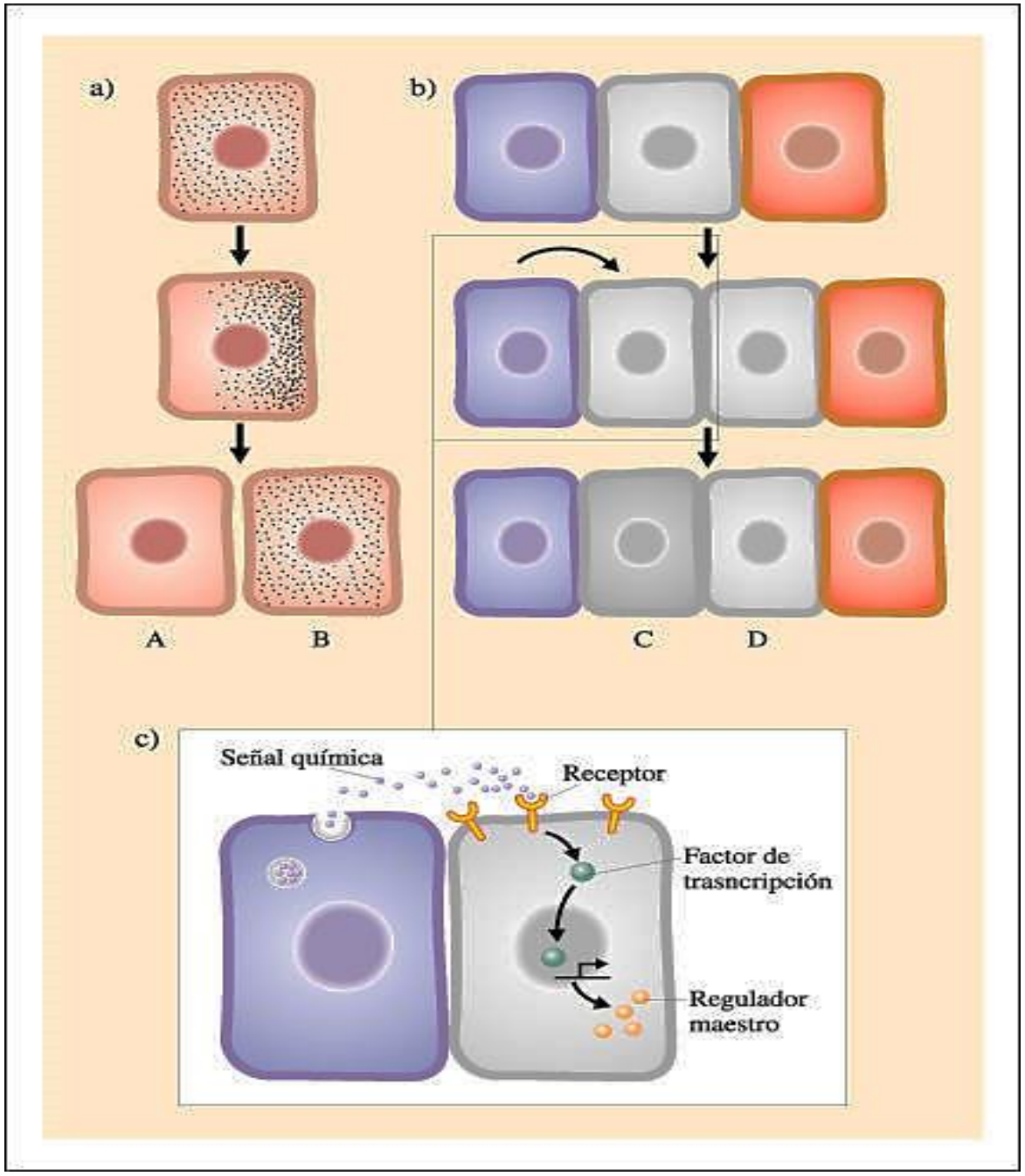
Tipos celulares

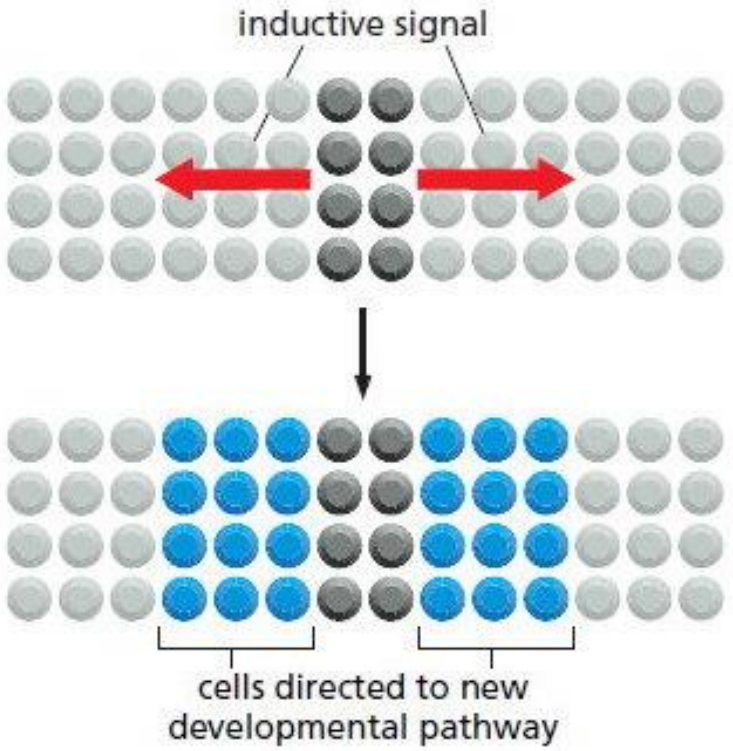
Organismo

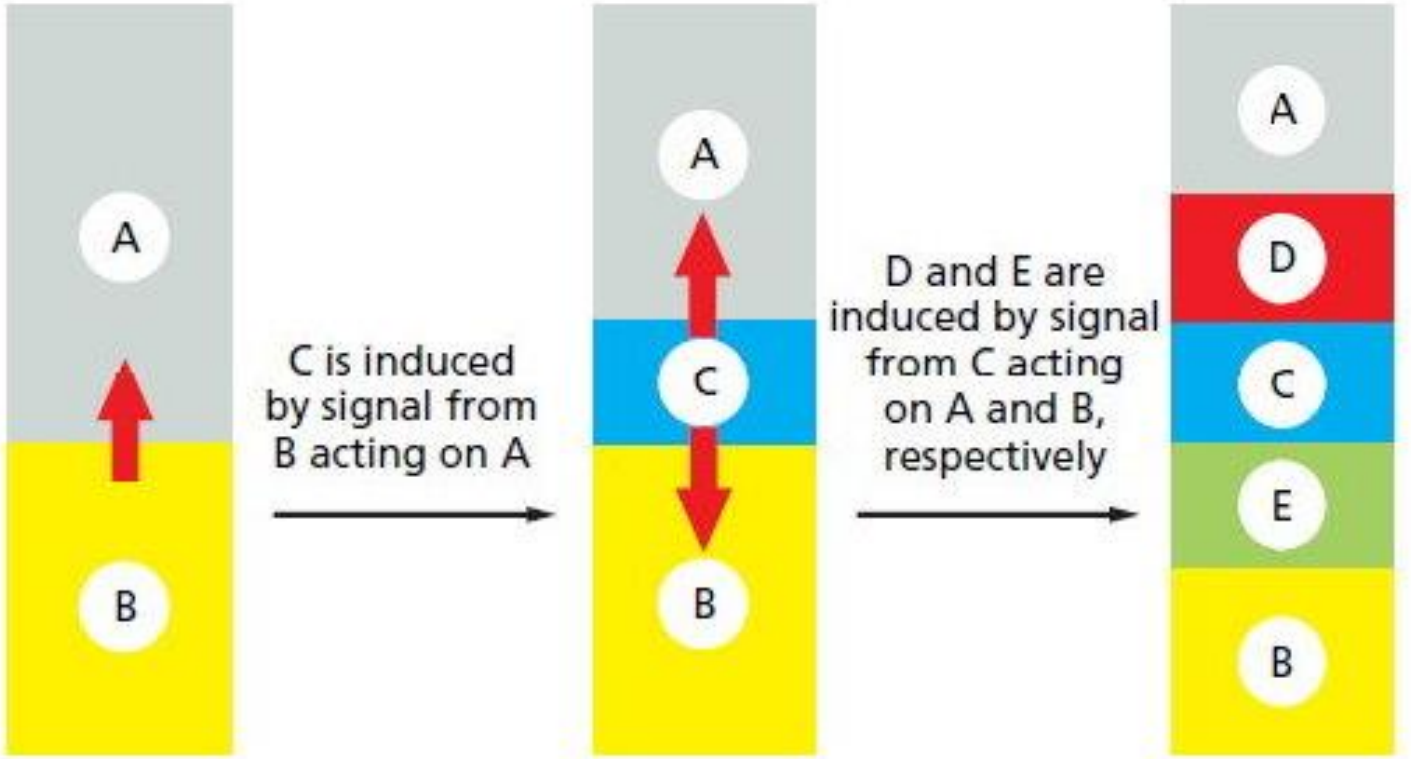


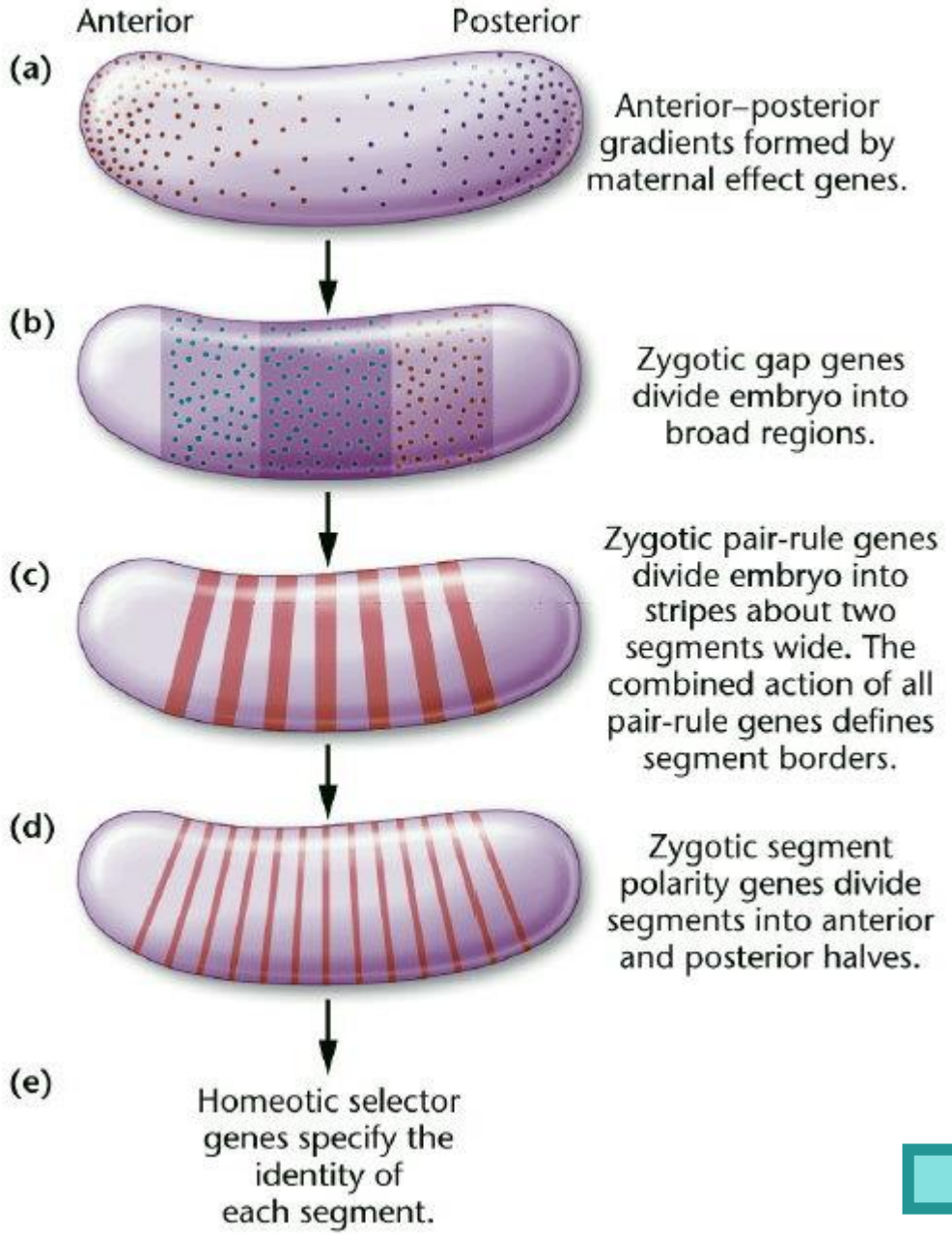



environmental asymmetry
divisional asymmetry
Ambiente A
Ambiente B
terminally differentiated cell
terminally differentiated cell

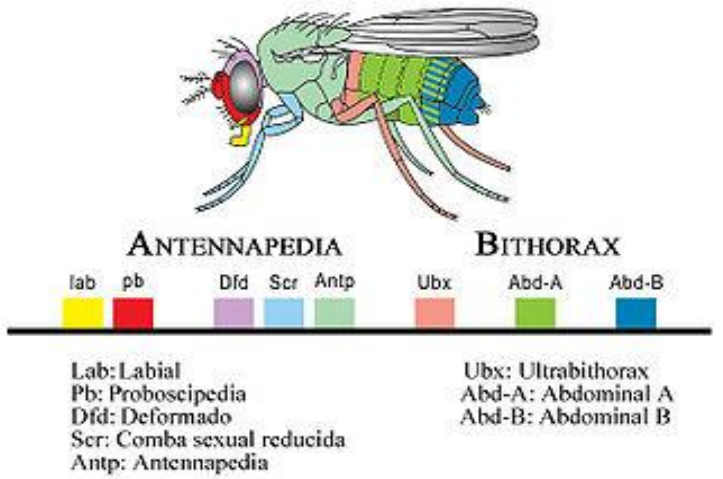

