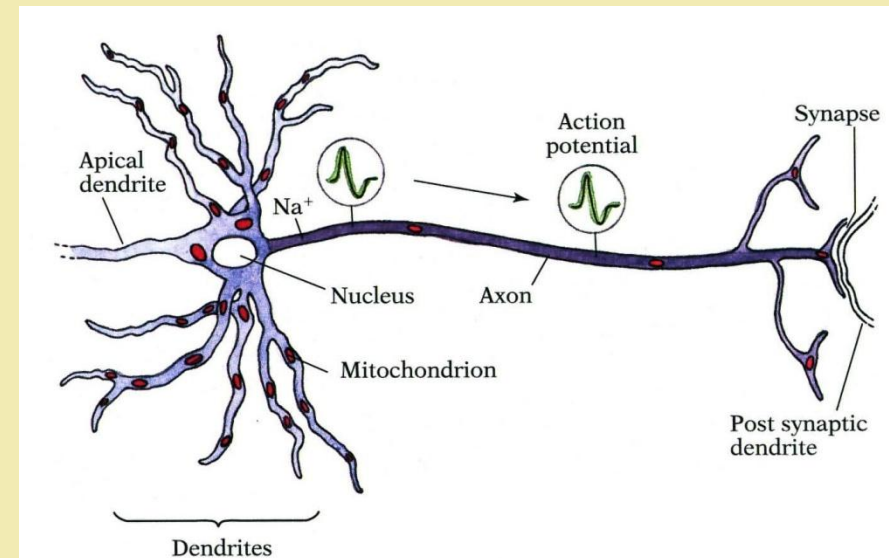


Nervový systém mají pouze mnohobuněční živočichové, ale

jednobuněčné organizmy jsou schopny reagovat na externí stimuly na subbuněčné úrovni. Jsou vybaveni specializovanými organelami a molekulární mašinerií nutnou k recepci chemických, mechanických a světelných stimulů, vedení signálu (sekrece biologicky aktivních látek resp. propagace membránového potenciálu) a generování efektorové odpovědi.



Histology

FIGURE 13-5
An idealized transverse section of the wall of the brain to show neuroglial cells; other non-nervous cells; and their relationships to neurons, the ventricular system, and blood vessels. (Modified from Williams et al.)

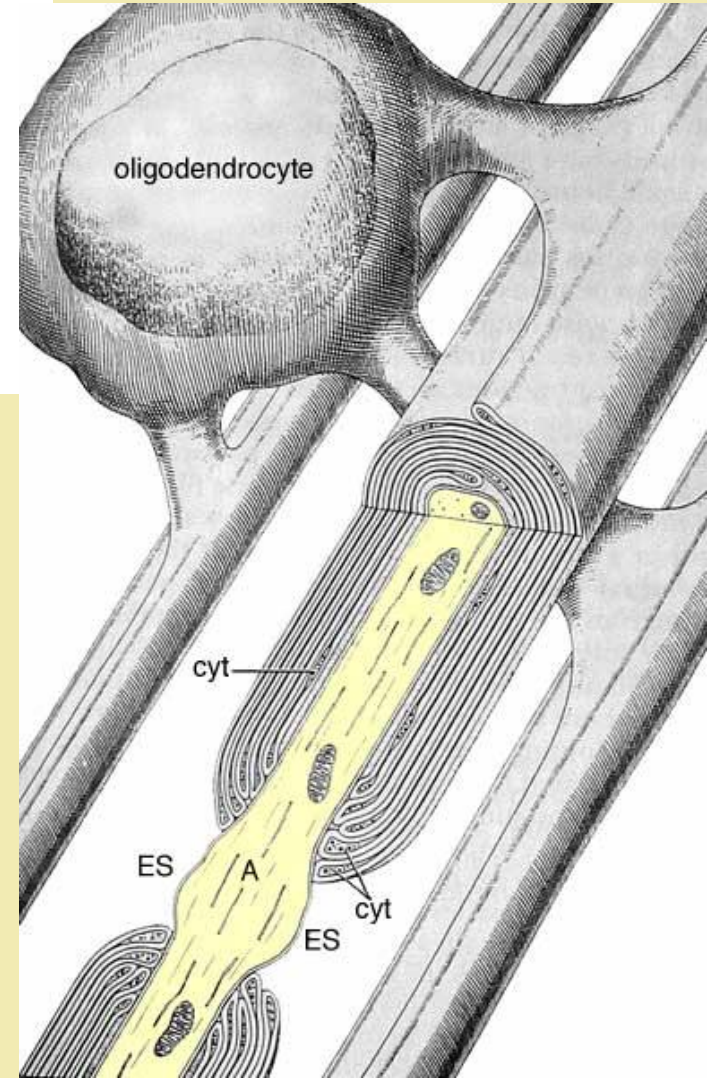
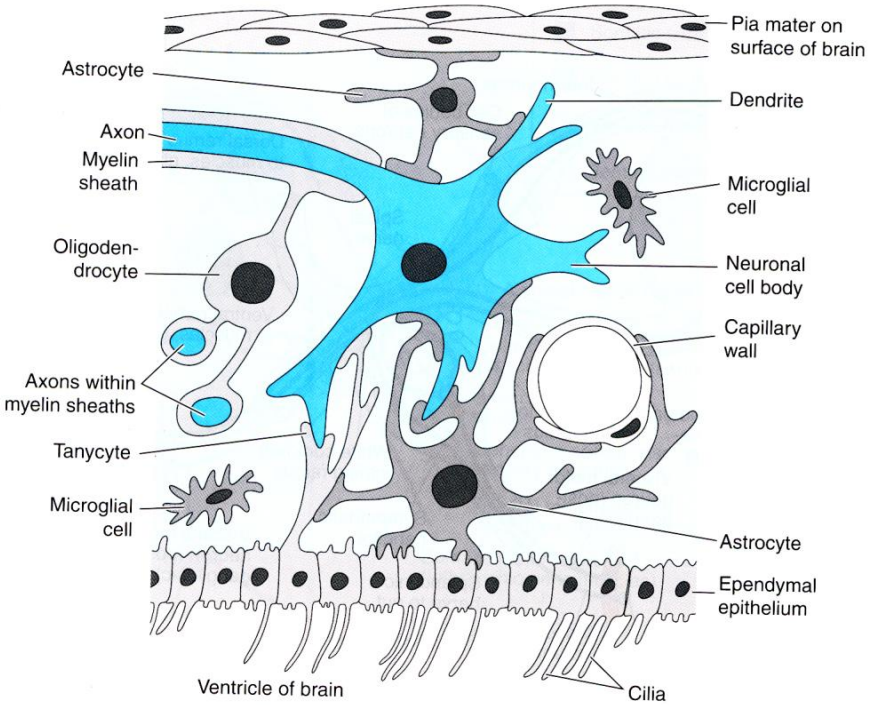
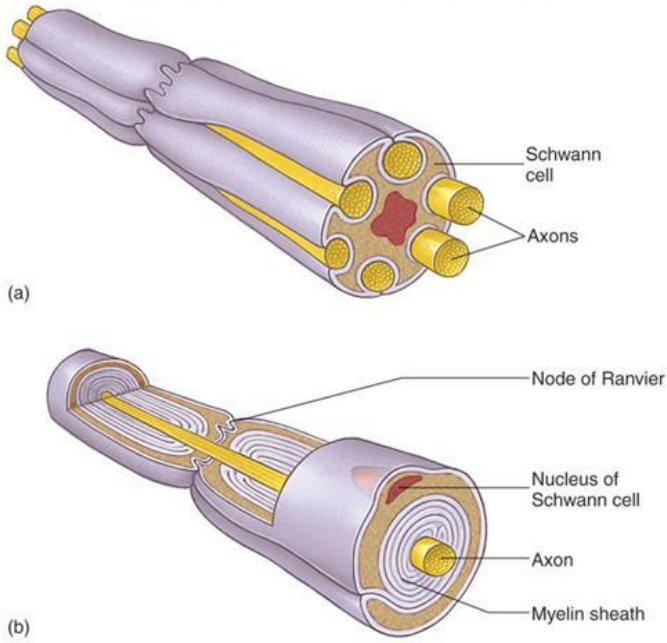
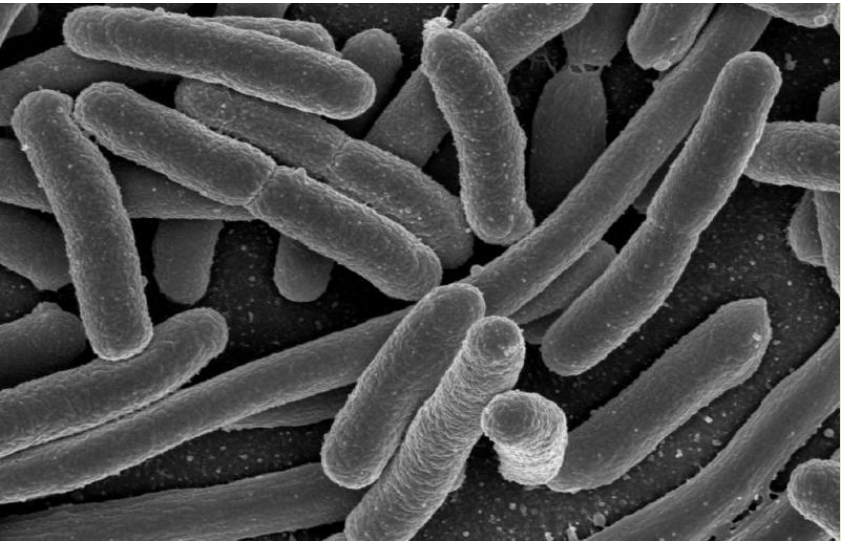
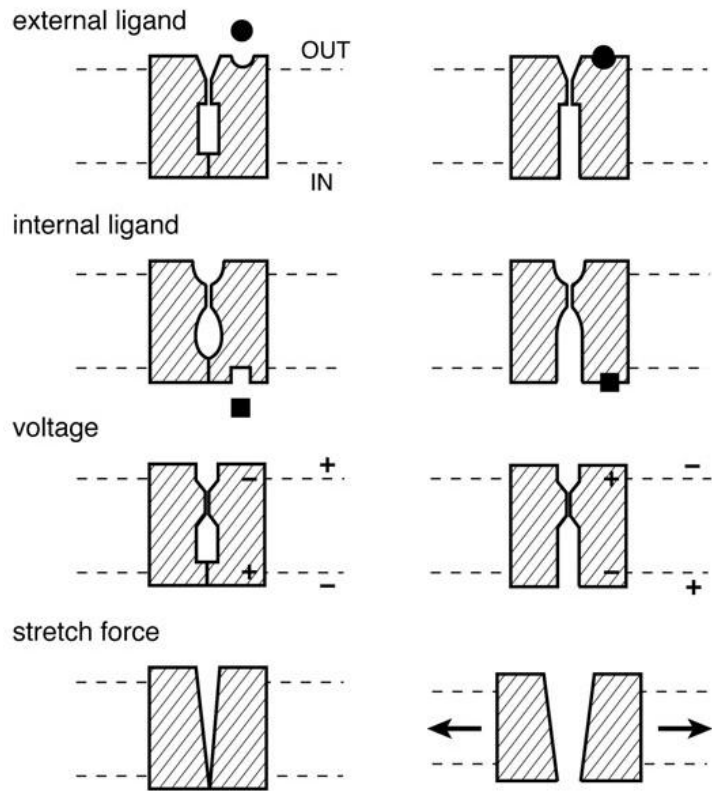


Fig. 8.6

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B. Gating by



Prokaryota

Mají iontové kanály, jejich funkce je většinou neznámá (většinou osmoregulace)

Např. Escherichia coli:

6 mechanicky vrátkovaných kanálů

3 napětově vrátkované kanály (jeden K^+ , dva Cl^-)



Protista

Neuroaktivní látky:

Adrenalin, noradrenalin, serotonin (5-HT), DOPA (3,4-dihydroxy-L-phenylalanine), dopamin, beta-endorphin; receptory acetylcholinu, katecholaminů a opiátů

Mechanicky a napět'ově nebo ligandem vrátkované kanály

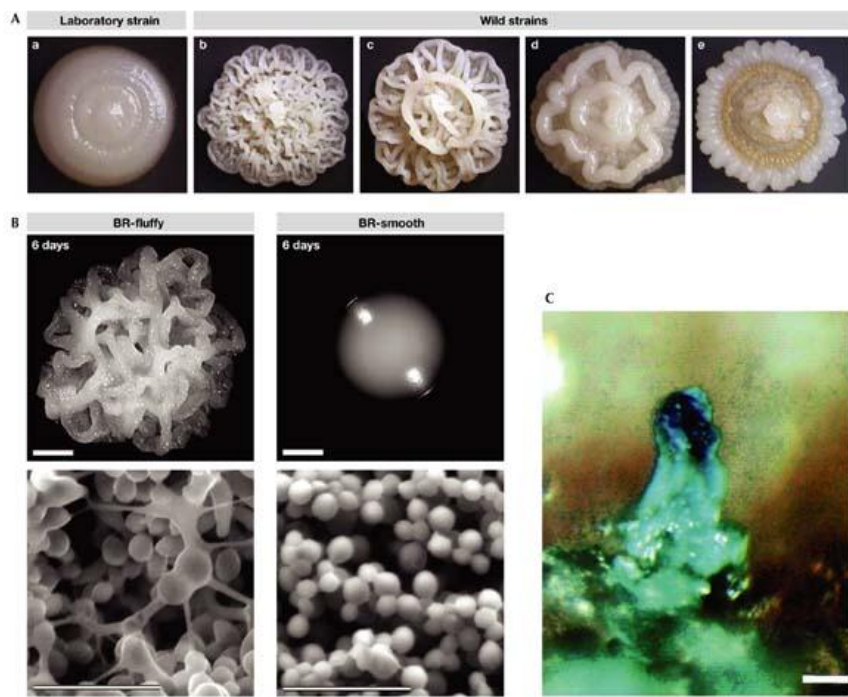
Depolarizace nebo hyperpolarizace membrány např. po mechanické stimulaci, u některých akční potenciál (většinou Ca^{2+})



Nálevníci – rody *Paramecium* (TREPKA), *Stylonichia* (SLÁVINKA) – opačné póly těla vybaveny různými iontovými kanály – orientovaná úniková reakce

Obrněnky (Dinoflagelata) – rod *Noctiluca* – dva různé typy pohybu bičíkem a bioluminiscence





Kvasinky

**Mechanicky a napět'ově
vrátkované kanály**

+ pheromonální komunikace
(často signální molekuly homologické
témuž u živočichů, např. alpha type mating
factor \approx gonadotropin-releasing hormone)

Rostliny

**Elektrický a humorální přenos
signálu**

**Akční potenciál (plasmodesmata
floemu; Ca^{2+} in, Cl^- out)**

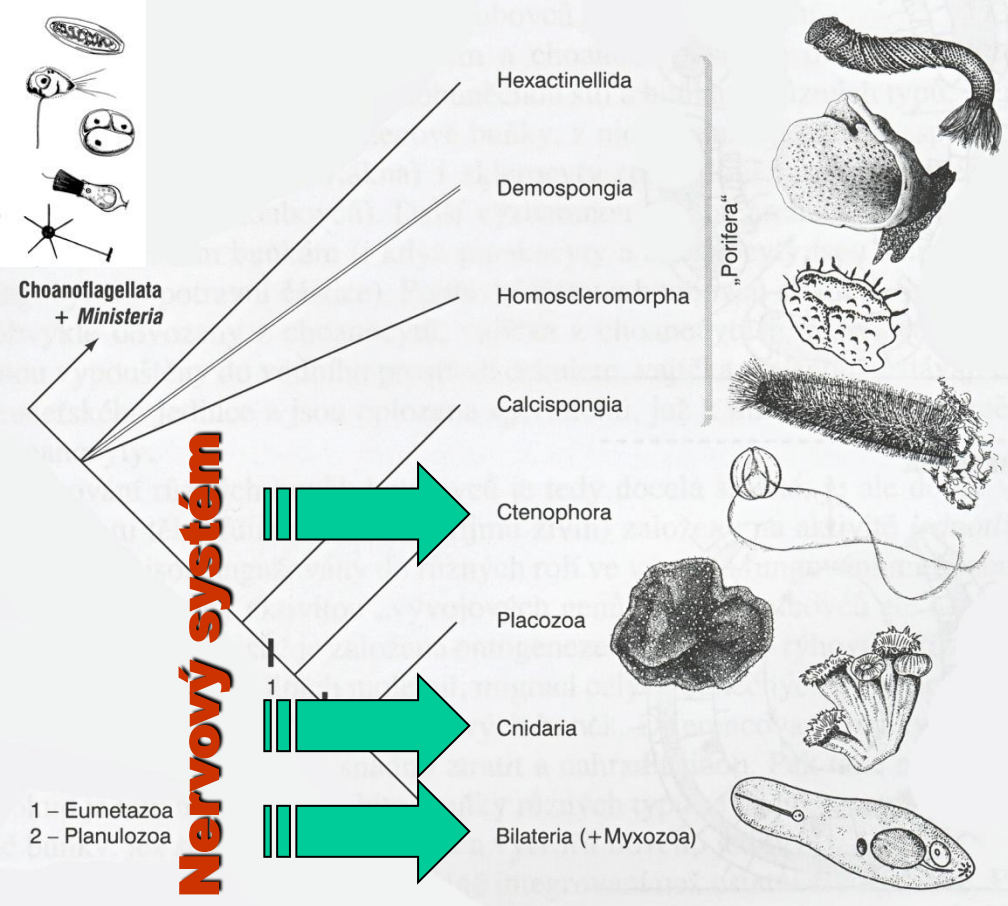
**GABA, glycine, glutamate,
acetylcholine (ale neúčastní se
chemického přenosu elektického
signálu; snad funkce v
metabolismu, cyrcadiínních
rytmech, etc.)**



Metazoa

Typické znaky:

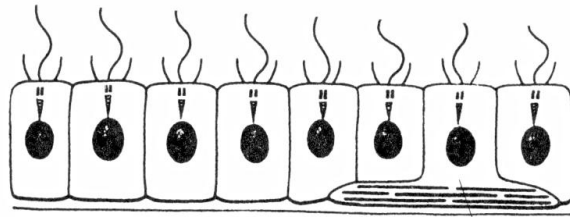
- ✓ **diploidní mnohobuněčné tělo**
- ✓ **haploidní fáze omezená na gamety**
- ✓ **extracelulární matrix (kolagen, glykoproteiny)**
- ✓ **pojivová tkáň a epitely**
- ✓ **mezibuněčné spoje**
- ✓ **struktura brv a bičíků (9x2+2, příčně pruhované kotvící kořinky)**
- ✓ **stavba spermie**
- ✓ **průběh ontogeneze (unikátní signální dráhy definující tělesné osy, gastrulace)**



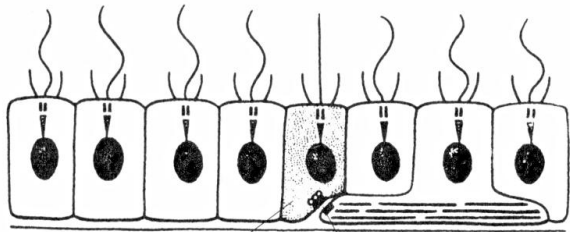
První živočichové neměli:

nervou soustavu, svalovou soustavu, smyslové orgány, trávicí dutinu ani pohlavní žlázy.