a)
b)
A
B
C
D
c)
Señal química
Receptor
Factor de
trasncripción
Regulador
maestro

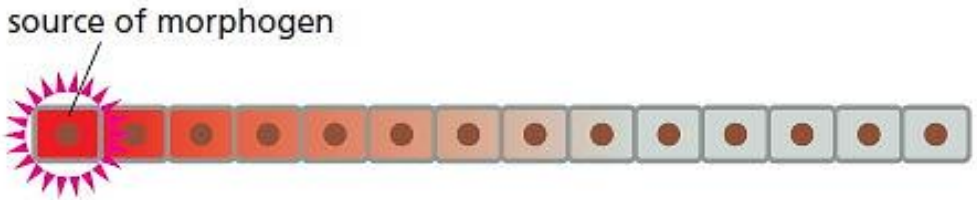

inductive signal
cells directed to new
developmental pathway

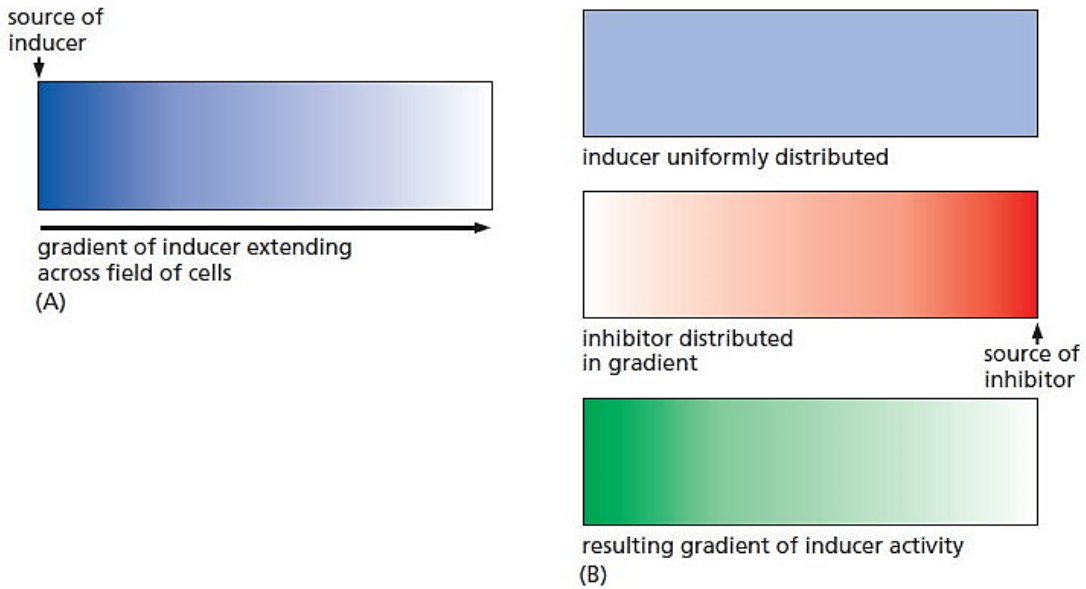

A
B
C is induced
by signal from
B acting on A
A
C
B
D and E are
induced by signal
from C acting
on A and B,
respectively
A
D
C
E
B