Vznik nervových a svalových buněk

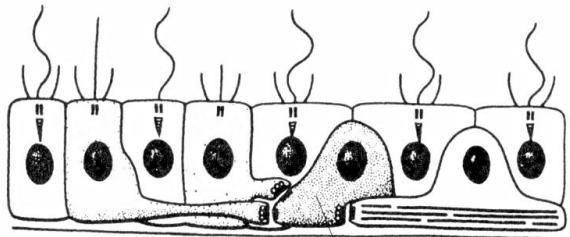


svalová buňka

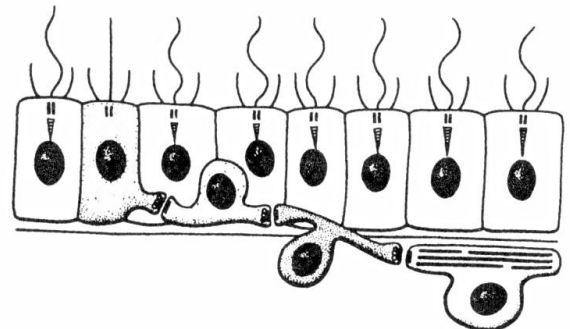


smyslová buňka

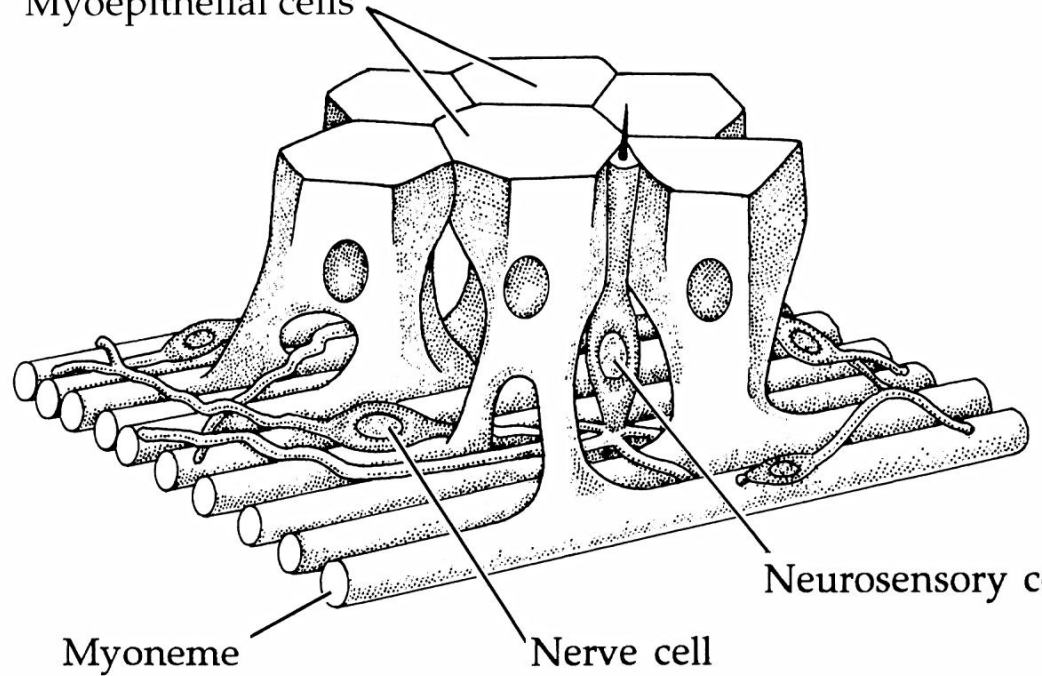
synapse



neuron

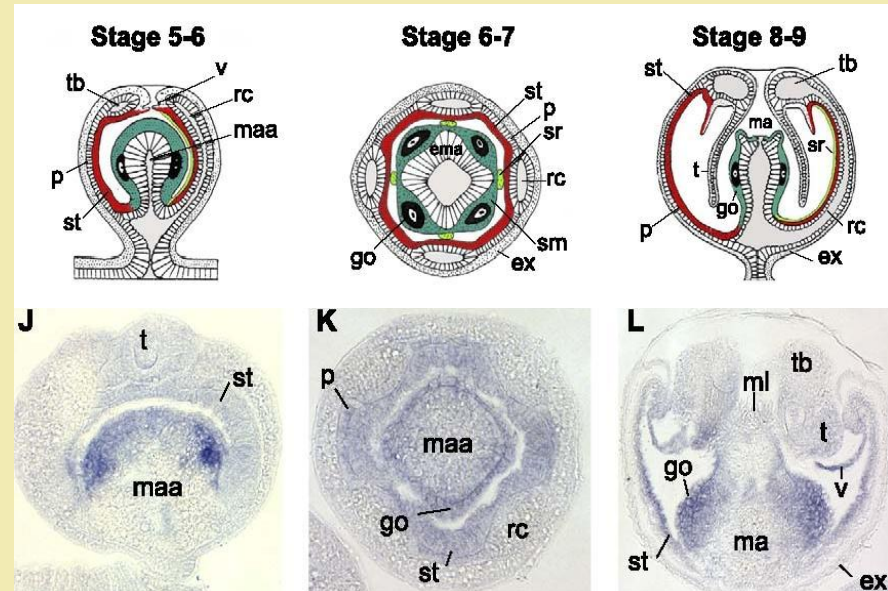
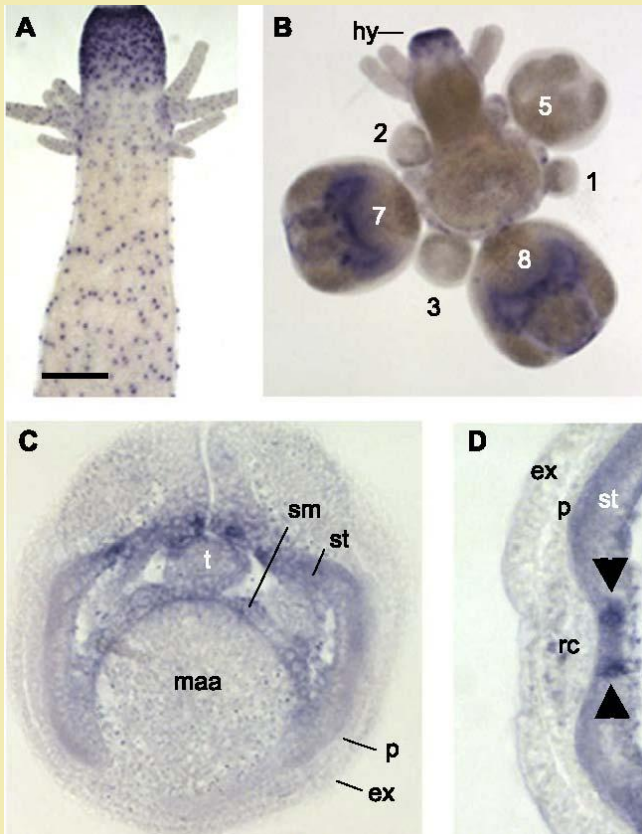


Myoepithelial cells



Společný vznik nervových a svalových buněk z myoepiteliálního prekursorů

Molekulární data ([Developmental Biology Volume 269, Issue 2, 2004, Pages 331-345](#))



Atonal-like gen At1 (rodina basic helix–loop–helix (bHLH) transcripčních faktorů) – exprese v nervových buňkách i svalech

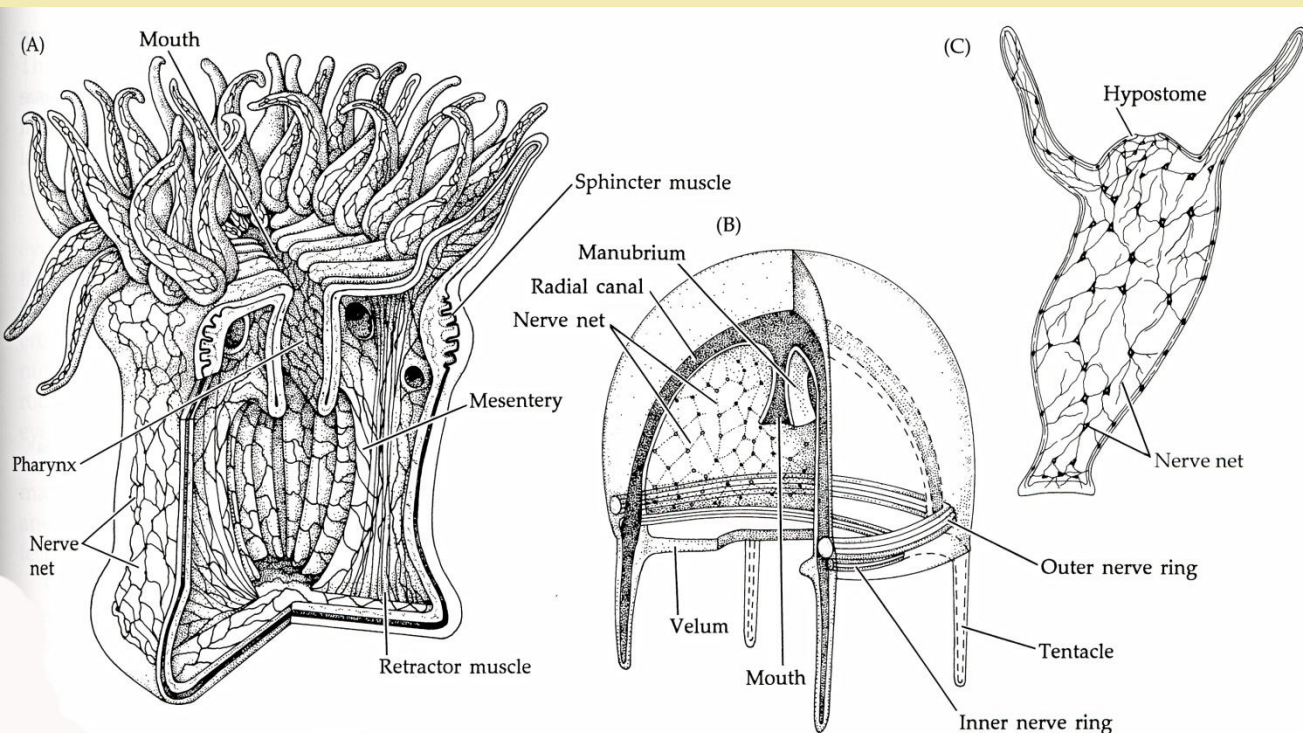
Polypovci (Hydrozoa): nezmarovka masitá (Podocoryne carnea)

Neuronální marker – gen NP kódující RF-amide neuropeptid – exprese v nervových buňkách i svalech

Žahavci (Cnidaria)

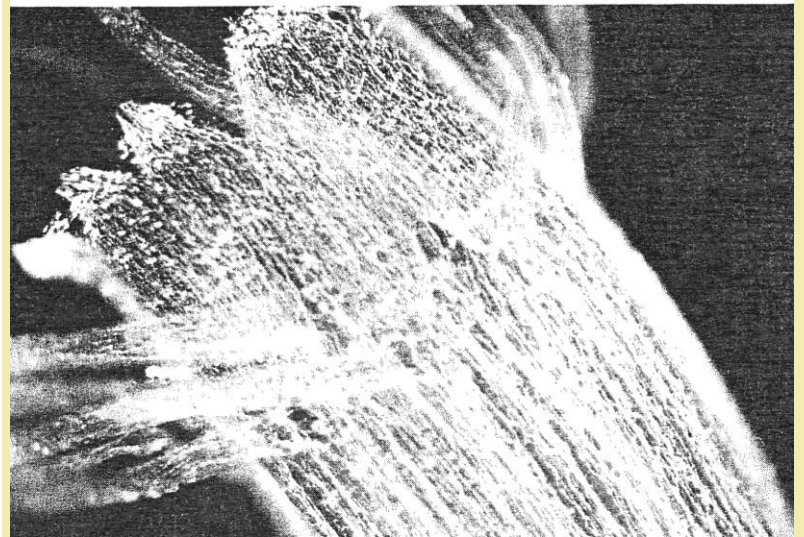
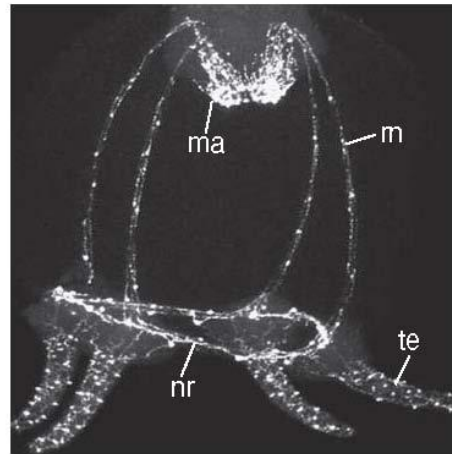
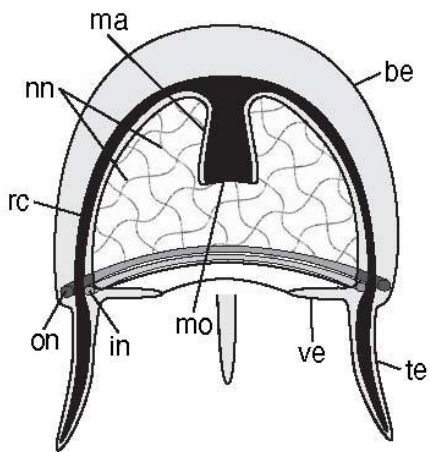
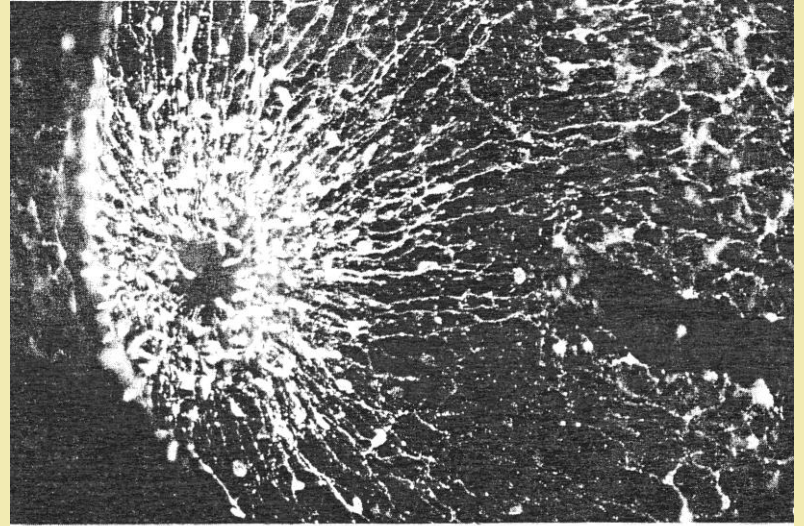
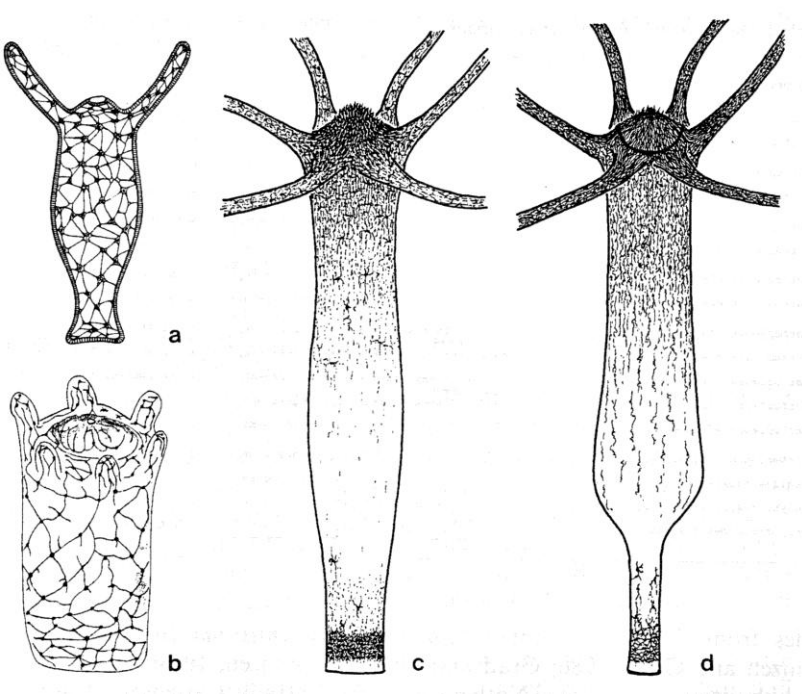
➡ „sít'ovitá“ nervová soustava

- koncentrace neuronů kolem ústního otvoru polypů a zvonu medúz)
- neuropeptidy – RFamidy
- několik typů neuronů



Žahavci (Cnidaria)

⇒ „sít'ovitá“ nervová

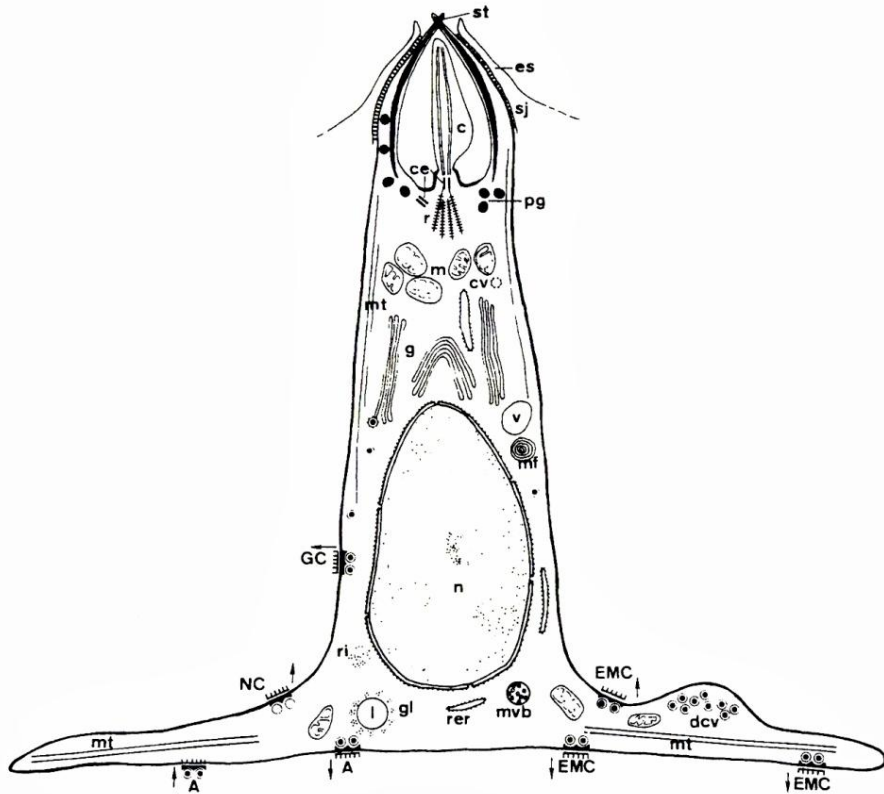


(b)

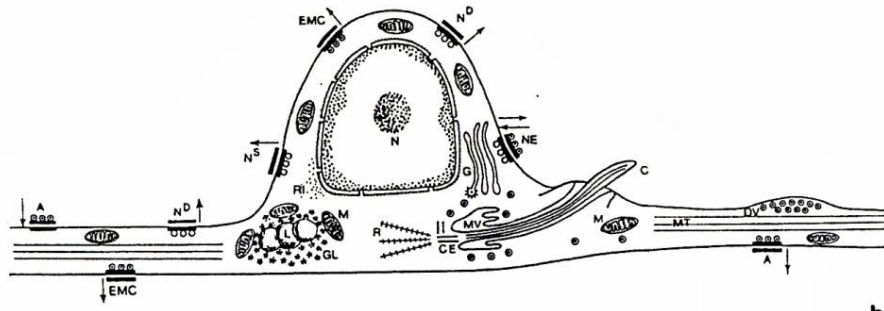
(c)

Žahavci (Cnidaria)

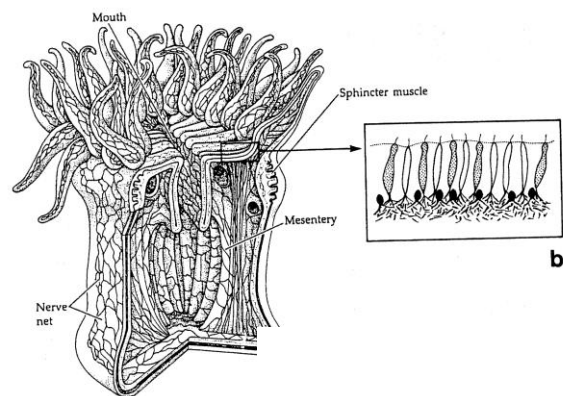
Neurony mají multifunkční charakteristiky



a



b



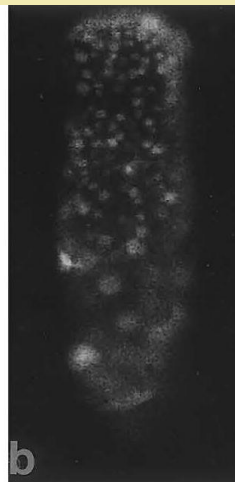
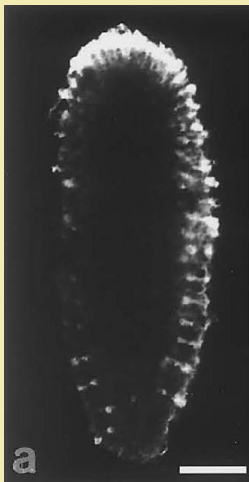
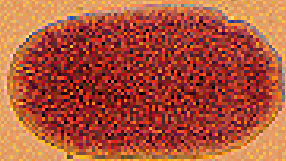
Žahavci – neuropeptidy

Nejméně 6 různých subpopulací neuronů
 Chybí acetylcholin; katecholaminy vzácné

Table 1. Neuropeptide families in cnidarians.