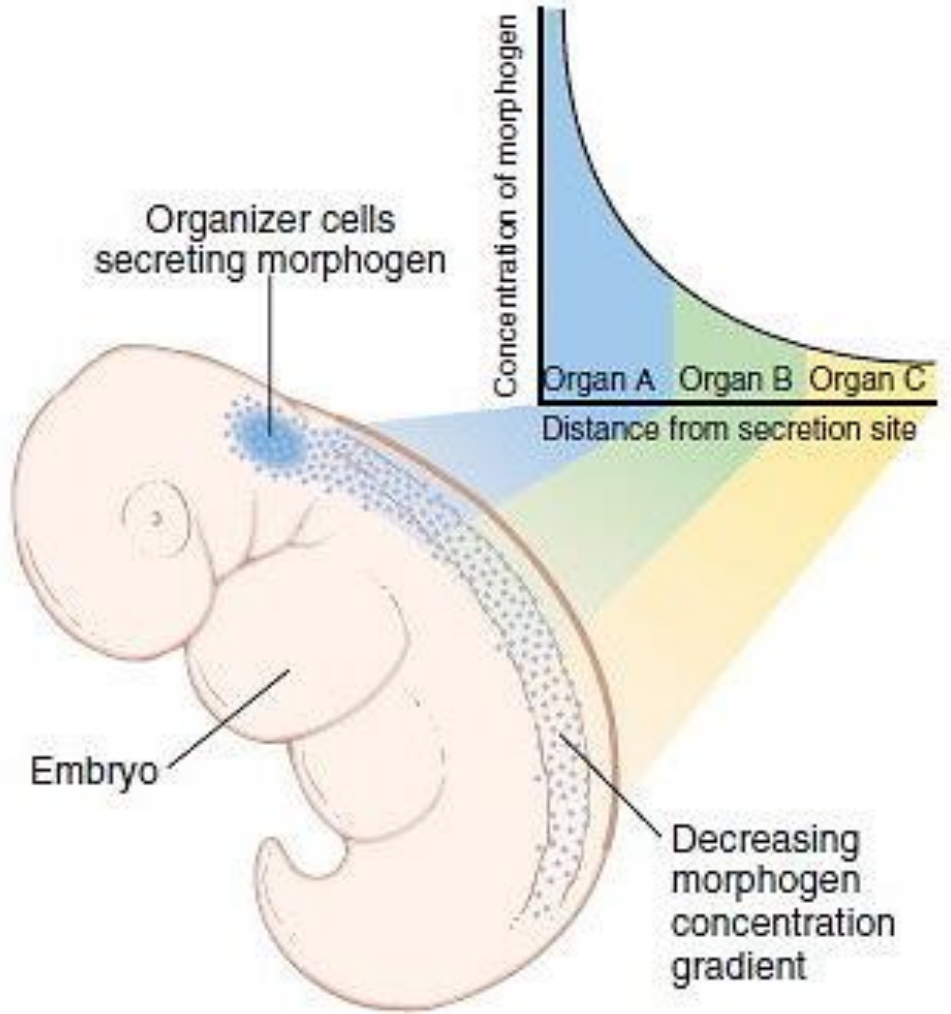


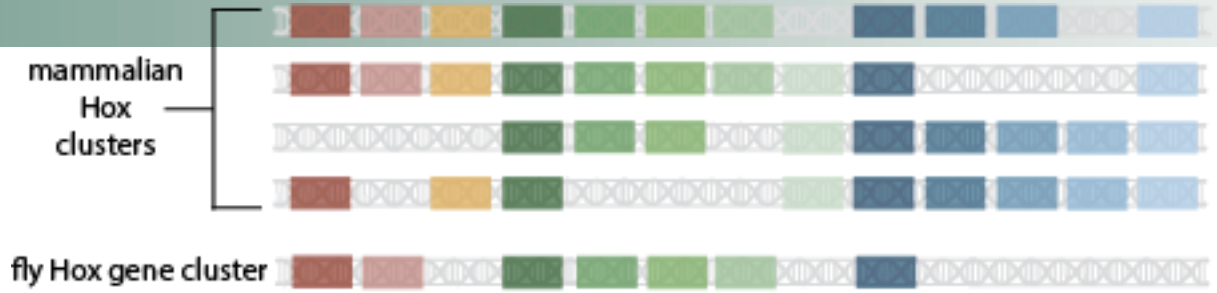
Gap Genes	Pair-Rule Genes	Segment Polarity Genes
Krüppel	*hairy*	*engrailed*
knirps	*even-skipped*	*wingless*
hunchback	*runt*	*cubitis interruptus*^{D}
giant	*fushi-tarazu*	*hedgehog*
tailless	*odd-paired*	*fused*
buckebein	*odd-skipped*	*armadillo*
	sloppy-paired	*patched*
		gooseberry
		paired
		naked
		disheveled

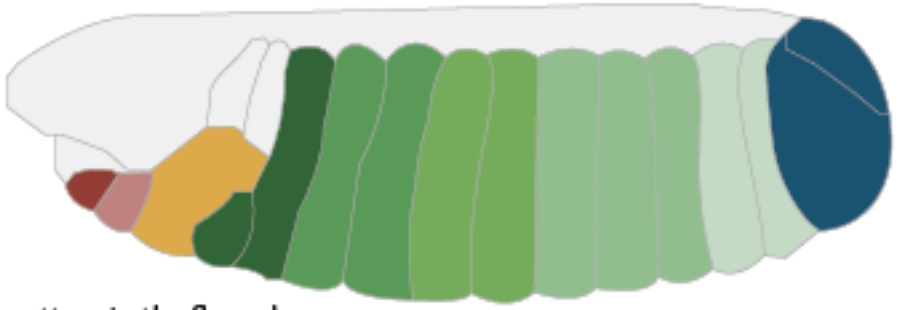



source of morphogen

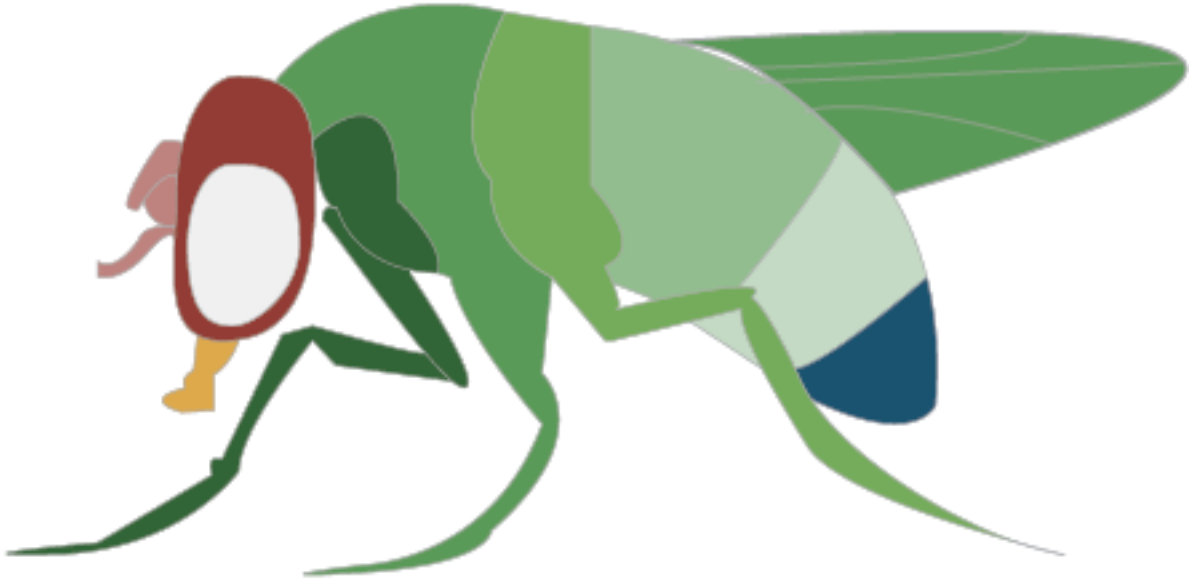

source of inducer
gradient of inducer extending across field of cells
(A)
inducer uniformly distributed
inhibitor distributed in gradient
source of inhibitor
resulting gradient of inducer activity
(B)


Concentration of morphogen
Organ A
Organ B
Organ C
Distance from secretion site
Organizer cells secreting morphogen
Embryo
Decreasing morphogen concentration gradient

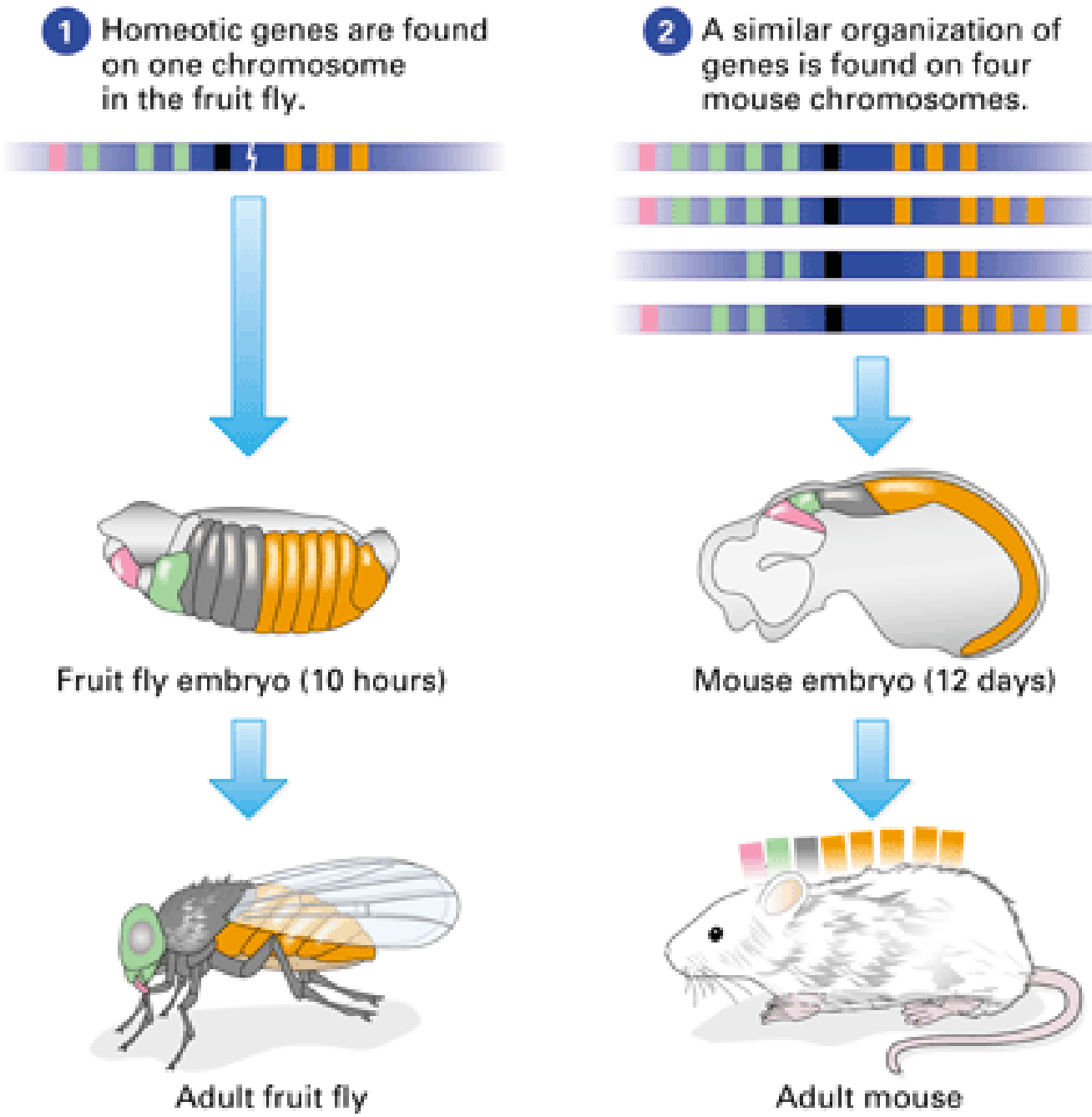




Hox gene pattern in the fly embryo

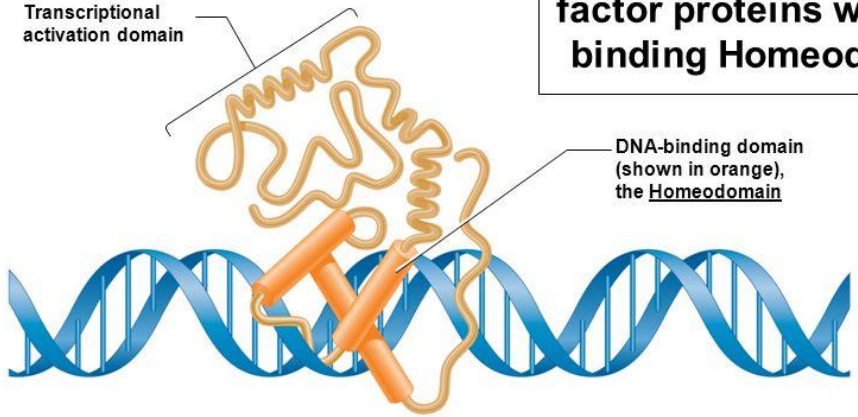


Adult fly structures from embryonic Hox gene expression



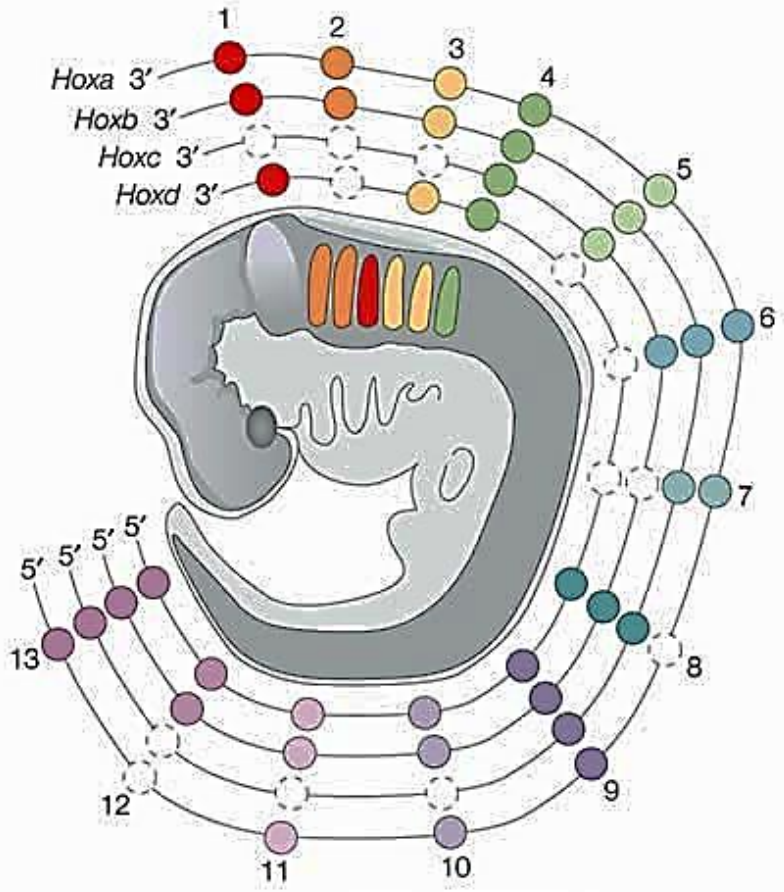
(a) Homeotic gene

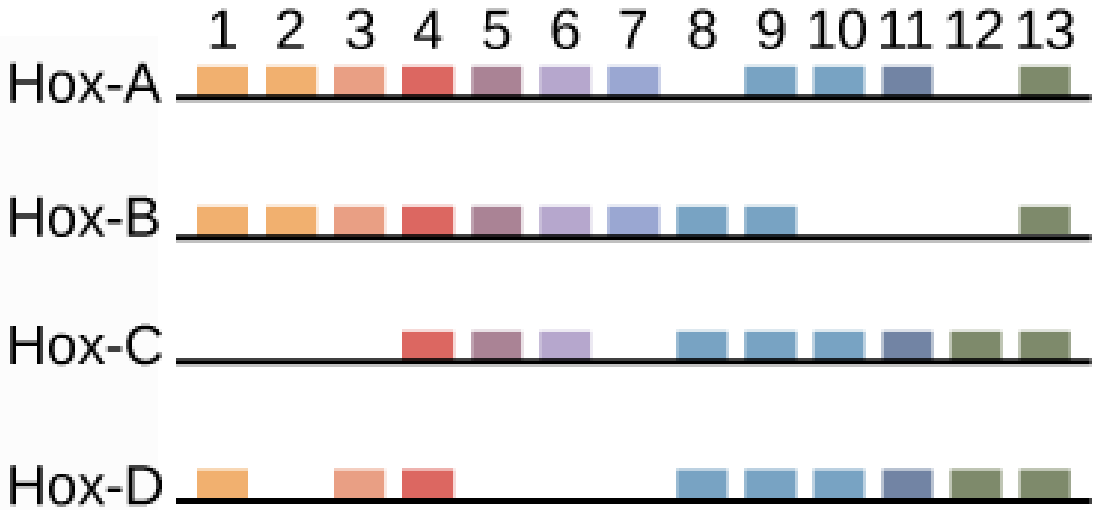
Homeotic Genes often identify transcription factor proteins with DNA-binding Homeodomains

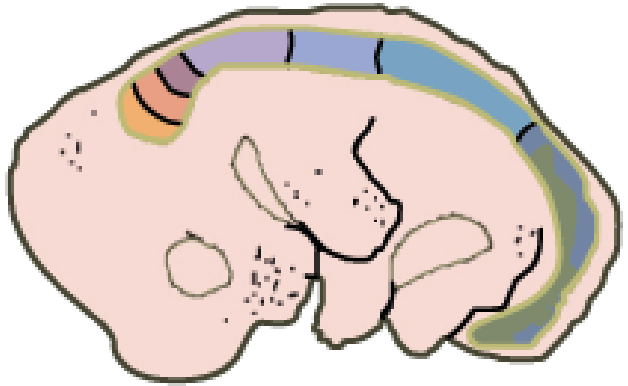


(b) Homeotic protein bound to DNA

Brooker, Fig 24 - 14



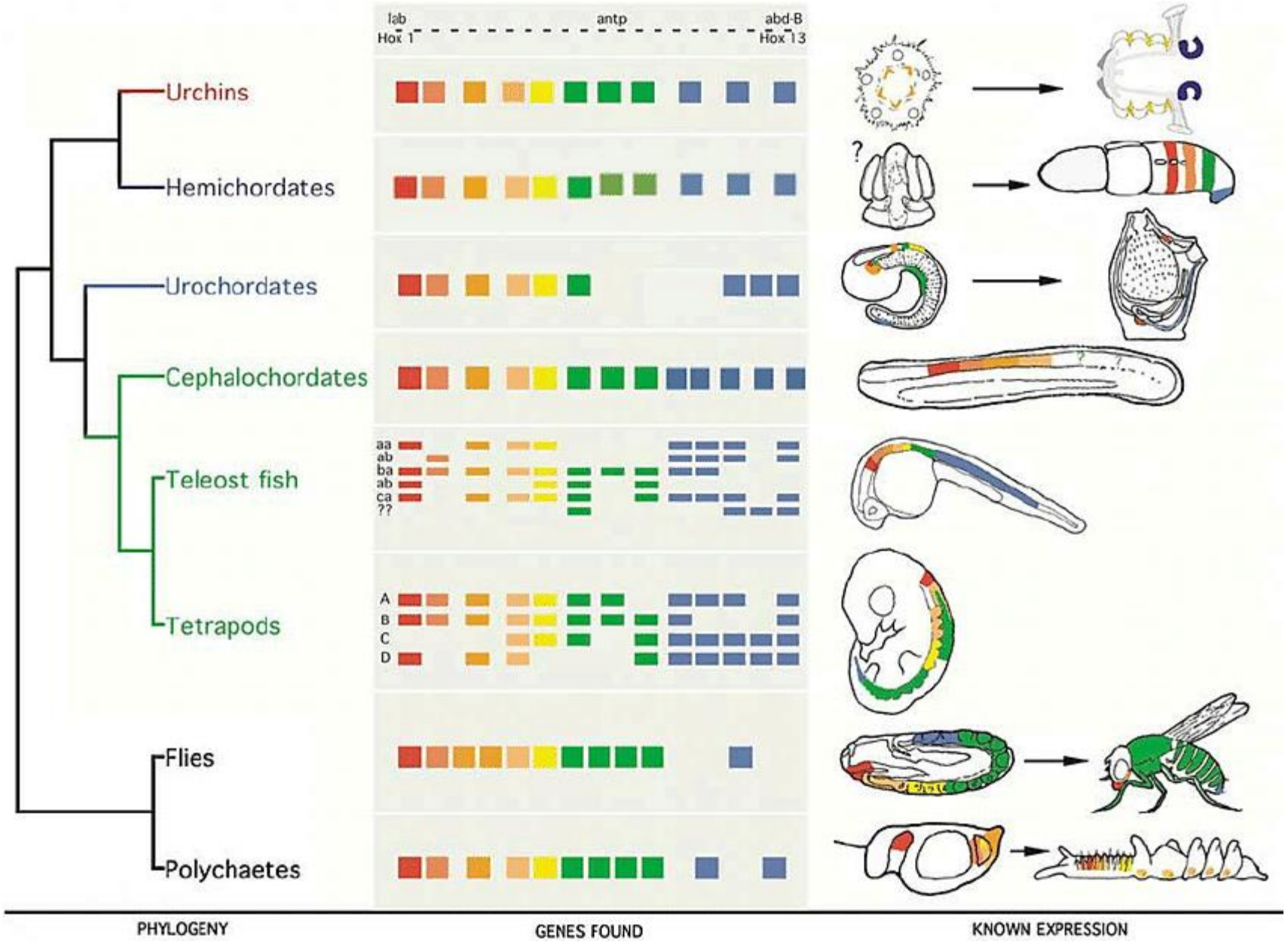




Mouse embryo

Adult human

1–4
5–6
7–8
9–13


lab
Hox 1
antp
abd-B
Hox 13
Urchins
Hemichordates
Urochordates
Cephalochordates
Teleost fish
Tetrapods
Flies
Polychaetes
aa
ab
ba
ab
ca
??
A
B
C
D
?
PHYLOGENY
GENES FOUND
KNOWN EXPRESSION

Vertebrate Gene	*Drosophila* Homolog	Expression in Vertebrate Eye	Loss of Function
Pax6	*eyeless, twin of eyeless*	Lens placode, optic vesicle	Aniridia (human), *small eye* (mouse)
Bmp4	*dpp*	Optic vesicle, head ectoderm	No lens (mouse)
Bmp7	*60A*	Optic vesicle, head ectoderm	No lens (mouse)
Eyal	*eyes absent*	Perioptic mesenchyme, weak lens expression	No eye phenotype (human) or (mouse), some human mutations lead to cataracts and anterior defects
Six3	*sine oculis*	Lens placode, optic vesicle	Very small eyes (human)
Optx2	*optix*	Optic vesicle	No eyes (human)
Dach1	*dachshund*	Optic vesicle	*n.d.

*n.d., not determined

Source: Wawersik, S. and Maas, R.L. 2000. Vertebrate eye development as modelled in *Drosophila*. *Hum. Mol. Genet.* 9:917–925, Table 1, p. 921.