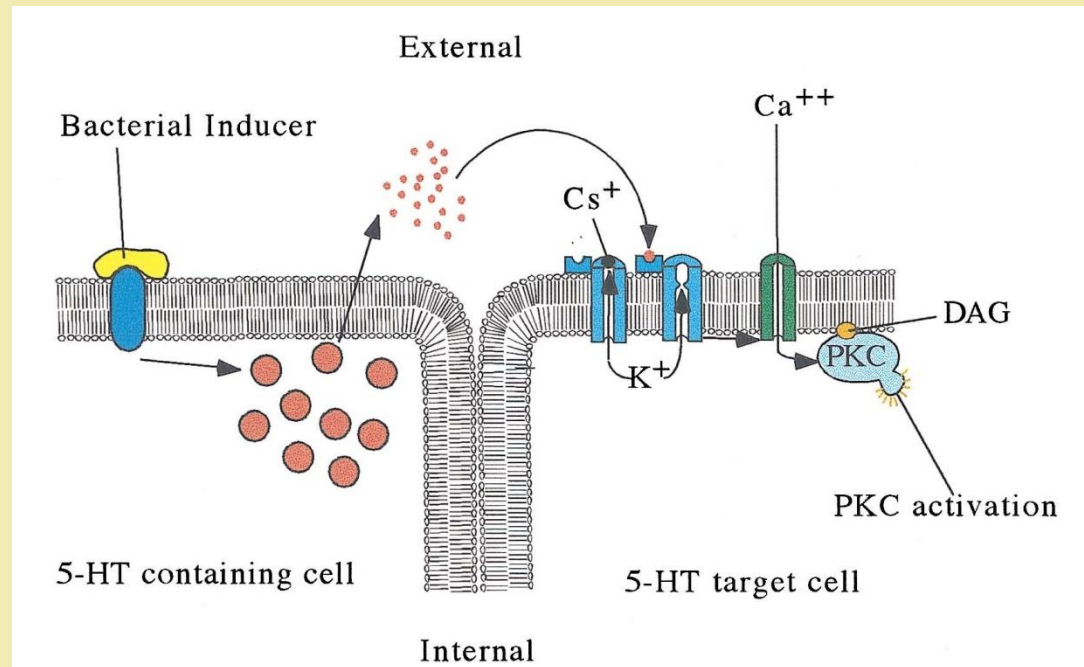
Species	Structure	Name
<i>Anthopleura elegantissima</i>	L-3-phenyllactyl-Phe-Lys-Ala-NH ₂	Antho-KAamide
<i>Anthopleura elegantissima</i>	L-3-phenyllactyl-Tyr-Arg-Ile-NH ₂	Antho-RIamide I
<i>Anthopleura elegantissima</i>	Tyr-Arg-Ile-NH ₂	Antho-RIamide II
<i>Anthopleura elegantissima</i>	L-3-phenyllactyl-Leu-Arg-Asn-NH ₂	Antho-RNamide I
<i>Anthopleura elegantissima</i>	Leu-Arg-Asn-NH ₂	Antho-RNamide II
<i>Anthopleura elegantissima</i>	<Glu-Ser-Leu-Arg-Trp-NH ₂	Antho-RWamide I
<i>Anthopleura elegantissima</i>	<Glu-Gly-Leu-Arg-Trp-NH ₂	Antho-RWamide II
<i>Anthopleura elegantissima</i>	<Glu-Asn-Phe-His-Leu-Arg-Pro-NH ₂	Antho-RPamide II
<i>Anthopleura elegantissima</i>	Leu-Pro-Pro-Gly-Pro-Leu-Pro-Arg-Pro-NH ₂	Antho-RPamide I
<i>Anthopleura elegantissima</i>	Gly-Pro-Hyp-Ser-Leu-Phe-Arg-Pro-NH ₂	Antho-RPamide IV
<i>Anthopleura elegantissima</i>	<Glu-Val-Lys-Leu-Tyr-Arg-Pro-NH ₂	Antho-RPamide III
<i>Anthopleura elegantissima</i>	Tyr-Arg-Pro-NH ₂	Antho-RPamide V
<i>Anthopleura elegantissima</i>	<Glu-Gly-Arg-Phe-NH ₂	Antho-RFamide
<i>Renilla köllikeri</i>	<Glu-Gly-Arg-Phe-NH ₂	Antho-RFamide
<i>Polyorchis penicillatus</i>	<Glu-Leu-Leu-Gly-Gly-Arg-Phe-NH ₂	Pol-RFamide I
<i>Polyorchis penicillatus</i>	<Glu-Trp-Leu-Lys-Gly-Arg-Phe-NH ₂	Pol-RFamide II

0.5mm



Žahavci (Cnidaria)

➤ **plnaktónní larvy (planula):**
– **serotonin, katecholaminy**
indukují metamorfózu



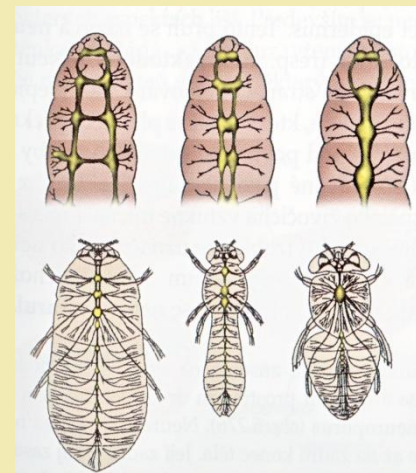
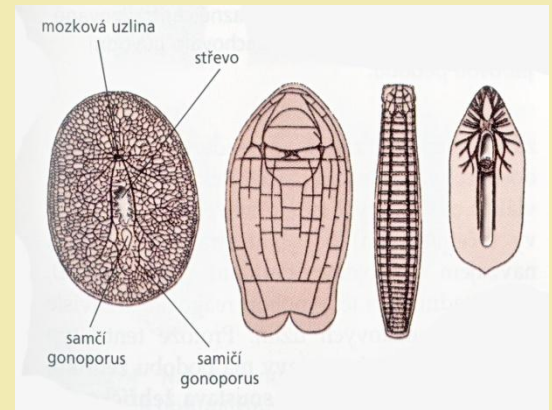
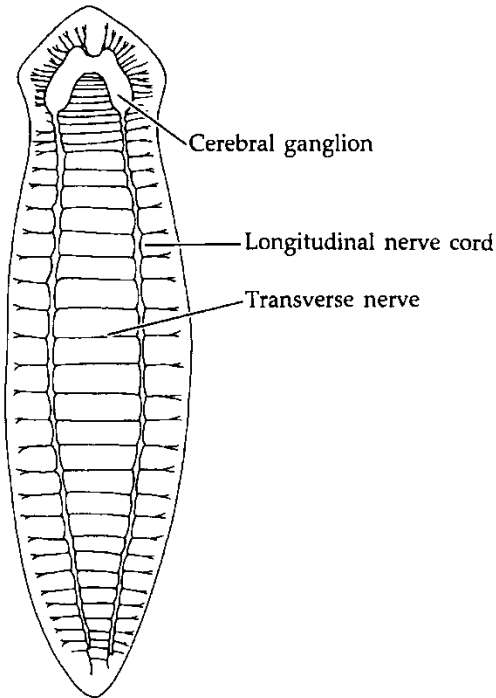
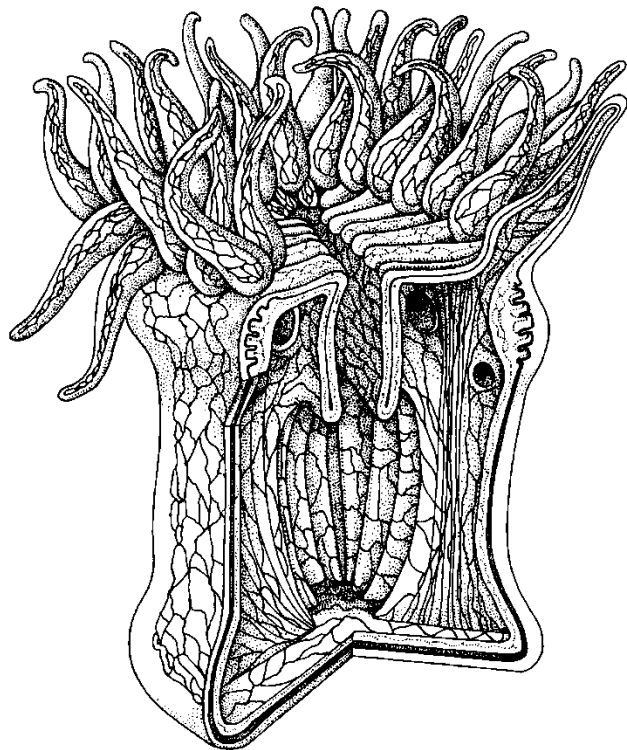
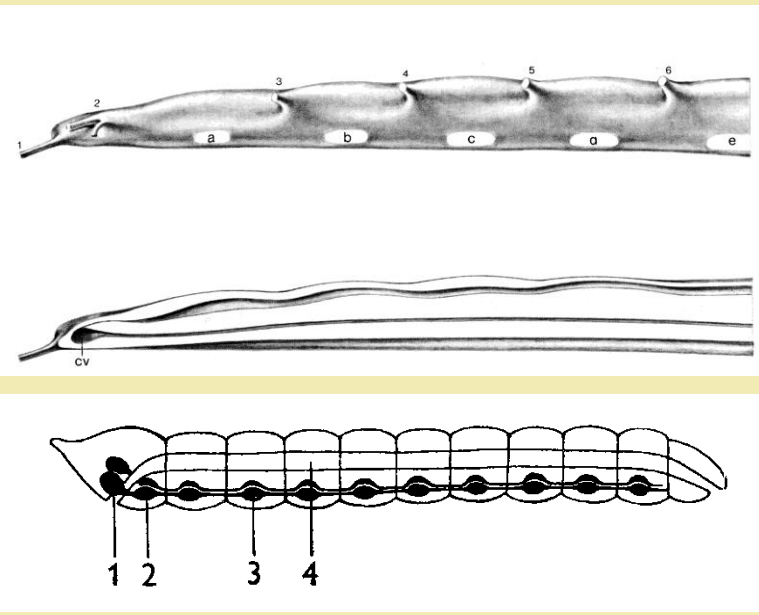
5-HT (5-hydroxytryptamin = serotonin)
imunopozitivní buňky v panule

Typy nervové soustavy (učebnicové schéma)

➤ Difuzní (syn. rozptýlená, síťovitá)

➤ Centralizovaná

gangliová / žebříčková
trubicovitá

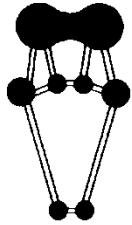


Cefalizace

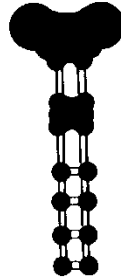


Centralizace
NS

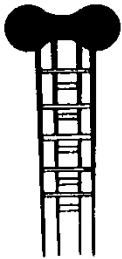
TETRANEURAL BAUPLAN
with Ganglia



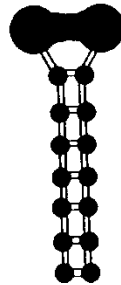
STRICKLEITER BAUPLAN
with Condensation of
Ganglia



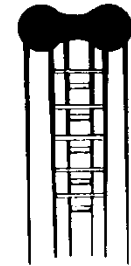
TETRANEURAL BAUPLAN
with Medullary Cords



STRICKLEITER BAUPLAN
without Condensation of
Ganglia



BASIC BILATERIAN BAUPLAN



NERVE PLEXUS

Typy nervové soustavy

Bilateria – ancestrální bauplan:

✓ **mozkové (nadjícnové) ganglion**

✓ **nervové pásy**

obsahující nervové vlákna i těla neuronů (nejspíše 3 páry – dorzální, ventrální a laterální)

Praploštěnci (Acoelomorpha)

Ploštěnci (Platyhelminthes)

Hlístice (Nematoda)

Pásnice (Nemertea)

Drápkovci (Onychophora)

+ v redukované formě asi také

Chapadlovky (Phoronida)

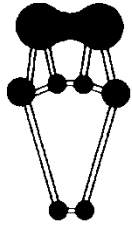
Ramenonožci (Brachiopoda)

Mechovci (Ectoprocta)

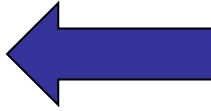
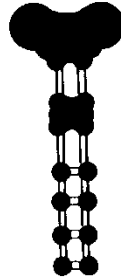


Na obrázku jsou černě vyznačeny části CNS obsahující těla neuronů, bíle nervové pásy a komisury neobsahující těla neuronů

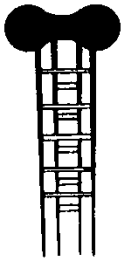
TETRANEURAL BAUPLAN
with Ganglia



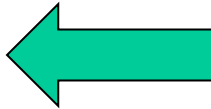
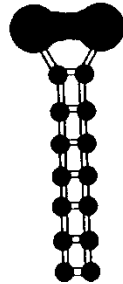
STRICKLEITER BAUPLAN
with Condensation of
Ganglia



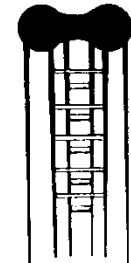
TETRANEURAL BAUPLAN
with Medullary Cords



STRICKLEITER BAUPLAN
without Condensation of
Ganglia



BASIC BILATERIAN BAUPLAN

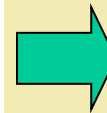


NERVE PLEXUS

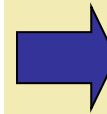
Typy nervové soustavy

Měkkýši – tetraneurální bauplan:

✓ 2 páry nervových páسů
(pleuroviscerální a pedální)



Červovci (Aplacophora)
Štítkonošci (Polyplacophora)
Monoplacophora



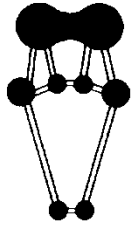
Píži (Gastropoda)
Mlži (Bivalvia)
Kelnatky (Scaphopoda)
Hlavonožci (Cephalopoda)



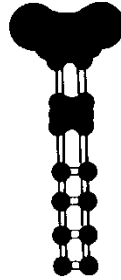
Kroužkovci skupiny Aciculata

Na obrázku jsou černě vyznačeny části CNS obsahující těla neuronů, bíle nervové pásy a komisury neobsahující těla neuronů

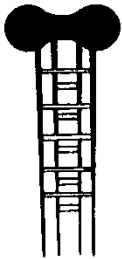
TETRANEURAL BAUPLAN
with Ganglia



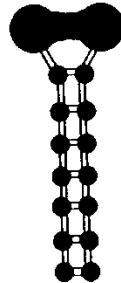
STRICKLEITER BAUPLAN
with Condensation of
Ganglia



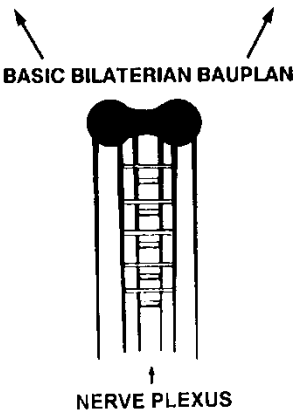
TETRANEURAL BAUPLAN
with Medullary Cords



STRICKLEITER BAUPLAN
without Condensation of
Ganglia



BASIC BILATERIAN BAUPLAN



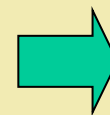
Typy nervové soustavy

Žebříčkovitá NS

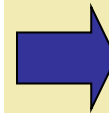
✓ 1 pár ventrálních nervových páسů

(neobsahují těla neuronů)

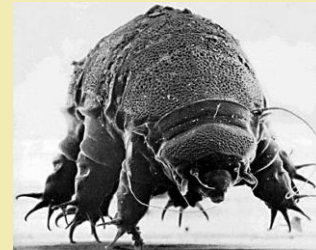
✓ segmentálně uspořádaná ganglia



Kroužkovci (Annelida)
Rypečky (Kinorhyncha)
Želvušky (Tardigrada)



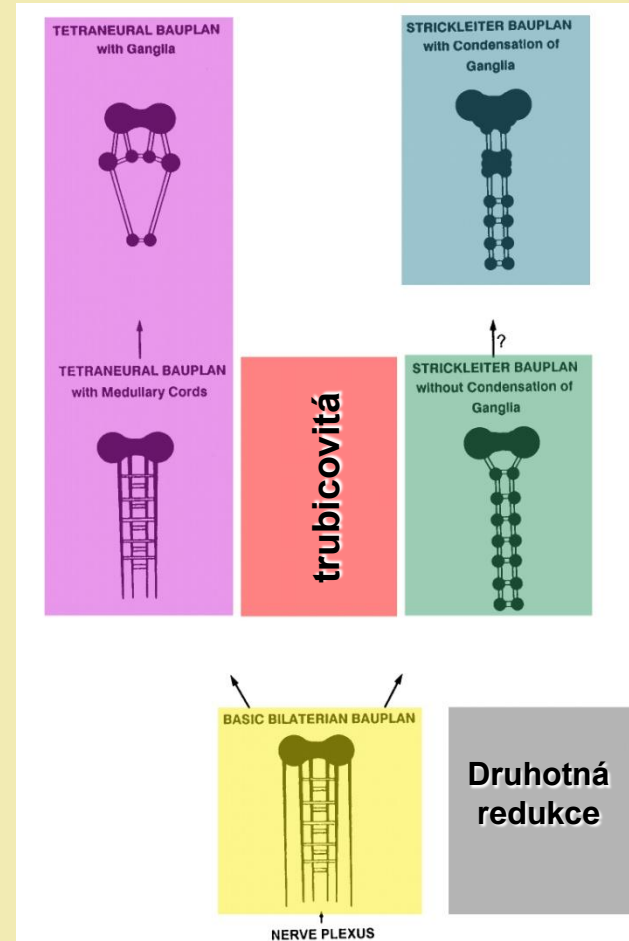
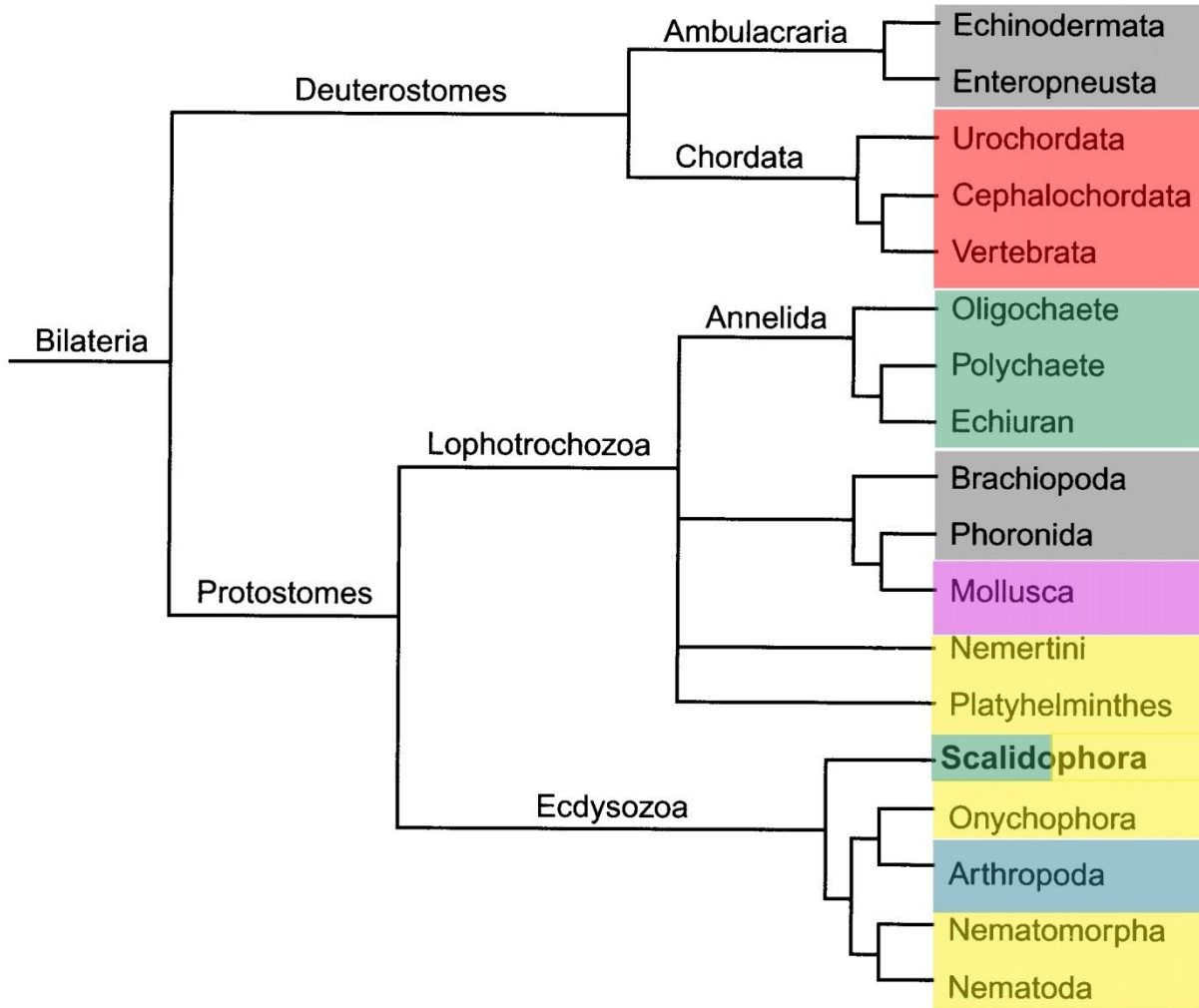
Členovci (Euartropoda)



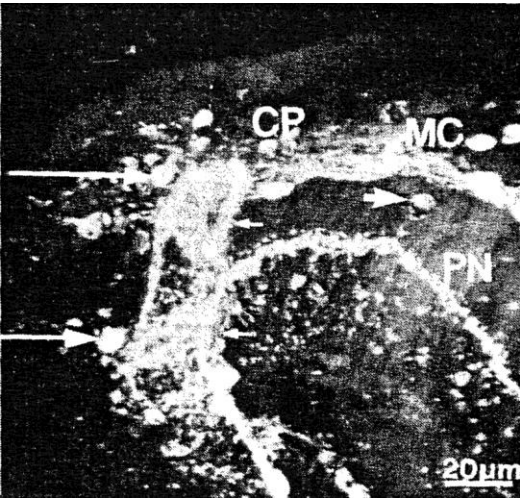
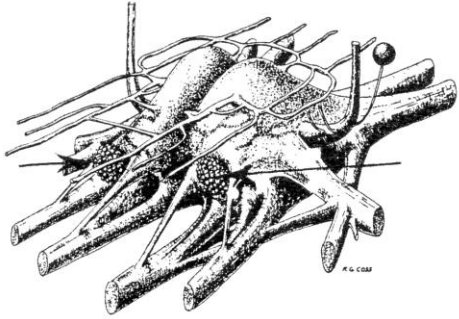
Na obrázku jsou černě vyznačeny části CNS obsahující těla neuronů, bíle nervové pásy a komisury neobsahující těla neuronů

Typy nervové soustavy

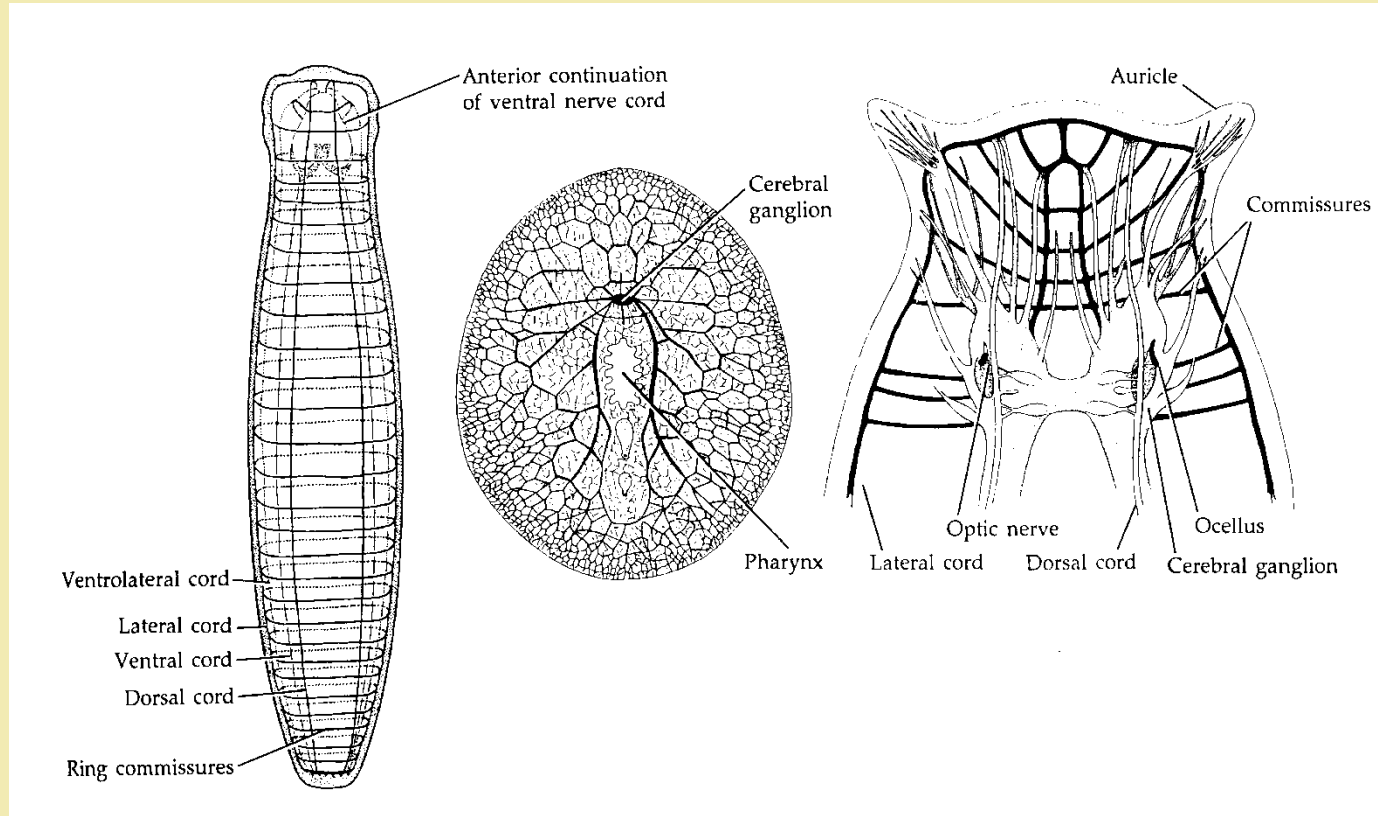
(zjednodušeno)



Ploštěnci (Platyhelminthes)



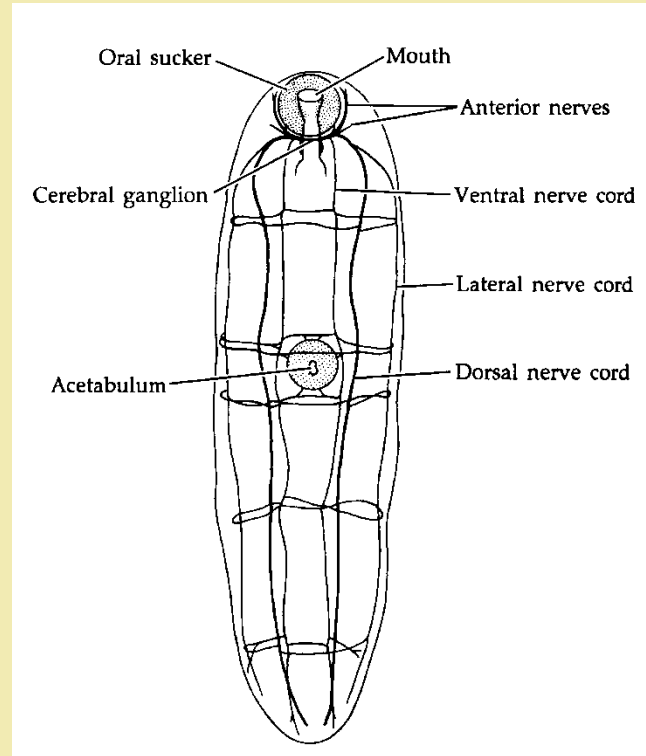
mozkové ganglion



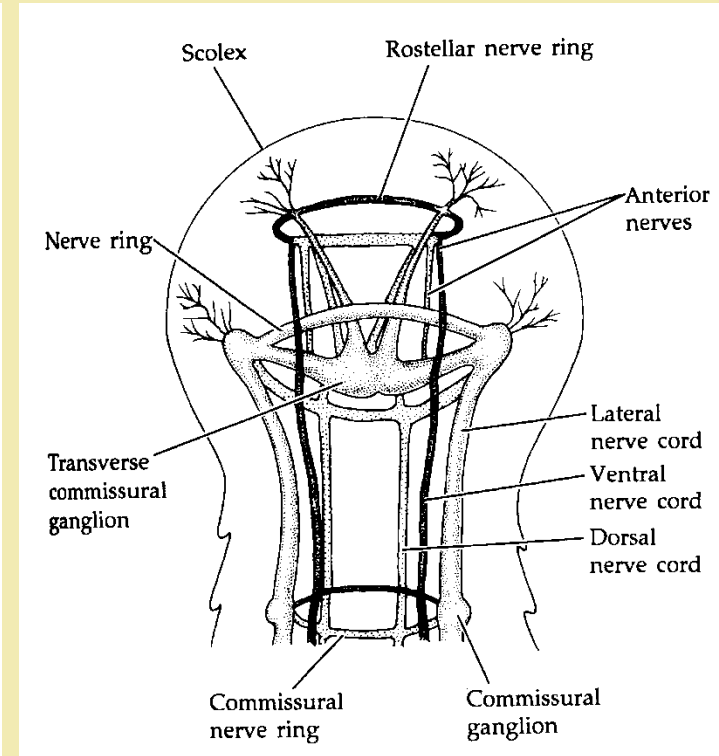
Ploštěnky (Turbelaria)

Ploštěnky skupiny Polycladida – laločnaté mozkové ganglion

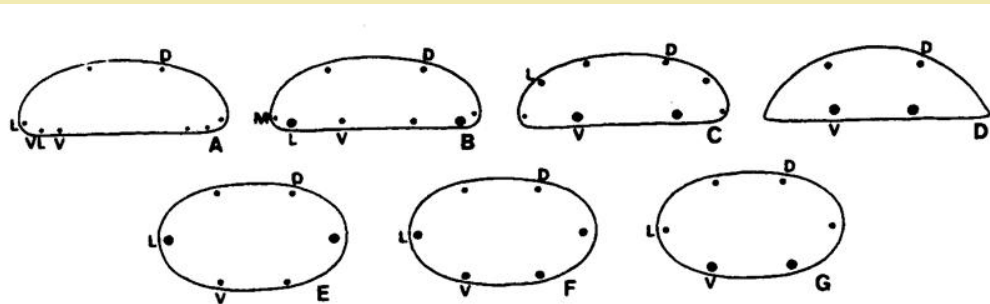
Ploštěnci (Platyhelminthes)



Motolice (Trematoda)



Tasemnice (Cestoda)

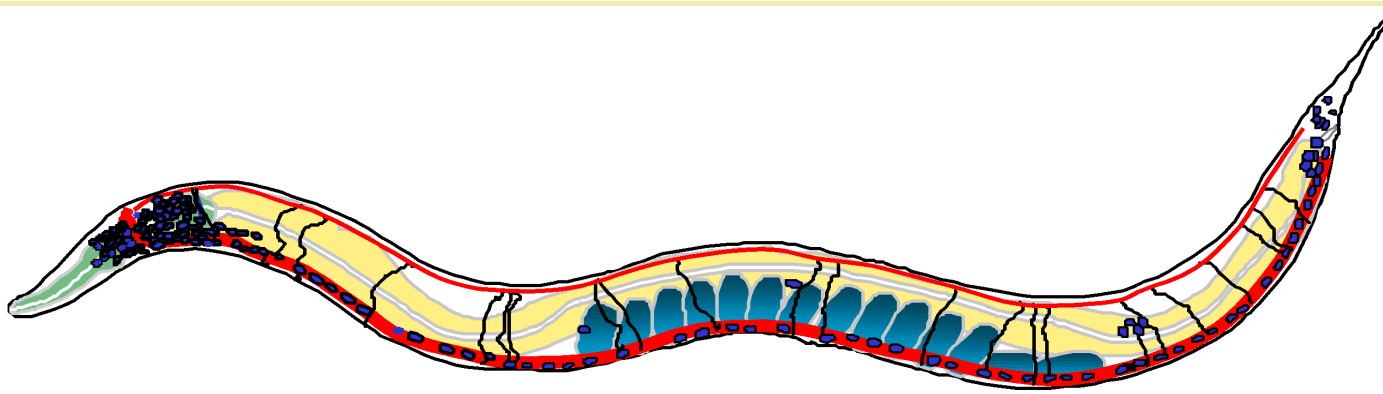
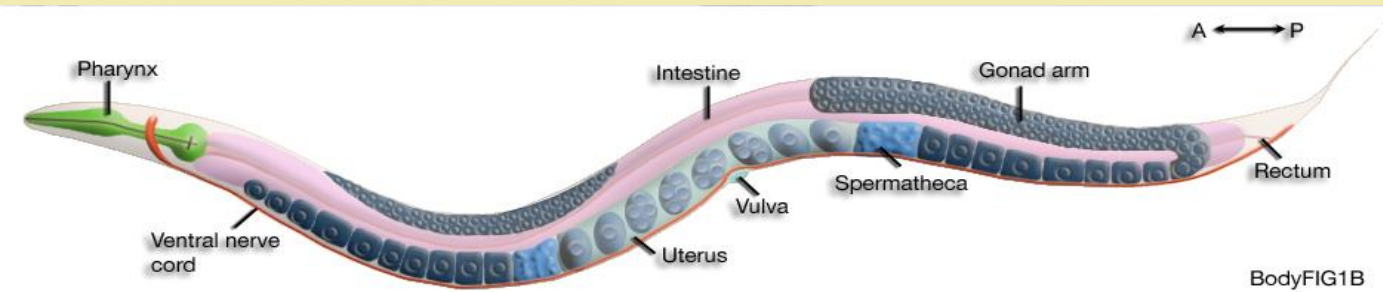


Počet a pozice nervových pářů u různých skupin ploštěnců

Hlístice (Nematoda)

(*Caenorhabditis elegans*)

<http://www.wormatlas.org/>



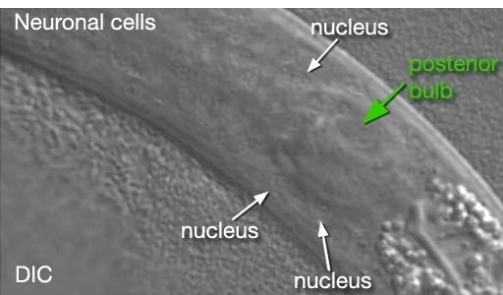
Hermafrodit:

302 neuronů (8)

cca 7000 synapsí

Male:

383 neuronů (89)



approximately 6400 chemical synapses, 900 gap junctions, and 1500 neuromuscular junctions

C. elegans

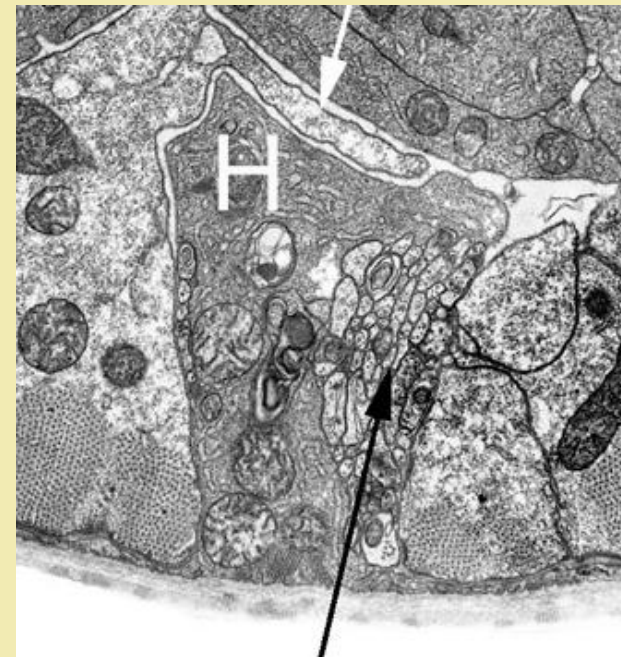
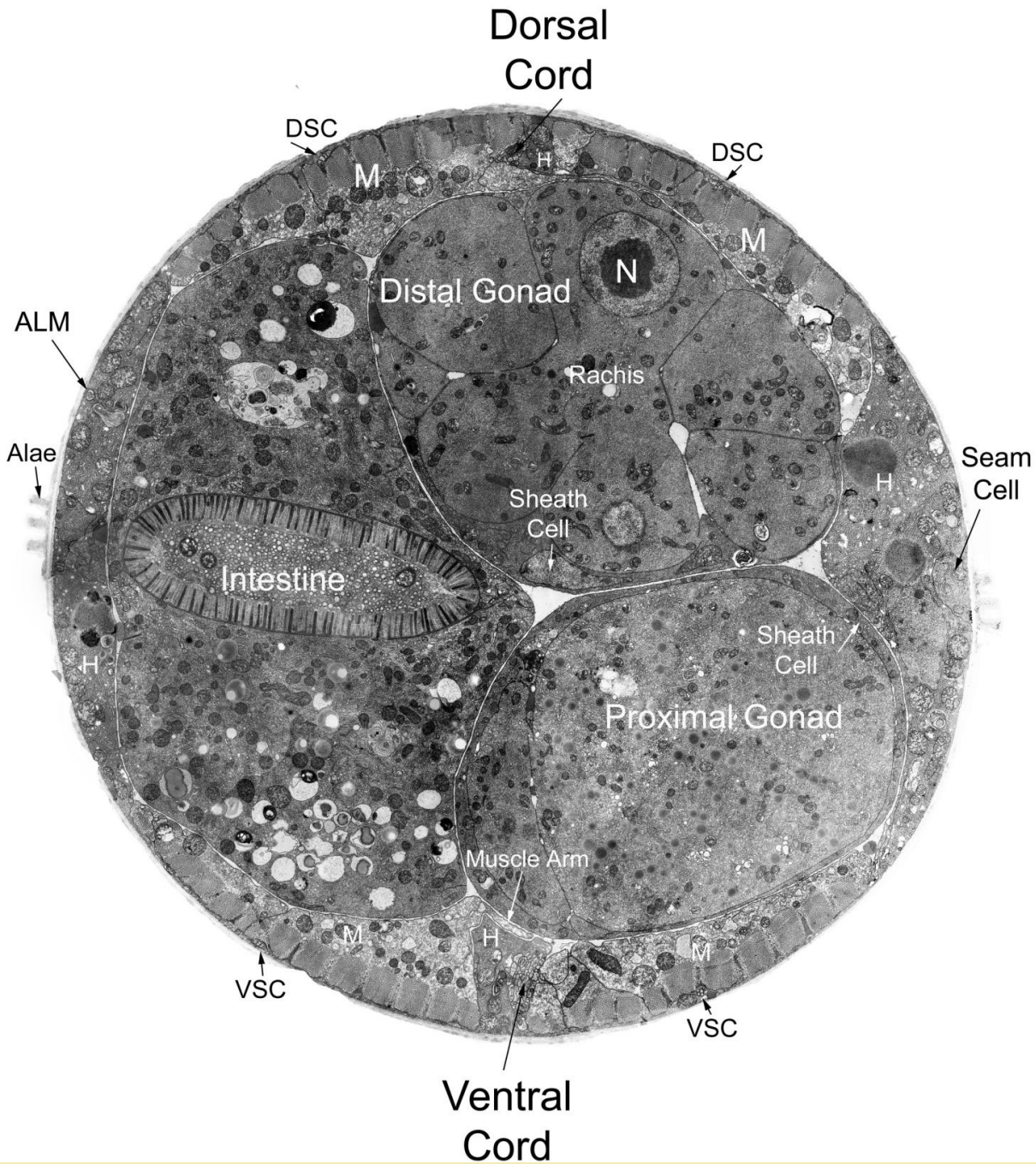
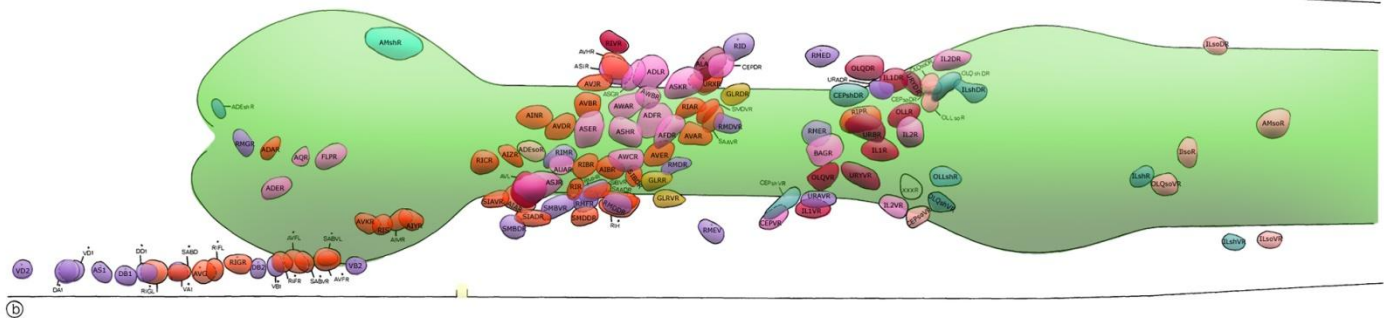
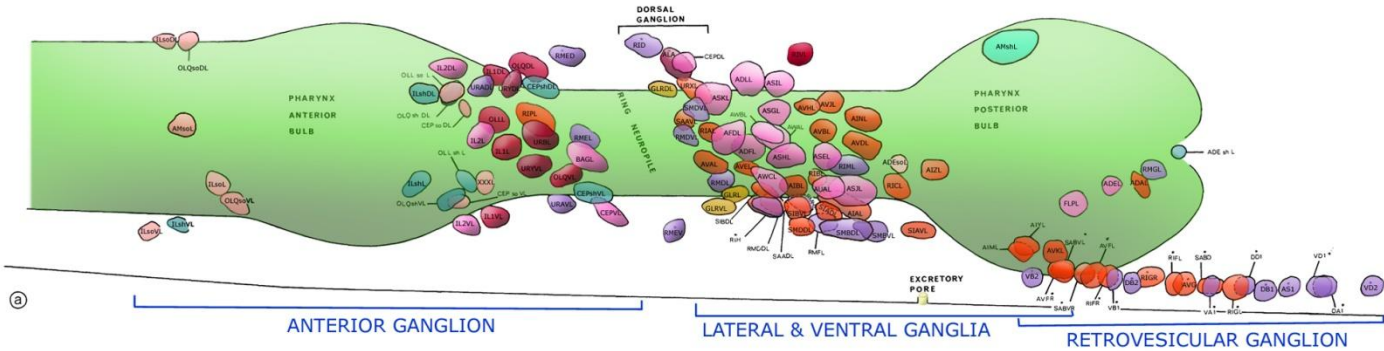
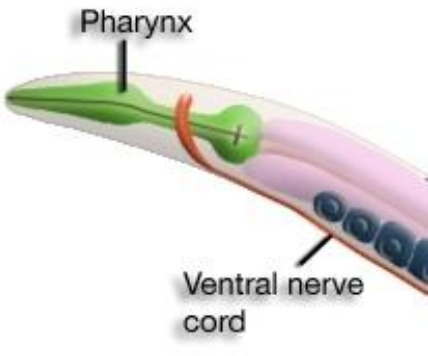
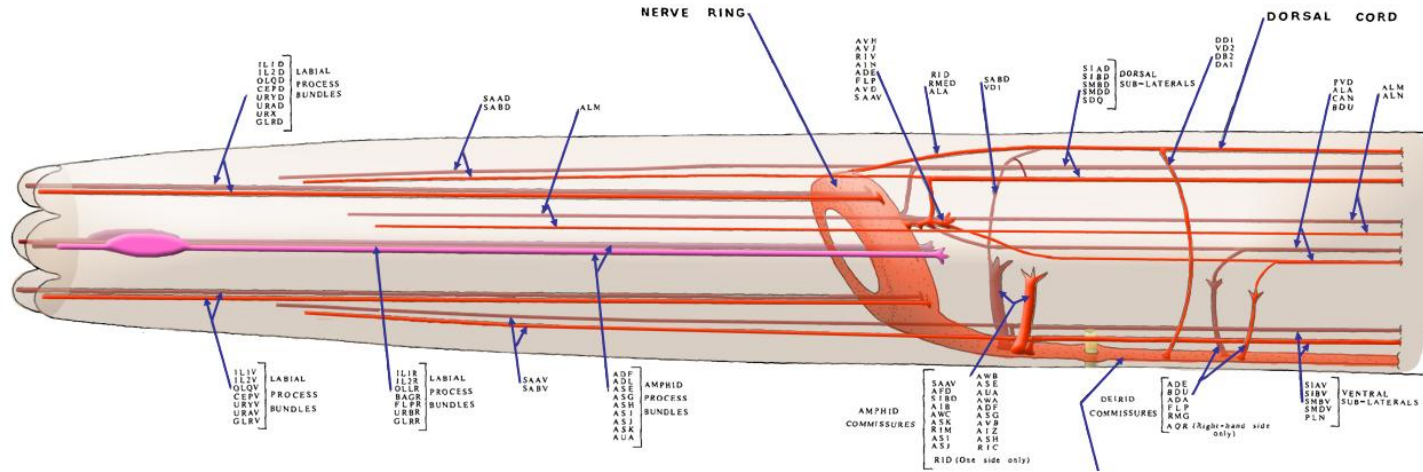


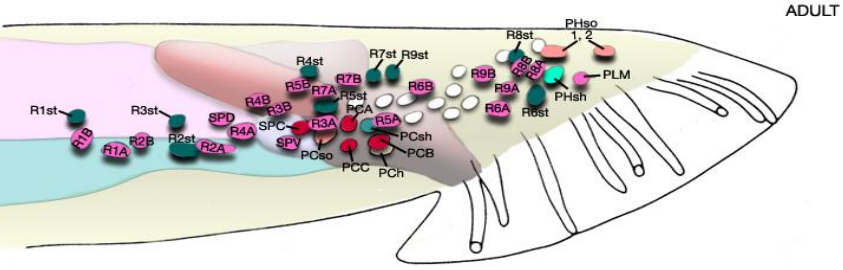
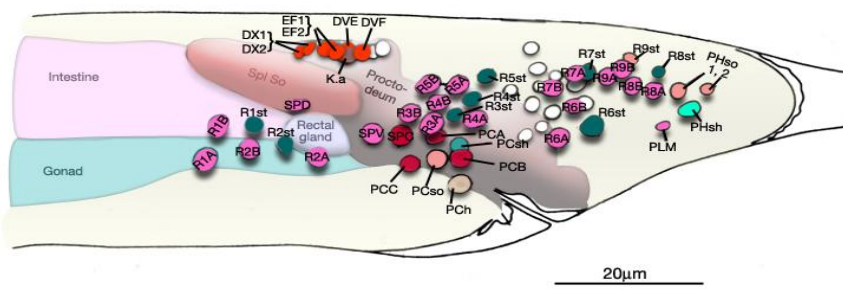


Image source: J. Berger & R. Sommer
 Max-Planck Institute for developmental biology
 BodyPlan

(*Caenorhabditis elegans*)



LATE L4 (42 hrs, 20°C)

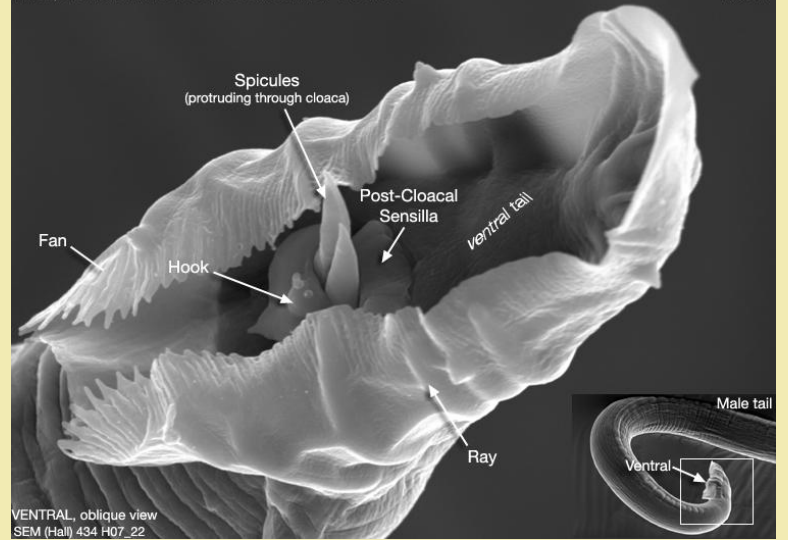


ADULT

LATERAL view, left side. Nuclei in left lumbar (LGL), left cloacal (CGL) and the dorsal rectal ganglion (DRG, shown in L4 figure only). CGL nuclei position largely invariant; those of lumbar ganglia more variable. Unmarked nuclei belong to juvenile or hermaphrodite cell groups. (Adapted from Sulston et al., 1980, Fig 12).