Table 22–1 Some Signal Proteins That Are Used Over and Over Again as Inducers in Animal Development

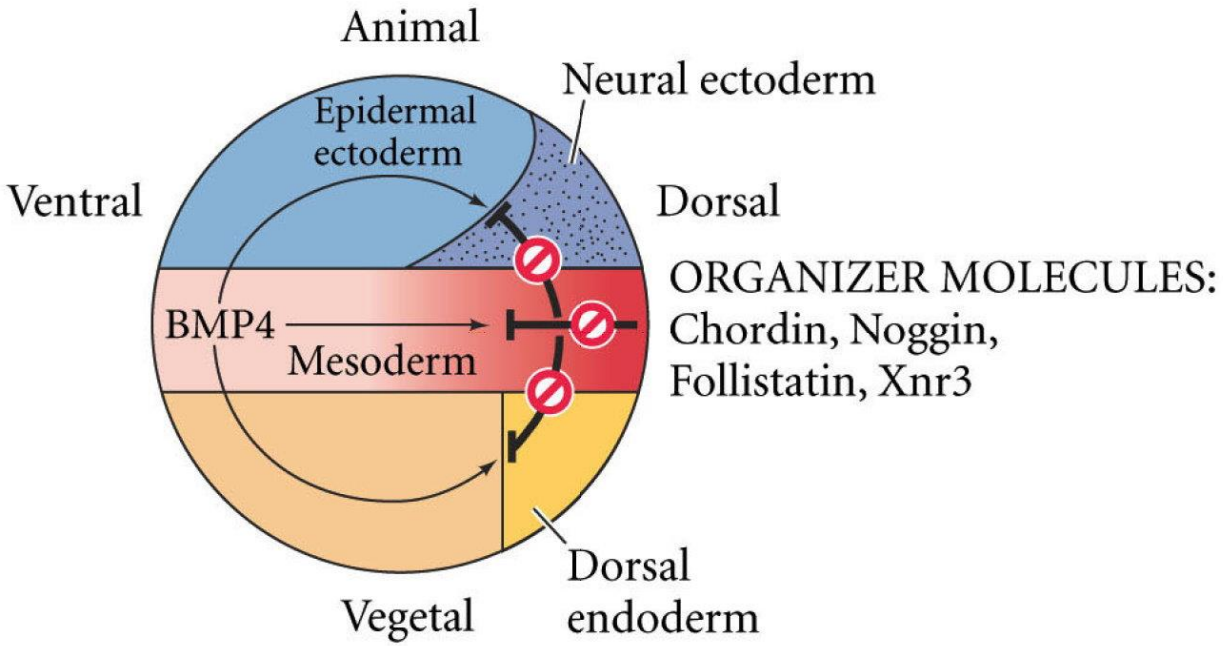
SIGNALING PATHWAY	LIGAND FAMIILY	RECEPTOR FAMILY	EXTRACELLULAR INHIBITORS/MODULATORS
Receptor tyrosine kinase (RTK)	EGF	EGF receptors	Argos
	FGF (Branchless)	FGF receptors (Breathless)	
	Ephrins	Eph receptors	
TGFβ superfamily	TGFβ	TGFβ receptors	chordin (Sog), noggin
	BMP (Dpp)	BMP receptors	
	Nodal		
Wnt	Wnt (Wingless)	Frizzled	Dickkopf, Cerberus
Hedgehog	Hedgehog	Patched, Smoothened	
Notch	Delta	Notch	Fringe

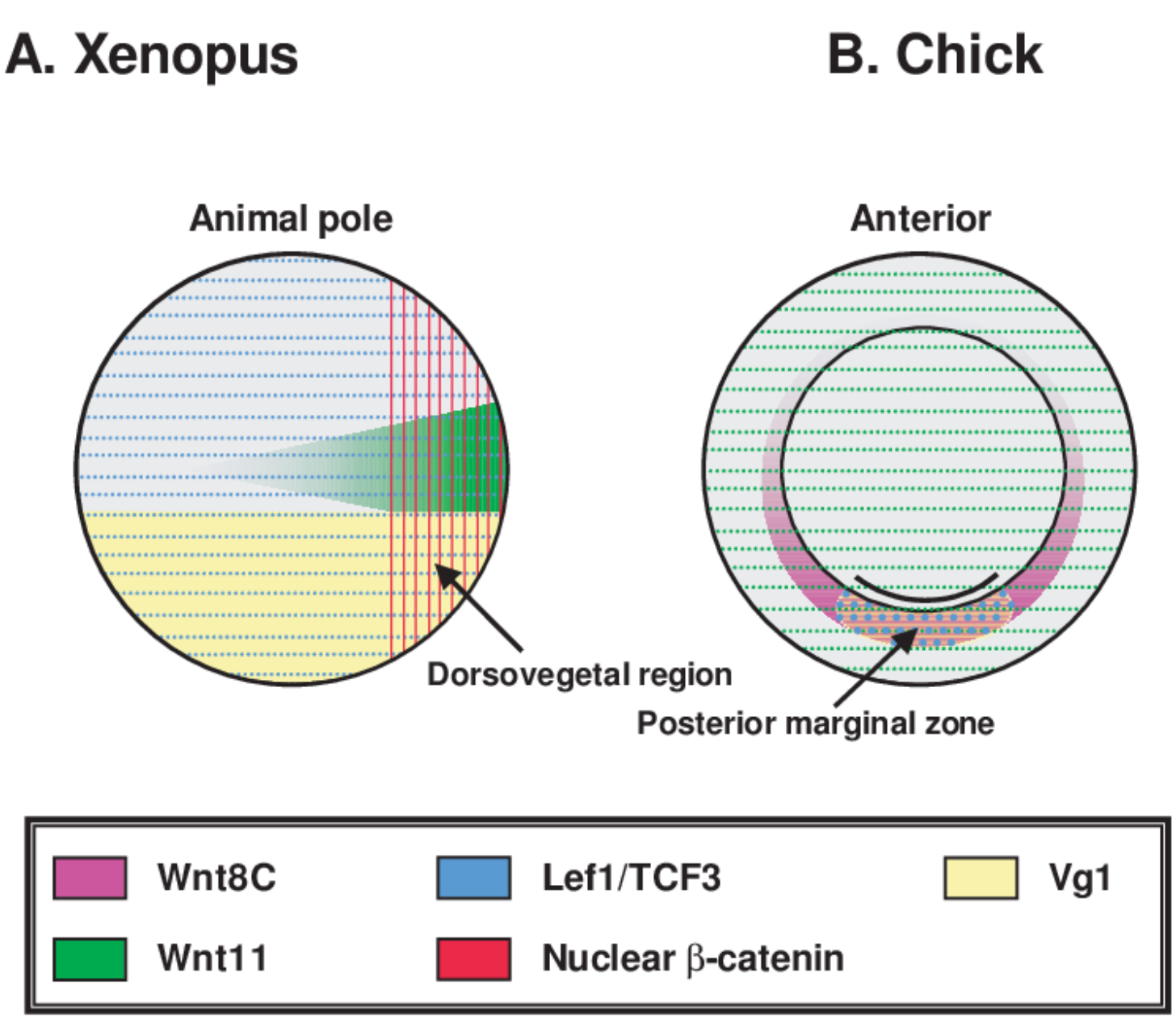
Only a few representatives of each class of proteins are listed—mainly those mentioned in this chapter. Names peculiar to *Drosophila* are shown in parentheses. Many of the listed components have several homologs distinguished by numbers (FGF1, FGF2, etc.) or by forenames (Sonic hedgehog, Lunatic fringe). Other signaling pathways, including the JAK/STAT, nuclear hormone receptor, and G-protein-coupled receptor pathways, also play important parts in some developmental processes.