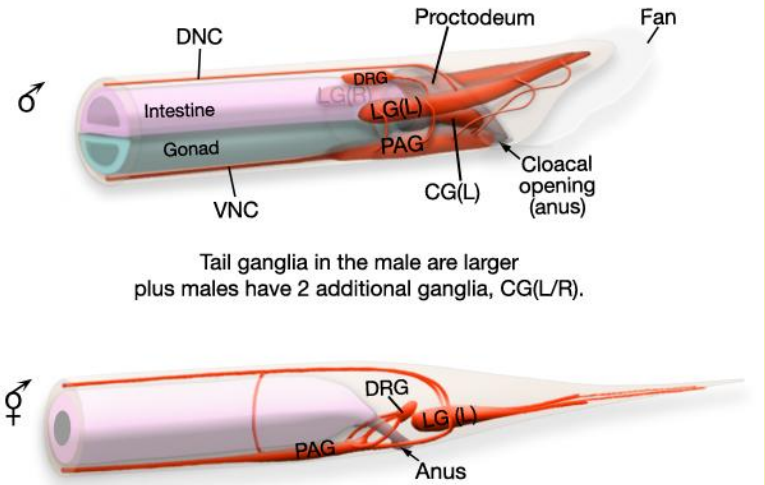
(*Caenorhabditis elegans*)

MaleEpiFIG10A: MALE-SPECIFIC SENSILLA OF THE TAIL ADULT



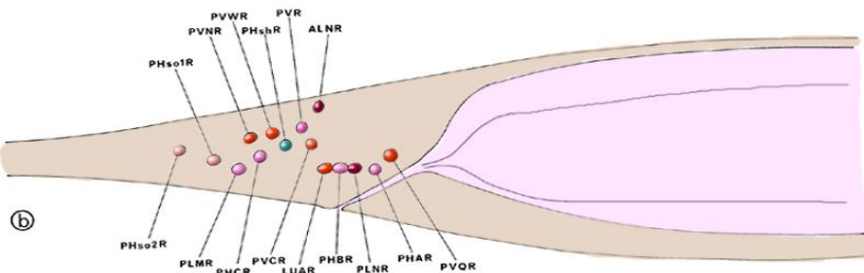
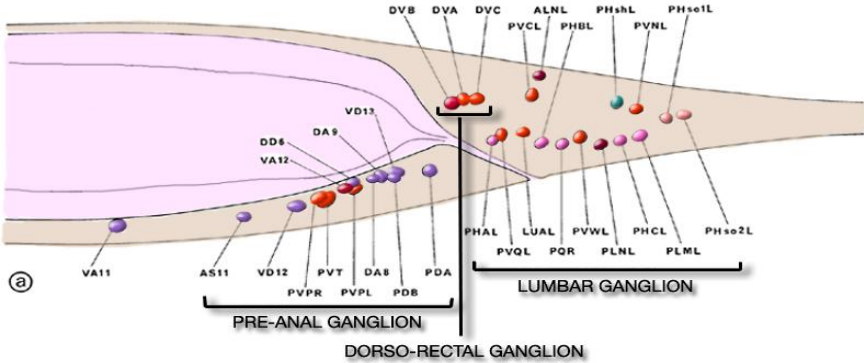
VENTRAL, oblique view SEM (Hall) 434 H07_22

MaleFIG7B

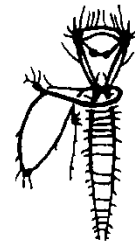
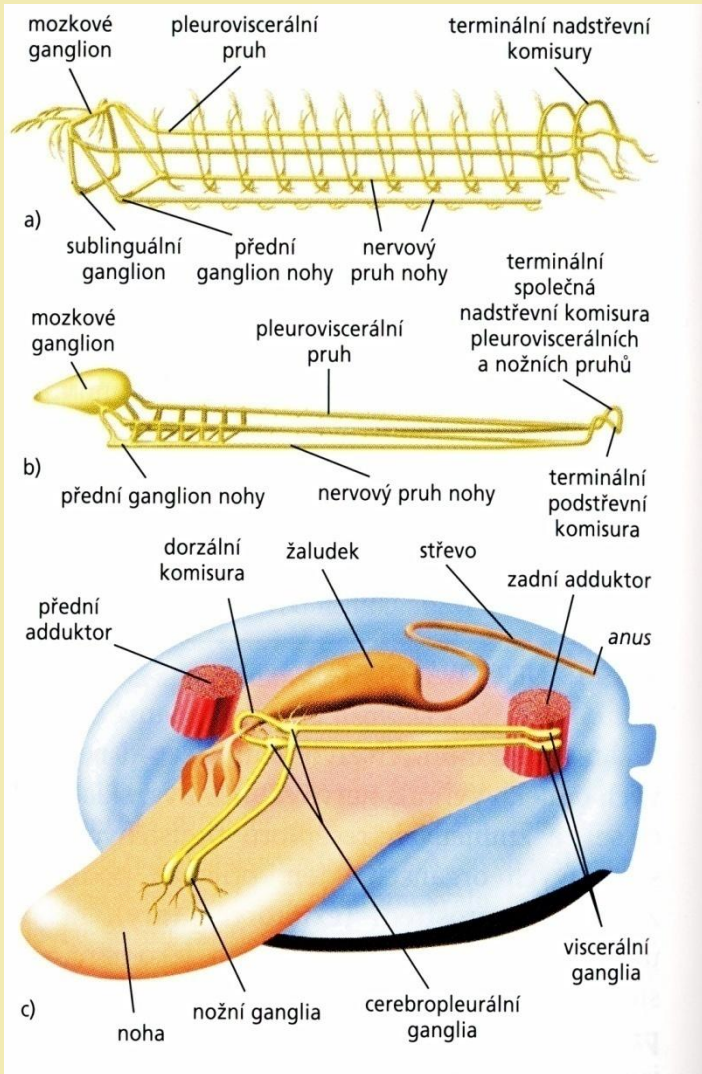


Tail ganglia in the male are larger plus males have 2 additional ganglia, CG(L/R).

CG(L/R), Cloacal Ganglia; DRG, Dorsorectal Ganglion; LG(R/L), Lumbar Ganglia; PAG, Pre-Anal Ganglion; VNC, Ventral Nerve Cord; DNC, Dorsal Nerve Cord.



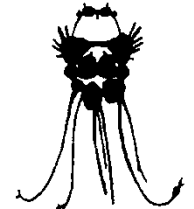
Měkkýši (Molusca)



Haliotis



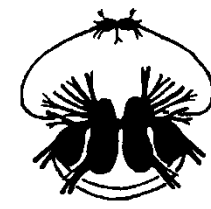
Aplysia



Lymnaea



Littorina

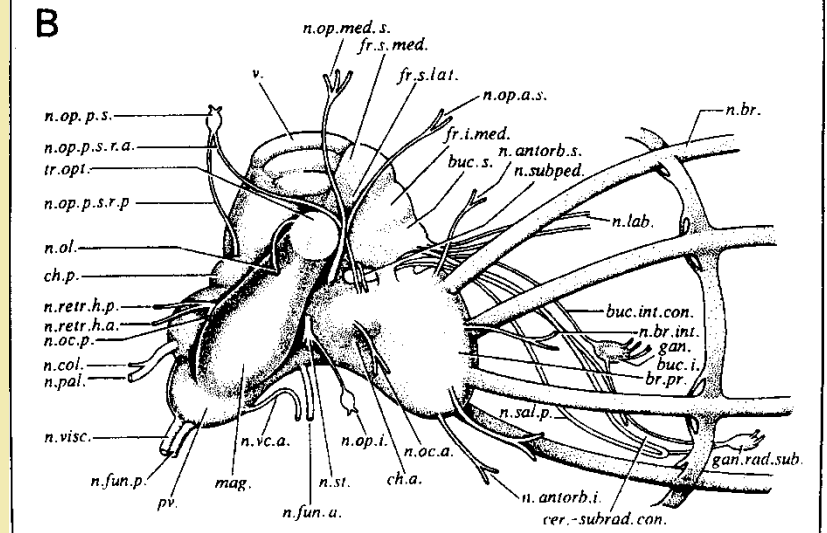
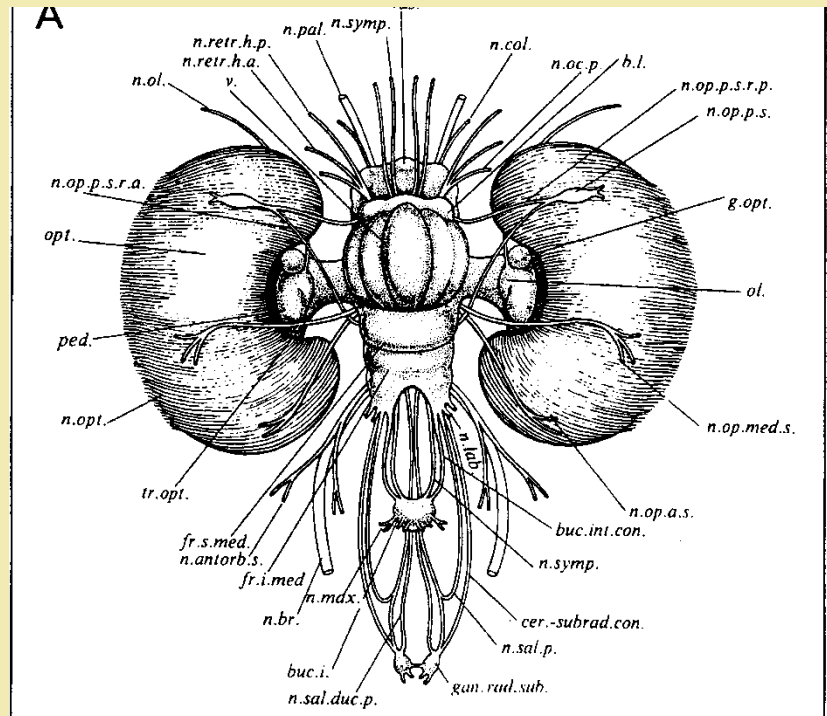
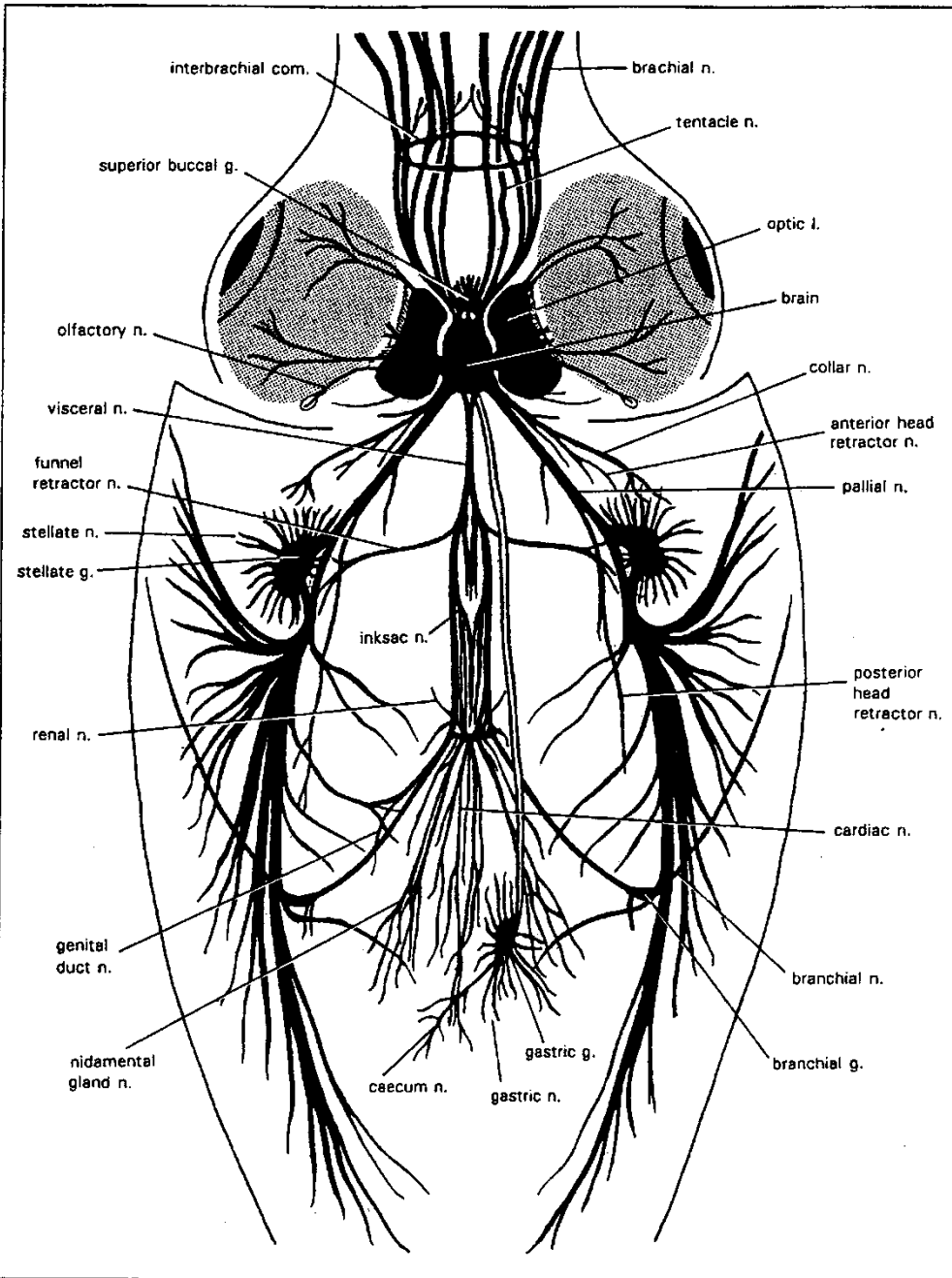


Tritonia



Helix

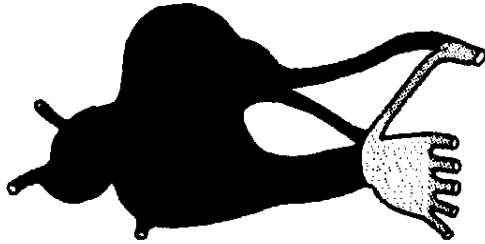
Měkkýši (Mollusca)



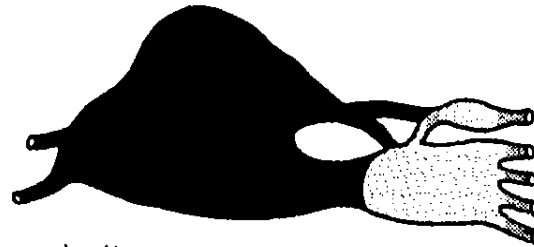
Měkkýši (Mollusca)



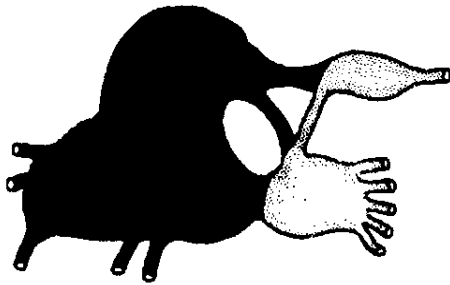
Ommastrephes



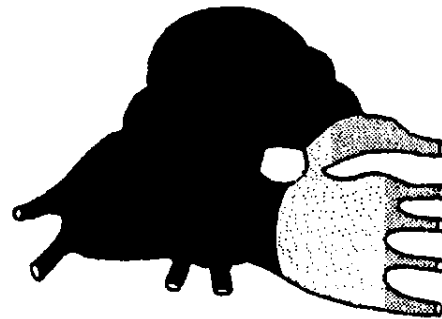
Sepiola



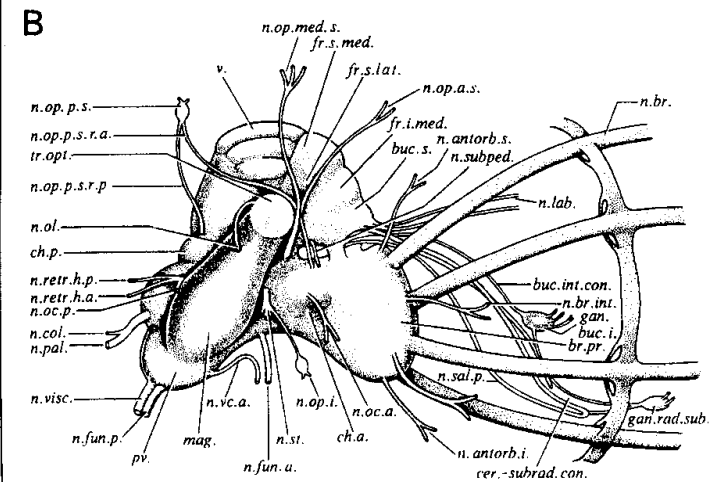
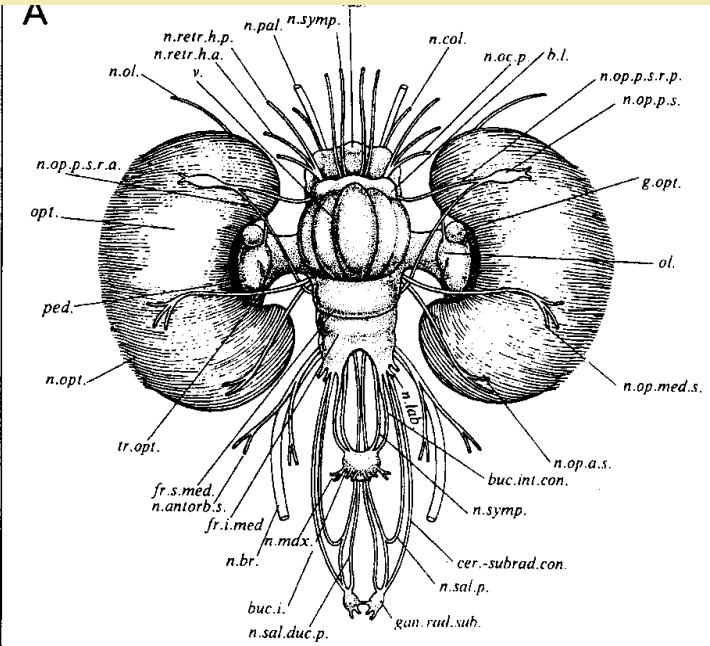
Loligo



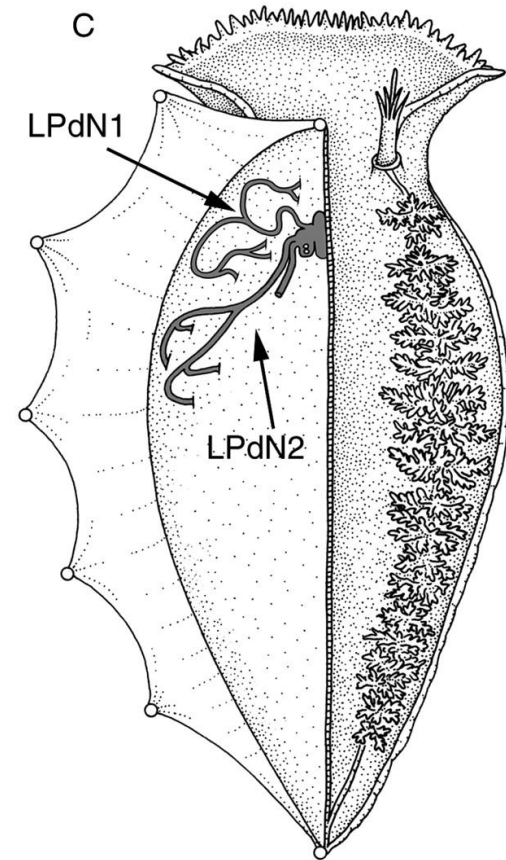
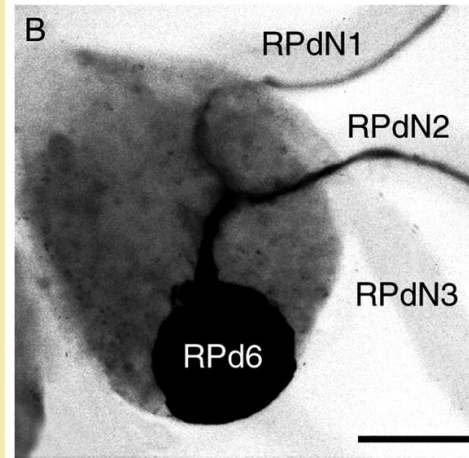
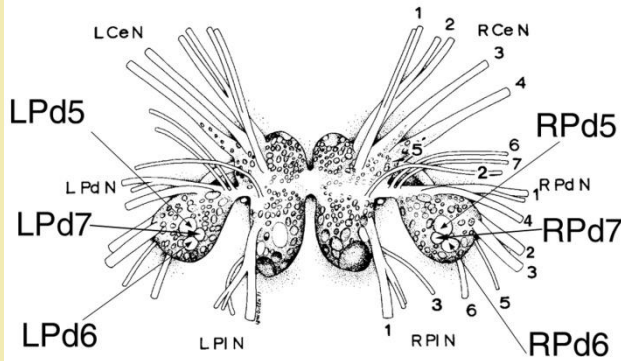
Sepia