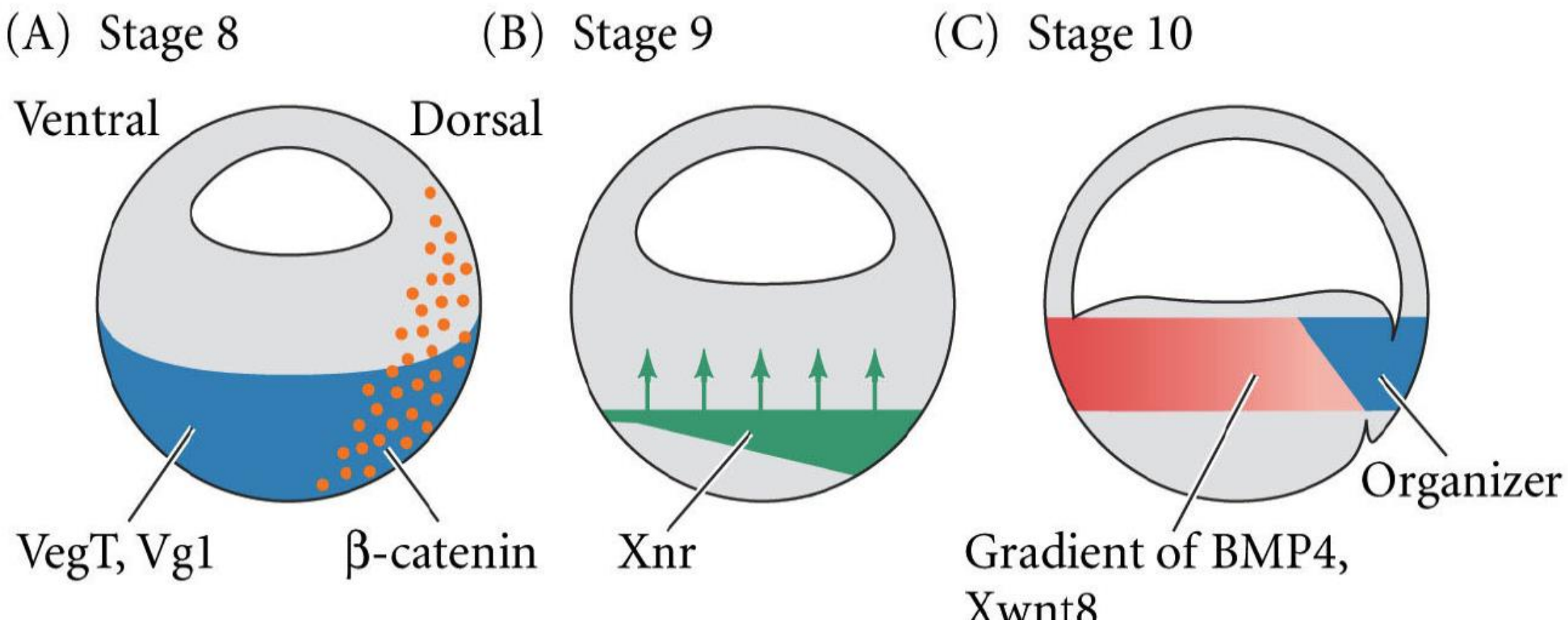
TABLE 10.2 Proteins expressed solely or almost exclusively in the organizer (partial list)

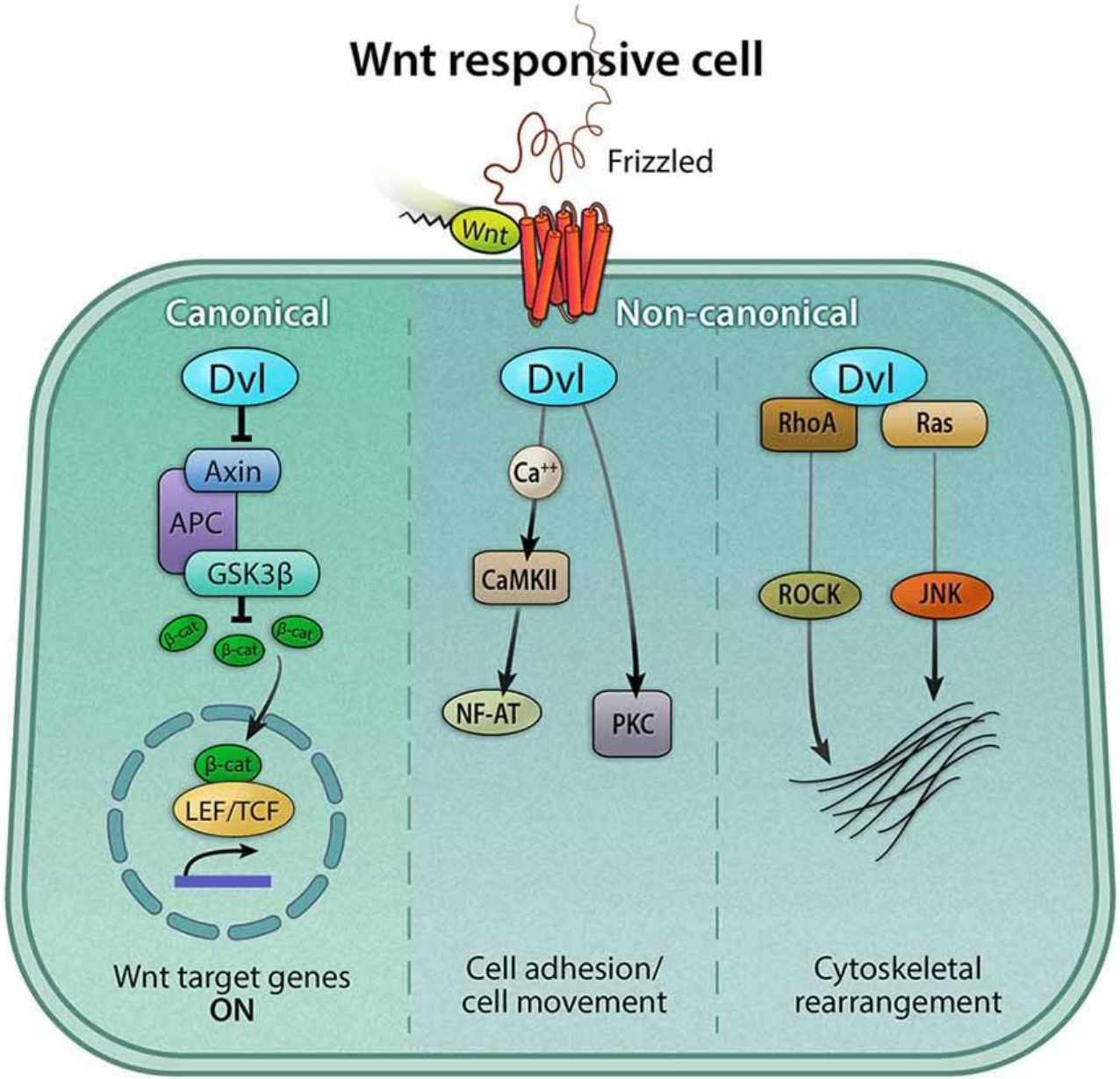
Nuclear proteins	Secreted proteins
Xlim1	Chordin
Xnot	Dickkopf
Otx2	ADMP
XFD1	Frzb
XANF1	Noggin
Goosecoid	Follistatin
HNF3b	Sonic hedgehog
	Cerberus
	Nodal-related proteins (several)

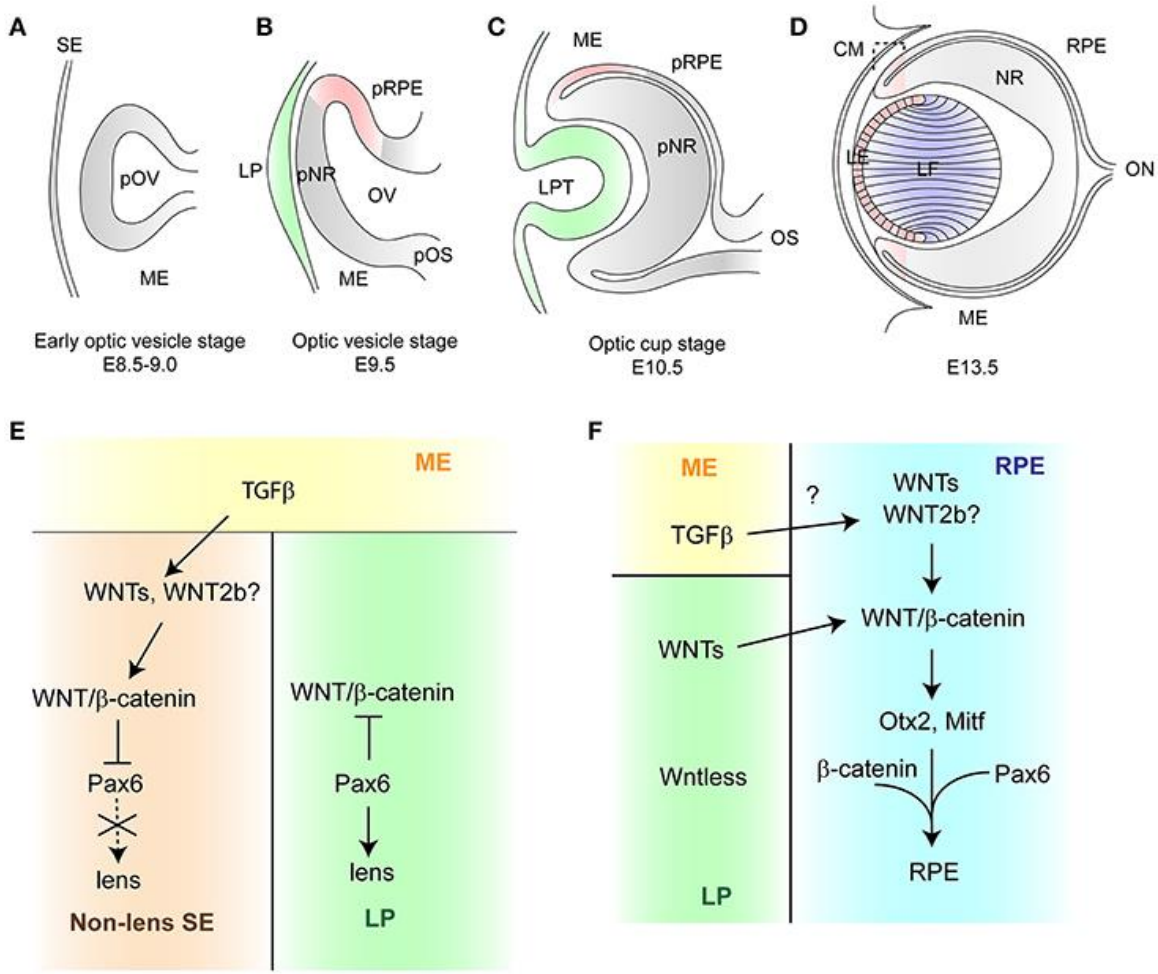
DEVELOPMENTAL BIOLOGY, Eighth Edition, Table 10.2 © 2006 Sinauer Associates, Inc




A. Xenopus
B. Chick
Animal pole
Anterior
Dorsovegetal region
Posterior marginal zone
Wnt8C
Lef1/TCF3
Vg1
Wnt11
Nuclear β-catenin


(A) Stage 8
(B) Stage 9
(C) Stage 10
Ventral
Dorsal
VegT, Vg1
β-catenin
Xnr
Organizer
Gradient of BMP4,
Xwnt8


Wnt responsive cell
Frizzled
Wnt
Canonical
Non-canonical
Dvl
Axin
APC
GSK3β
β-cat
β-cat
β-cat
β-cat
LEF/TCF
Wnt target genes
ON
Dvl
Ca++
CaMKII
NF-AT
PKC
Cell adhesion/
cell movement
Dvl
RhoA
Ras
ROCK
JNK
Cytoskeletal
rearrangement


A
SE
pOV
ME
Early optic vesicle stage
E8.5-9.0
B
pRPE
LP
pNR
OV
pOS
ME
Optic vesicle stage
E9.5
C
ME
pRPE
pNR
LPT
OS
Optic cup stage
E10.5
D
CM
RPE
NR
LF
LF
ON
ME
E13.5
E
ME
TGFβ
WNTs, WNT2b?
WNT/β-catenin
Pax6
lens
Non-lens SE
WNT/β-catenin
Pax6
lens
LP
F
ME
RPE
TGFβ
?
WNTs
WNT2b?
WNTs
WNT/β-catenin
Otx2, Mitf
Wntless
β-catenin
Pax6
RPE
LP

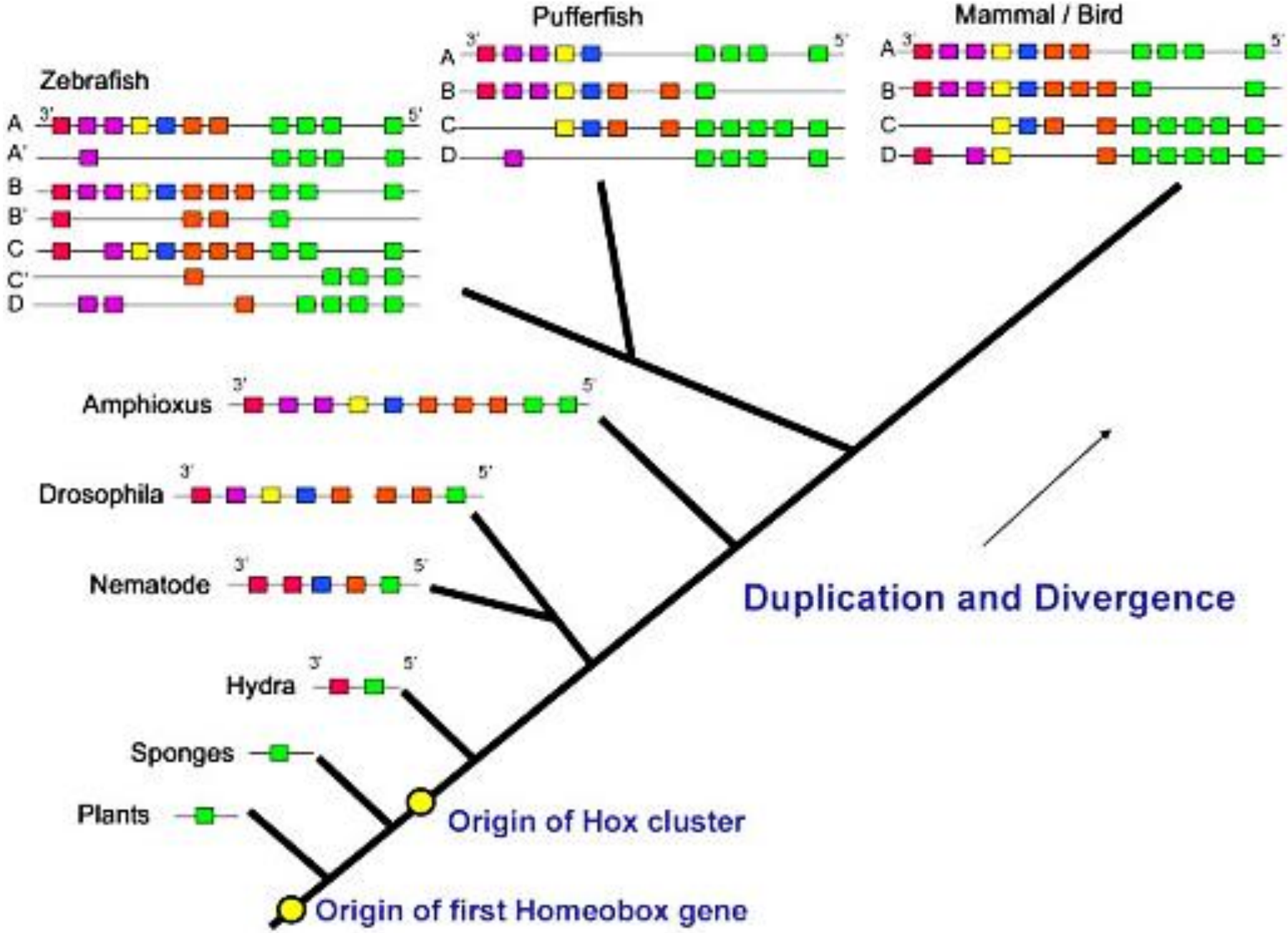

Pufferfish
Mammal / Bird
Zebrafish
A
A'
B
B'
C
C'
D
3'
5'
Amphioxus
Drosophila
Nematode
Hydra
Sponges
Plants
Duplication and Divergence
Origin of Hox cluster
Origin of first Homeobox gene

TABLE 2.1 Some major transcription factor families and subfamilies

Family	Representative transcription factors	Some functions
Homeodomain:		
Hox	Hoxa1, Hoxb2, etc.	Axis formation
POU	Pit1, Unc-86, Oct-2	Pituitary development; neural fate
Lim	Lim1, Forkhead	Head development
Pax	Pax1, 2, 3, 6, etc.	Neural specification; eye development
Basic helix-loop-helix (bHLH)	MyoD, MITF, daughterless	Muscle and nerve specification; *Drosophila* sex determination; pigmentation
Basic leucine zipper (bZip)	C/EBP, AP1	Liver differentiation; fat cell specification
Zinc-finger:		
Standard	WT1, Krüppel, Engrailed	Kidney, gonad, and macrophage development; *Drosophila* segmentation
Nuclear hormone receptors	Glucocorticoid receptor, estrogen receptor, testosterone receptor, retinoic acid receptors	Secondary sex determination; craniofacial development; limb development
Sry-Sox	Sry, SoxD, Sox2	Bend DNA; mammalian primary sex determination; ectoderm differentiation

***DEVELOPMENTAL BIOLOGY 10e*, Table 2.1**

Pioneer transcription factor: open up the repressed chromatin and maintain activation status