Octopus



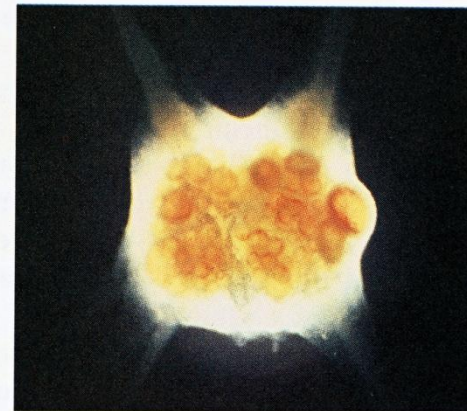
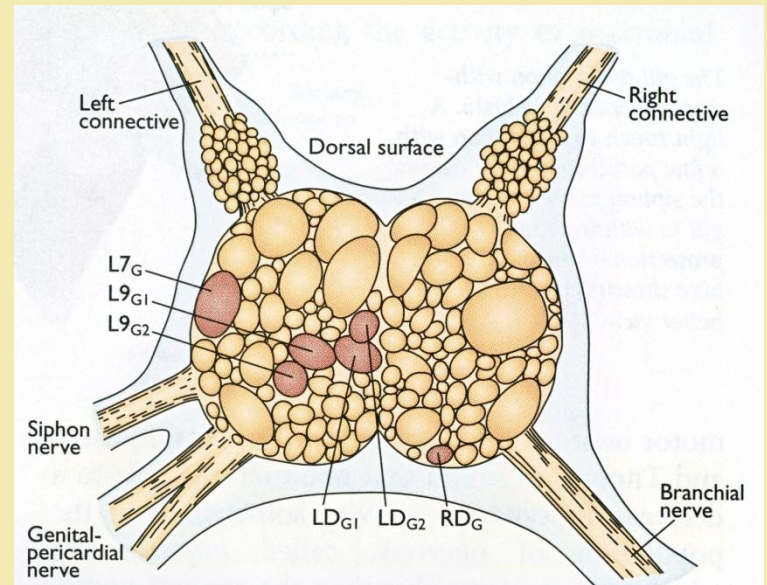
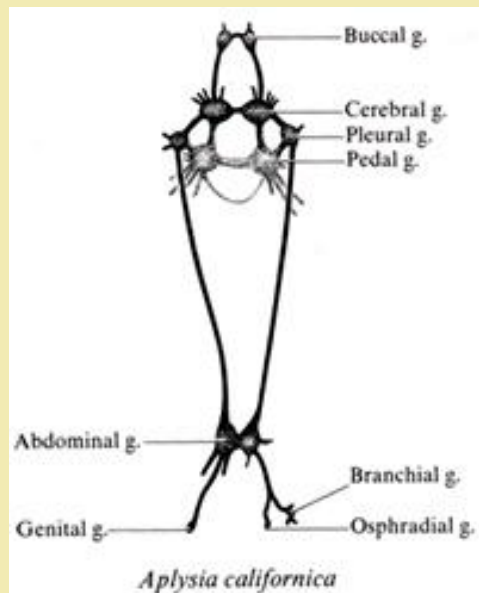
Koncept „identifikovatelného neuronu“



Tritonia diomedea

Zej kalifornský (*Aplysia californica*)

cca 20 000 neuronů



Členovci (Arthropoda)

Hmyz (Insecta)

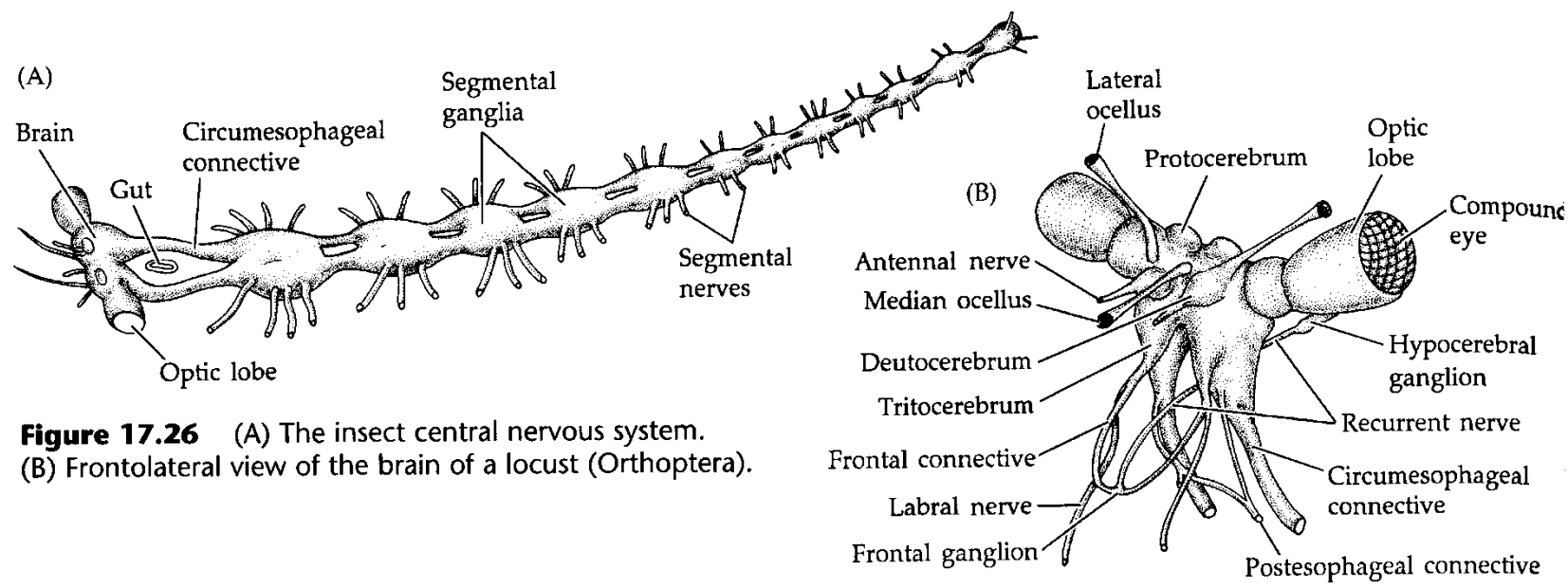
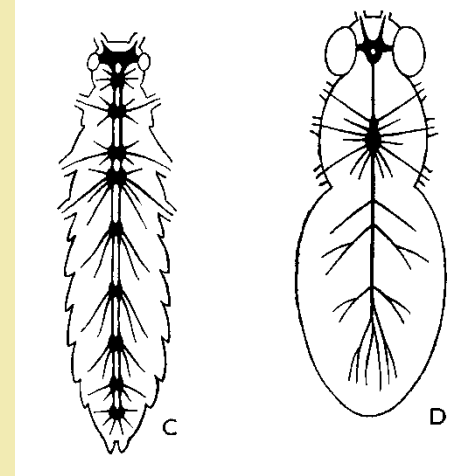
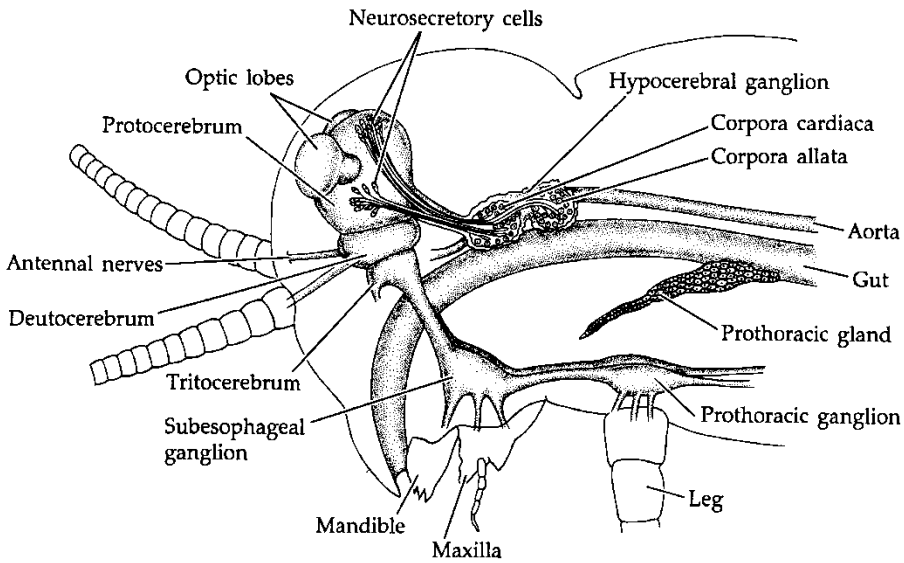
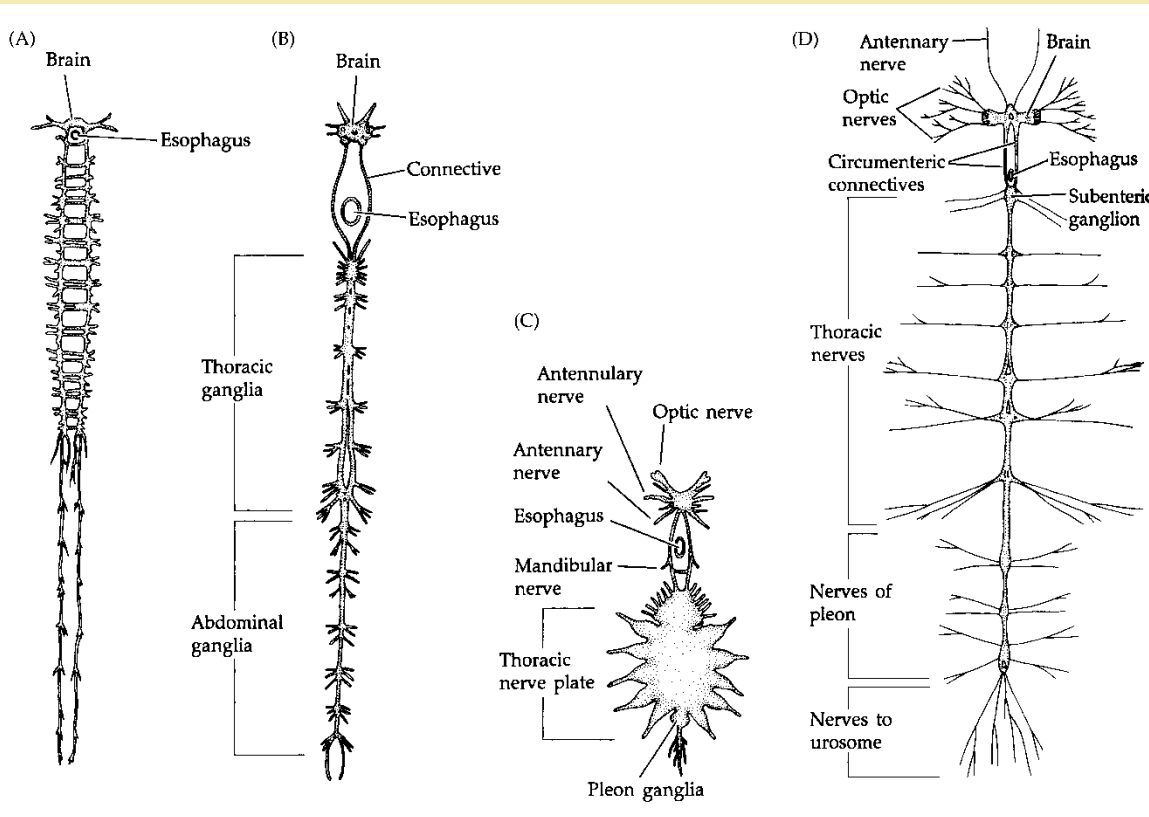


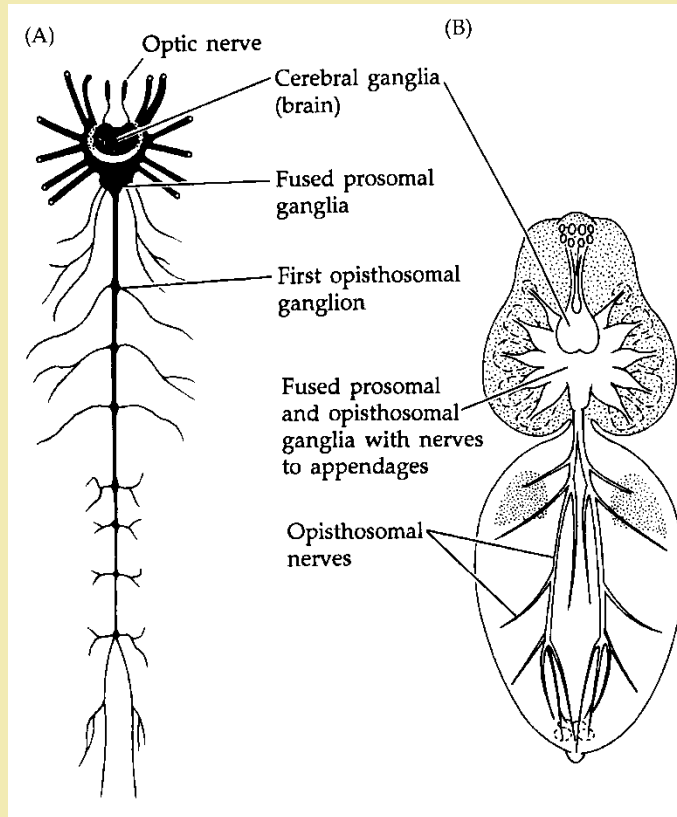
Figure 17.26 (A) The insect central nervous system. (B) Frontolateral view of the brain of a locust (Orthoptera).

Členovci (Arthropoda)



Korýši (Crustacea)

A) žábřonožka, B) rak, C) krab, D) blešivec



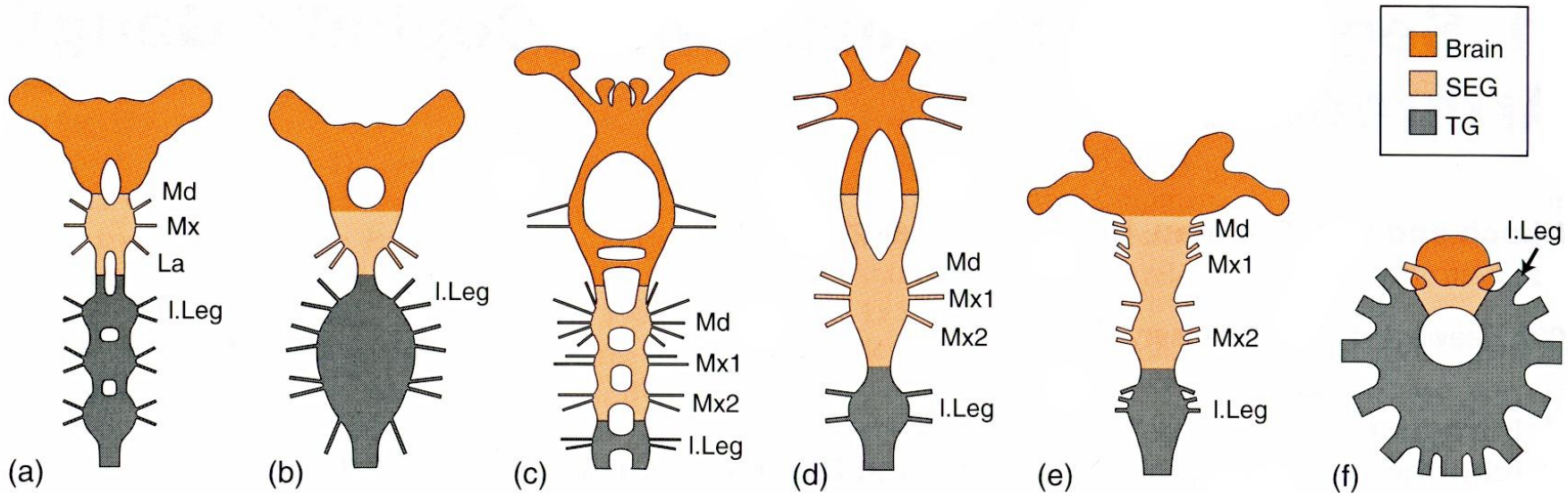
Klepitkatci (Chelicerata)

A) štír, B) pavouk

Chybí:

↗ **deuteroocerebrum**

Členovci (Arthropoda)



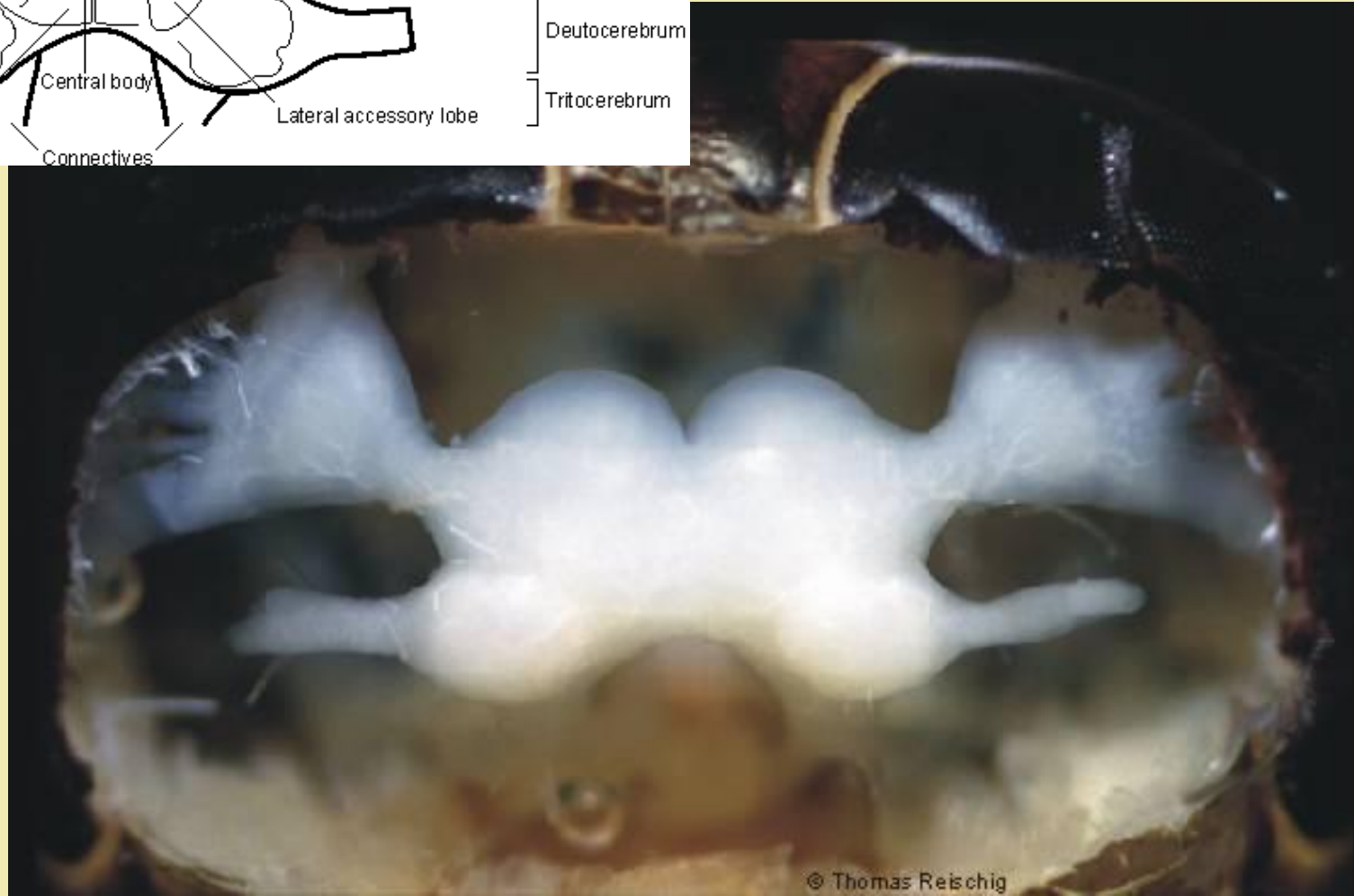
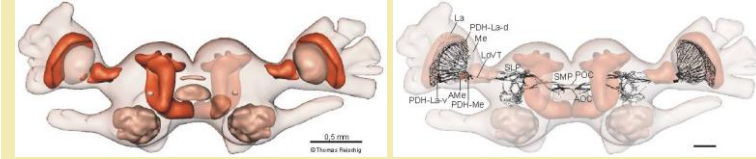
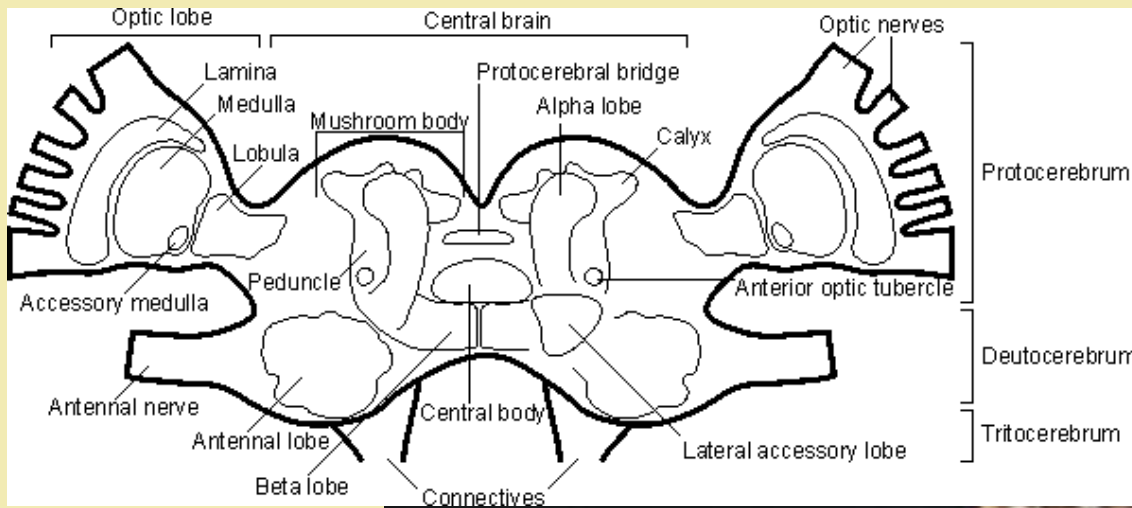
a) saranče, b) moucha, c) listonoh, d) humr, e) stonožka, f) ostrorep

SEG – podjícnová (subesophageální) ganglia

TG – hrudní (thorakální) ganglia

Členovci (Arthropoda)

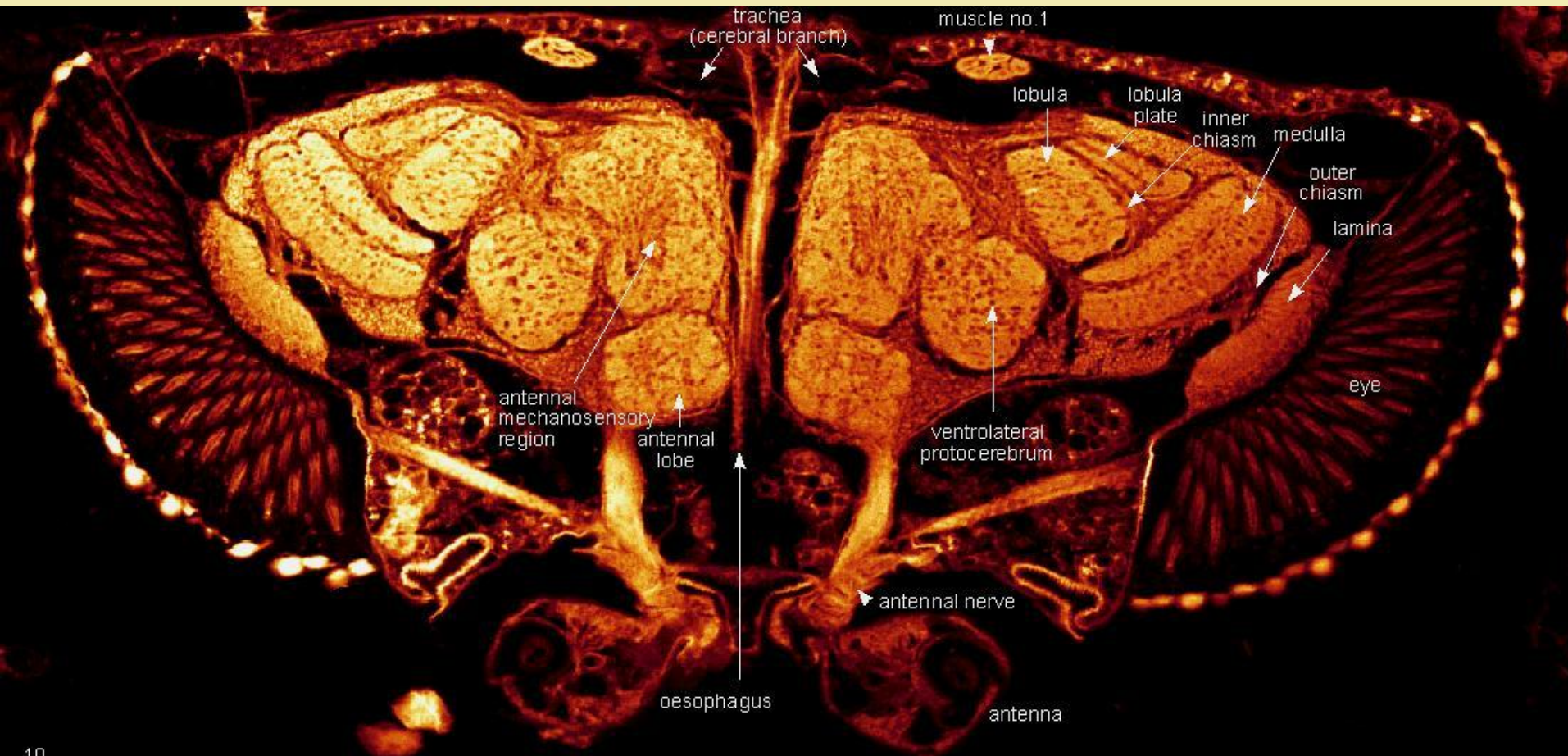
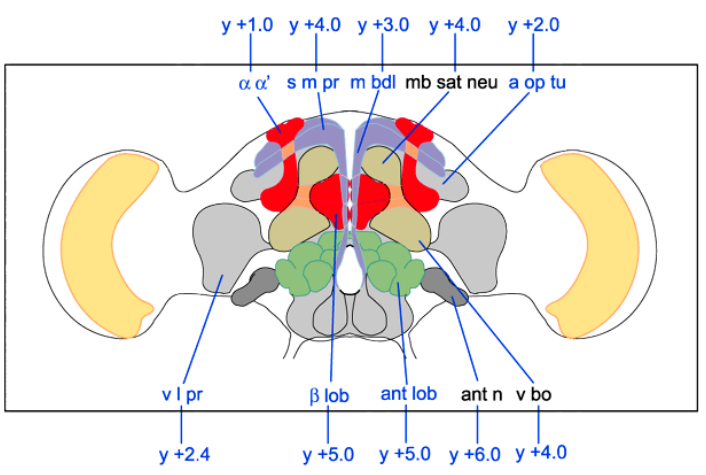
Hmyz (Insecta)



Hmyz (Insecta)

Drosophila melanogaster

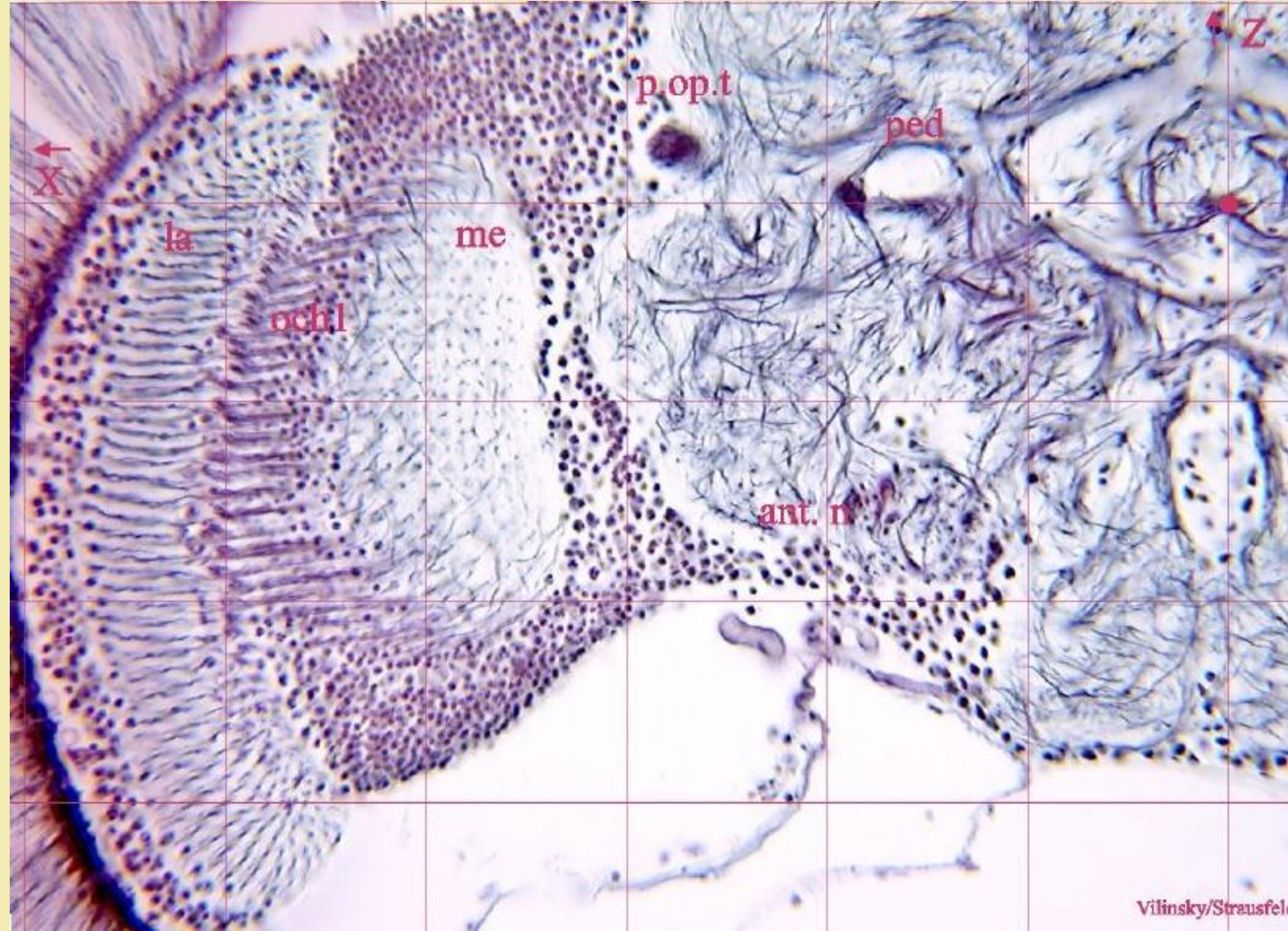
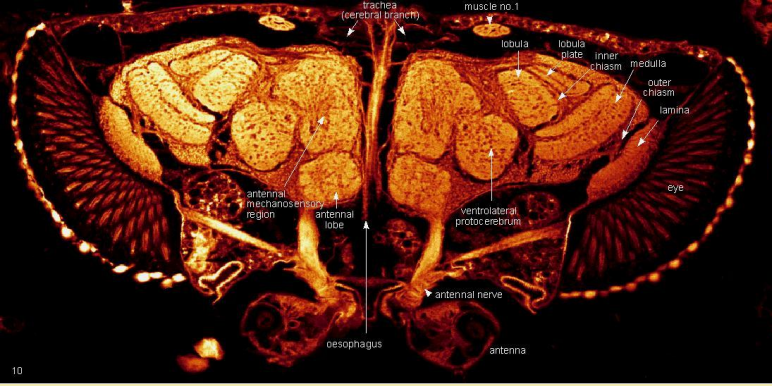
<http://www.neurofly.de/>



Hmyz (Insecta)

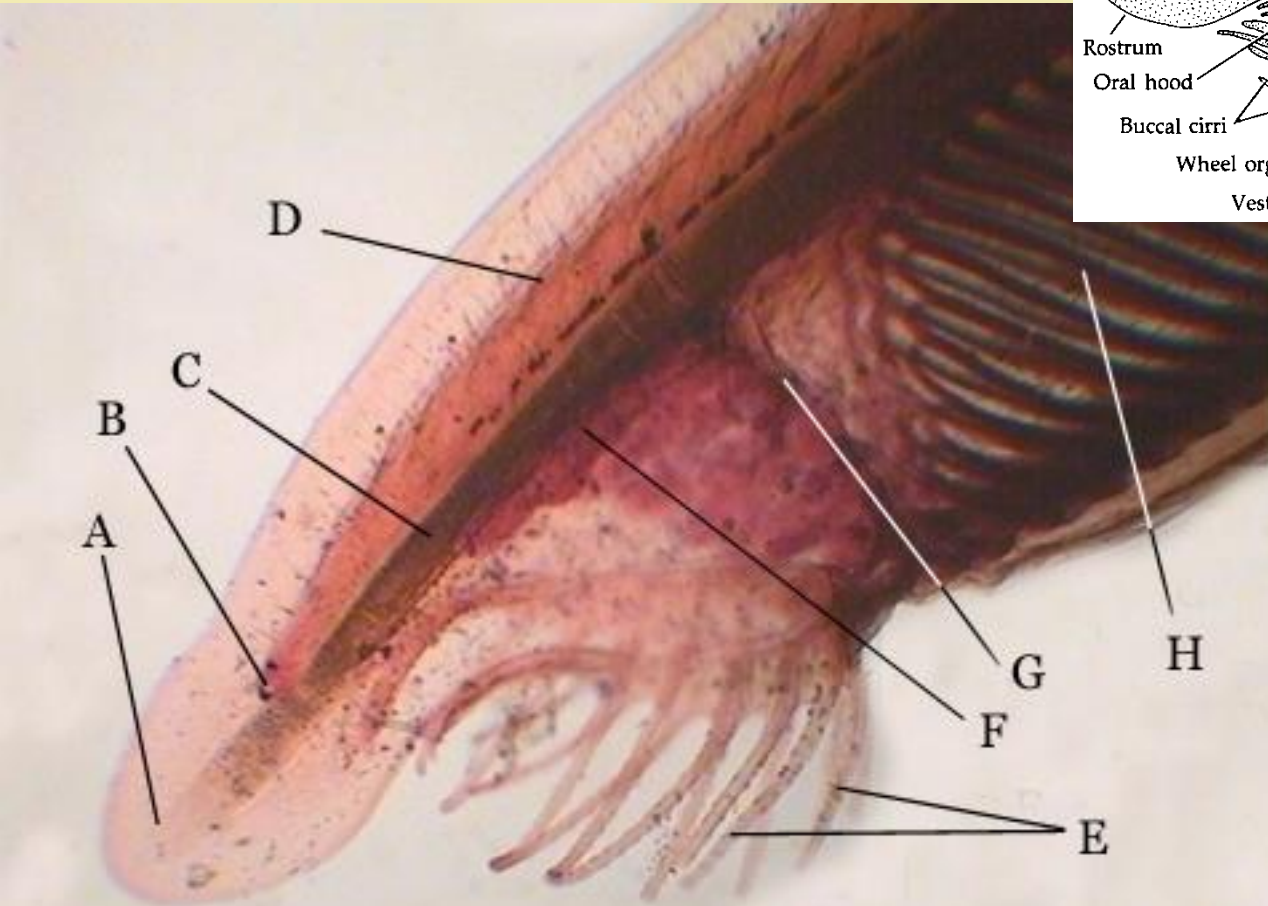
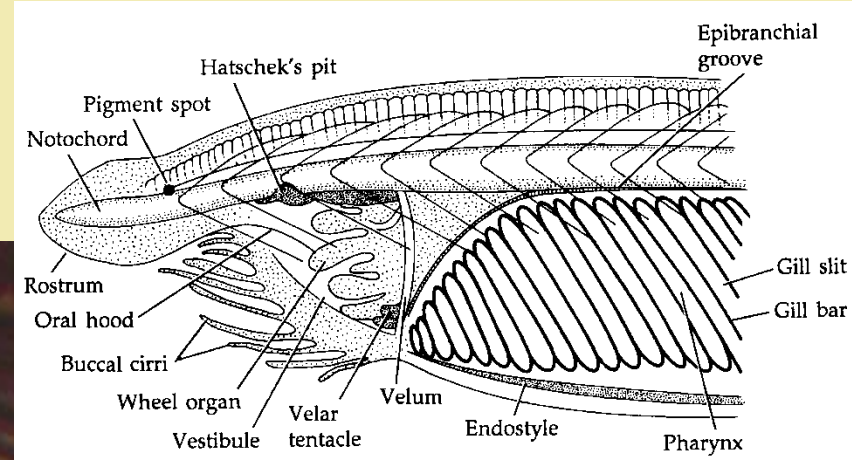
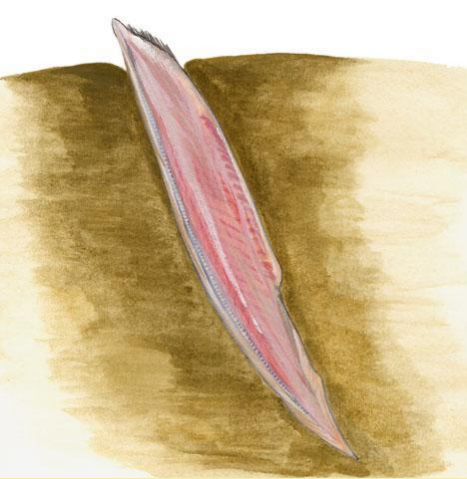
Drosophila melanogaster

<http://www.neurofly.de/>



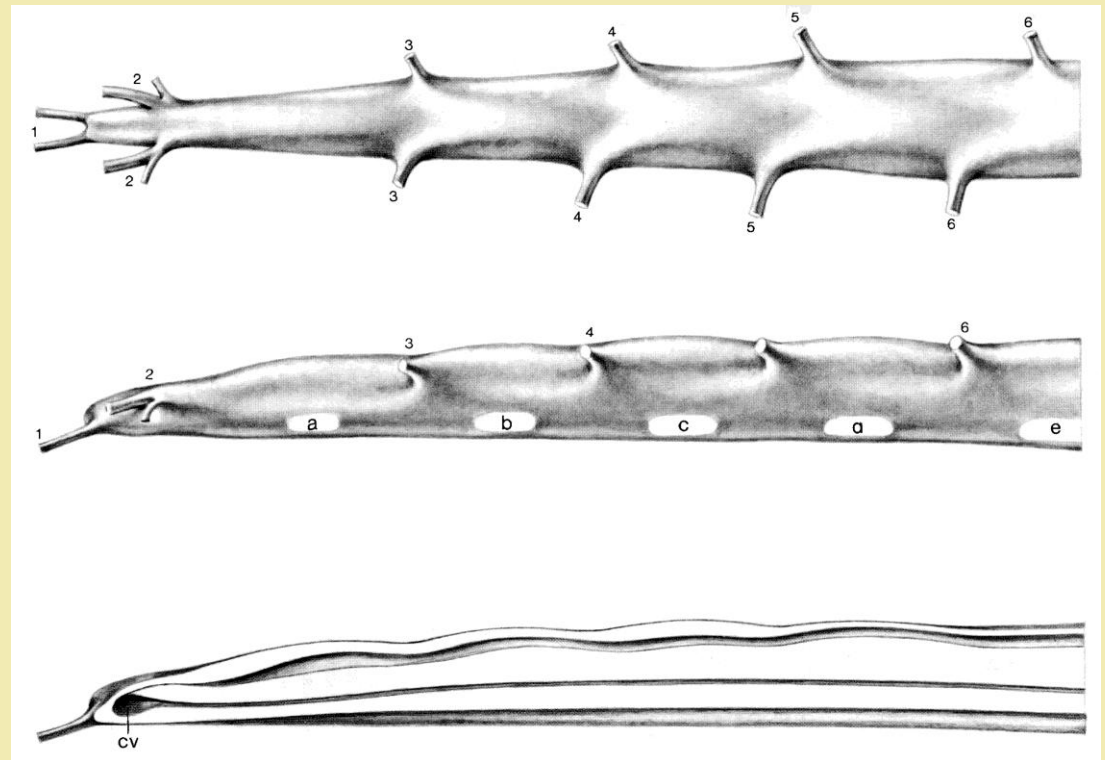
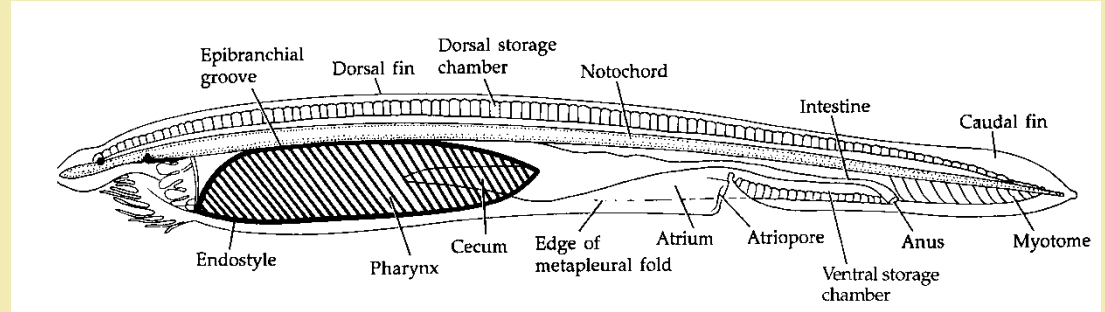
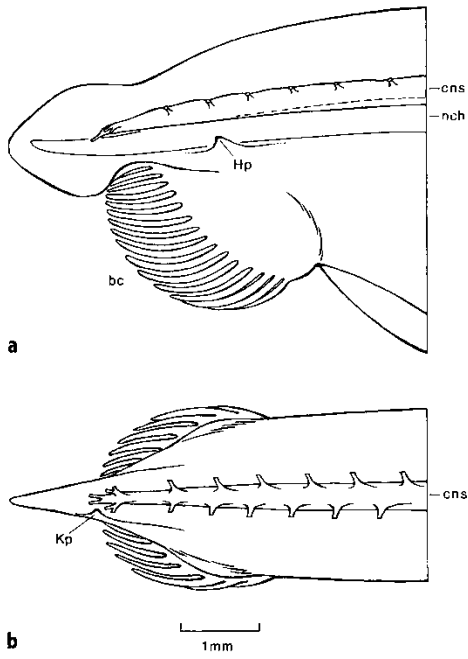
Kopinatci (Cephalochordata)

(Branchiostoma lanceolatum)



Kopinatci (Cephalochordata)

(Branchiostoma lanceolatum)



✓ **60 párů míšních nervů**
(místo odstupu pravého a levého vždy alternuje)

✓ **spinální nerv tvoří jen dorzální kořeny**

Chybí:

↗ **spinální ganglia**

↗ **ventrální kořeny míšních nervů**

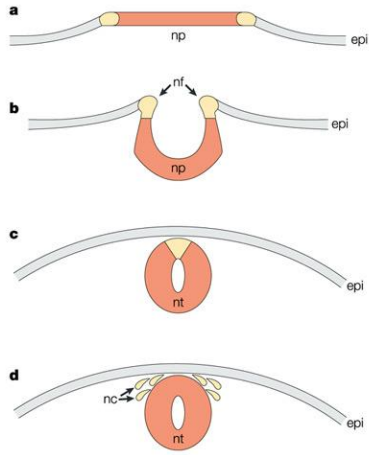
(tvořeny výběžky svalových buněk; vůči dorzálním kořenům v intersegmentální pozici)

Branchiostoma lanceolatum

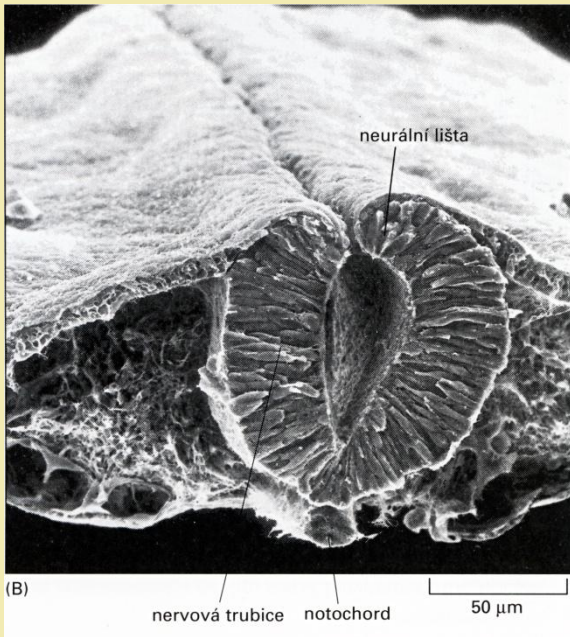
Neurulace

Chybí:

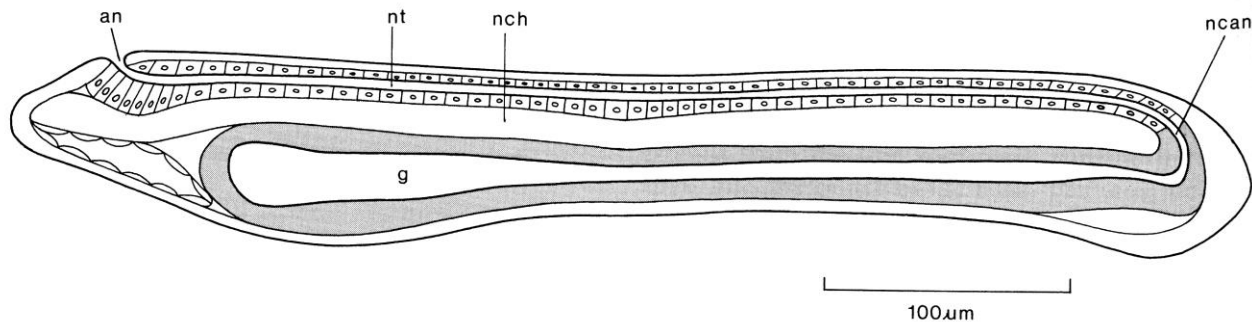
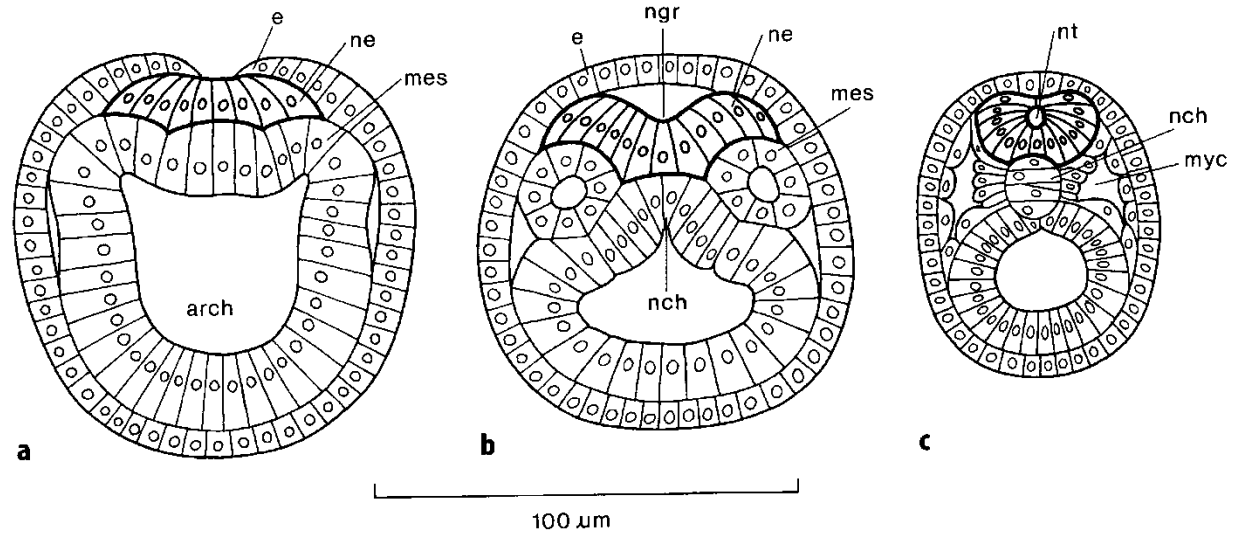
neurální lišta



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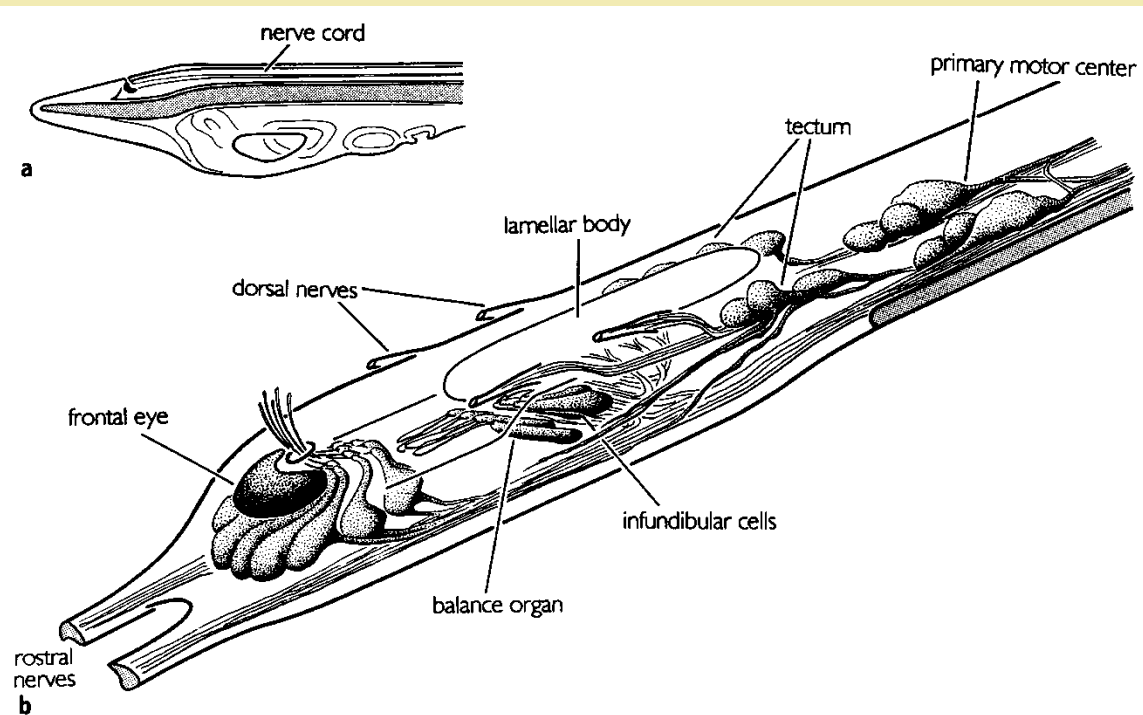
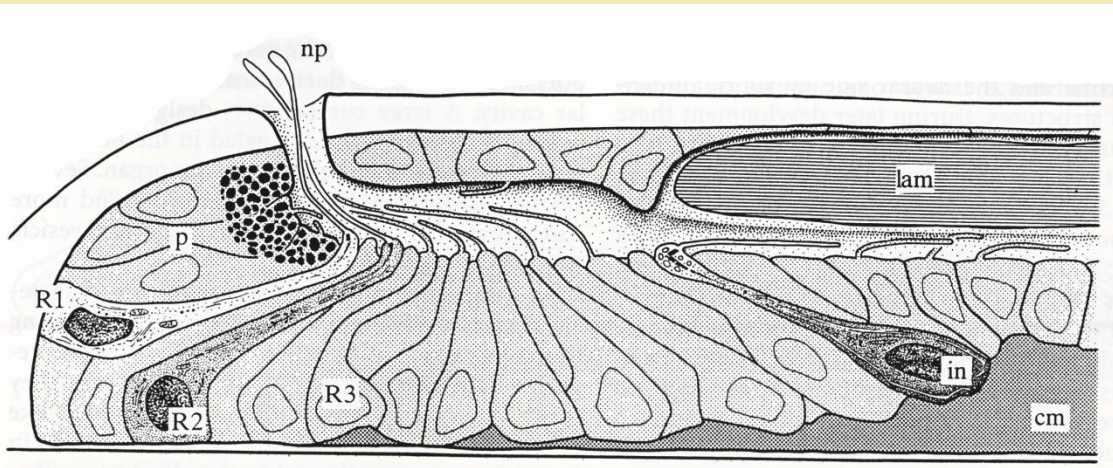


Obratlovci



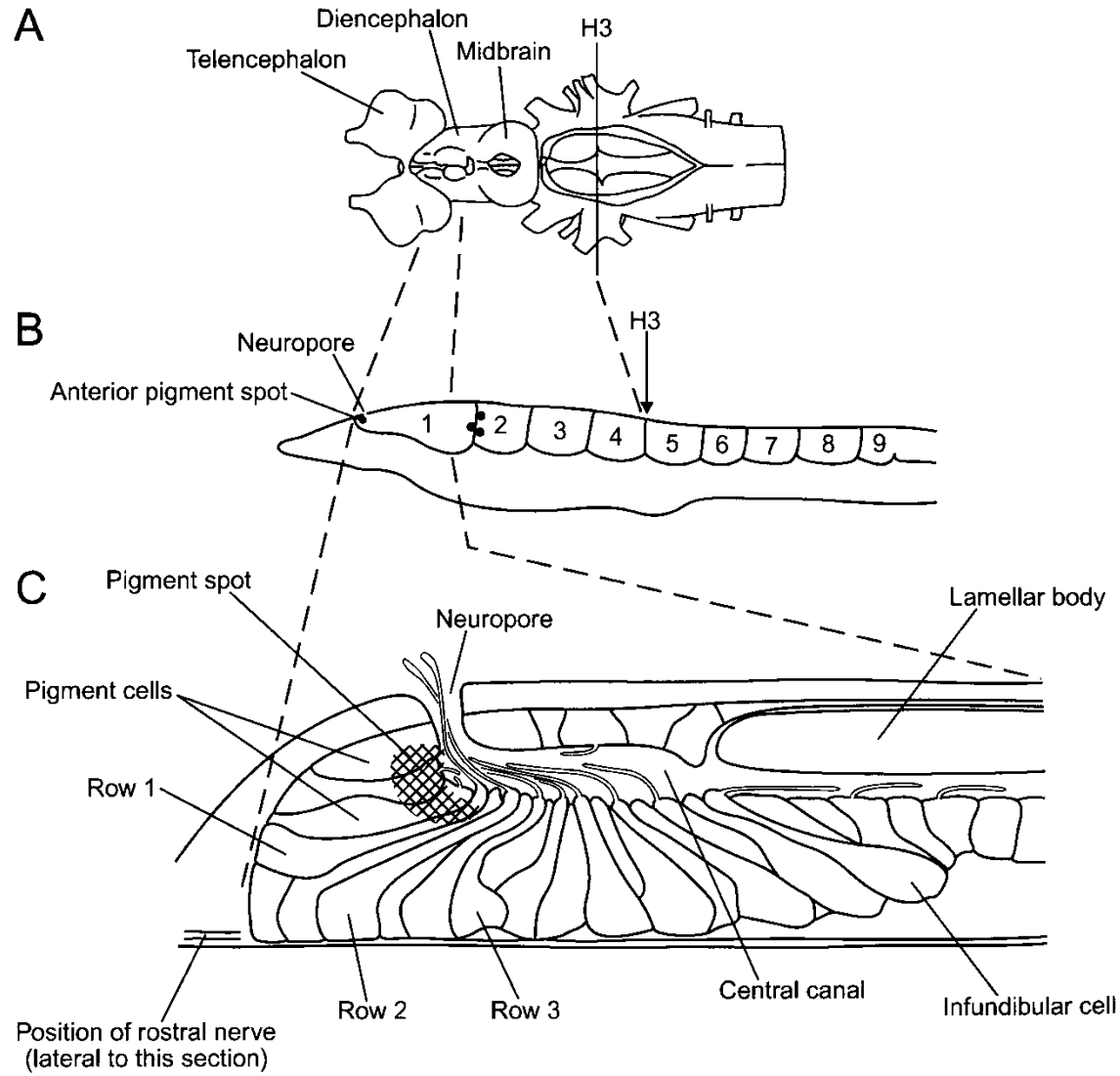
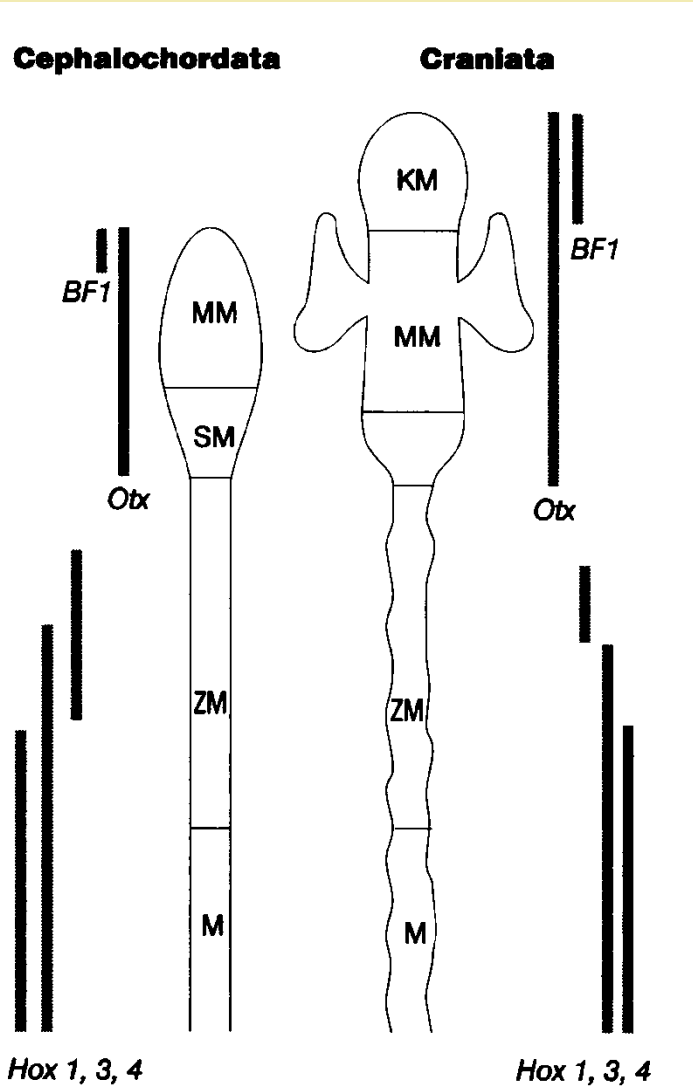
Branchiostoma lanceolatum

„Larvální mozek“ podle Lacalliho



Branchiostoma lanceolatum

Aktivita regulačních genů a homologie mozku kopinatce a obratlovce



Branchiostoma lanceolatum

✓ **CNS největší průměr ve středu těla** (směrem kaudálním i rostrálním i se zužuje)

Chybí:

⚡ **lokální reflexy**

✓ **buňky soustředěny okolo komory** (periferně jsou podélně probíhající nervová vlákna)

✓ **různé funkční typy neuronů**

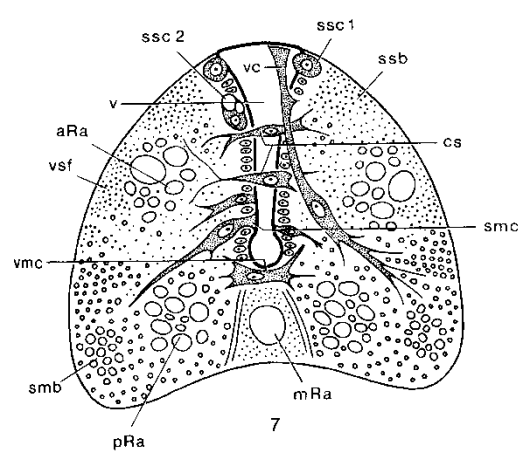


Fig. 9.16

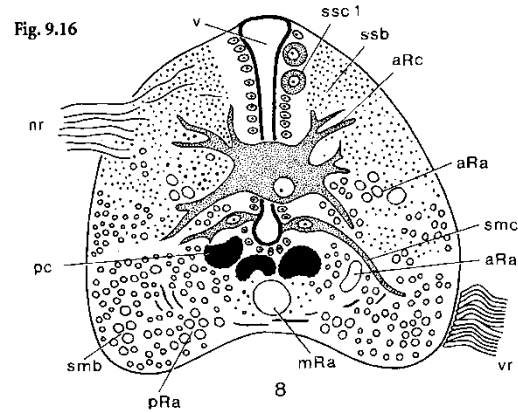


Fig. 9.17

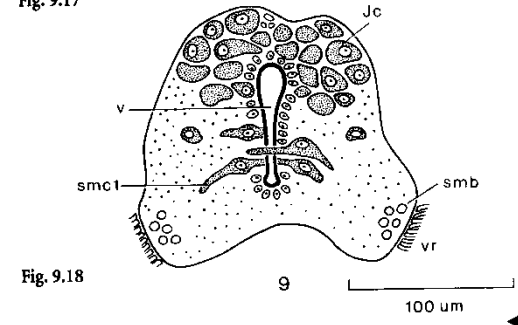


Fig. 9.18

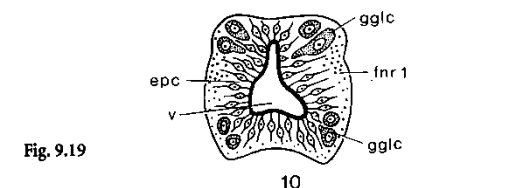


Fig. 9.19

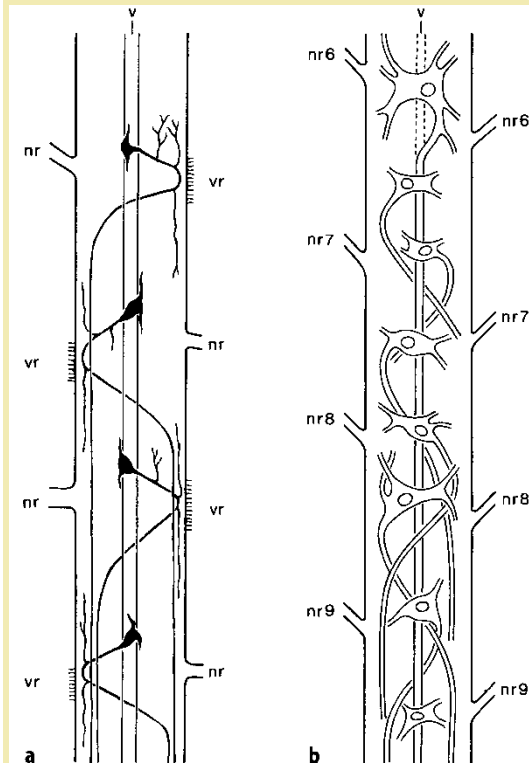


Fig. 9.22a,b. Rohde cells in the spinal cord of *Branchiostoma lanceolatum* in dorsal view. a Some Rohde cells and their processes, as observed in a methylene blue preparation (redrawn from Retzius 1891, Fig. 1). b The most rostrally situated elements of the anterior group of Rohde cells (based on Franz 1923, Fig. 24). For abbreviation see list on p. 378

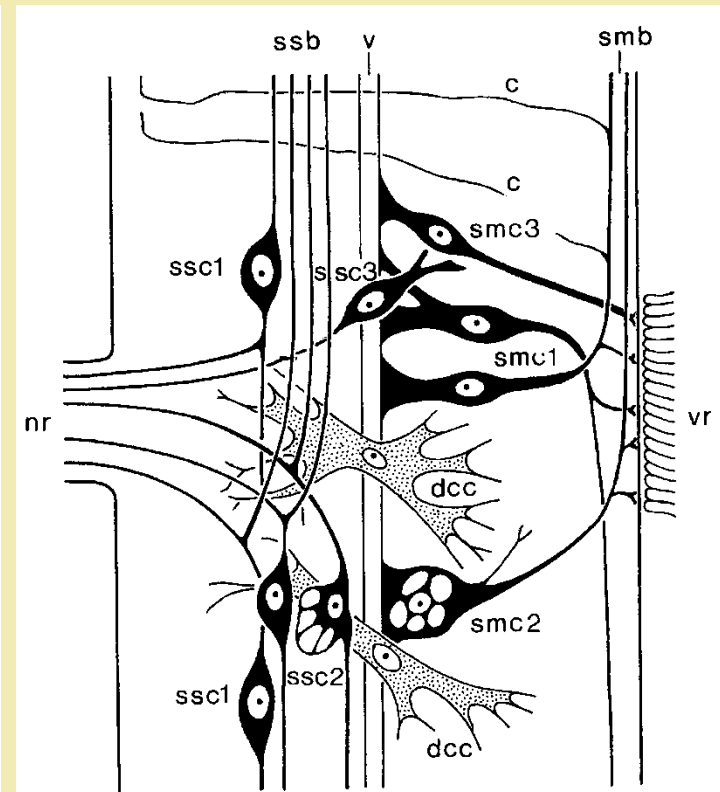


Fig. 9.21. Horizontal projection of a number of neurons in the spinal cord of *Branchiostoma lanceolatum*; for abbreviations see list on p. 378 (based on Bone 1960b, Figs. 3 and 5)

Branchiostoma lanceolatum

„mozek“

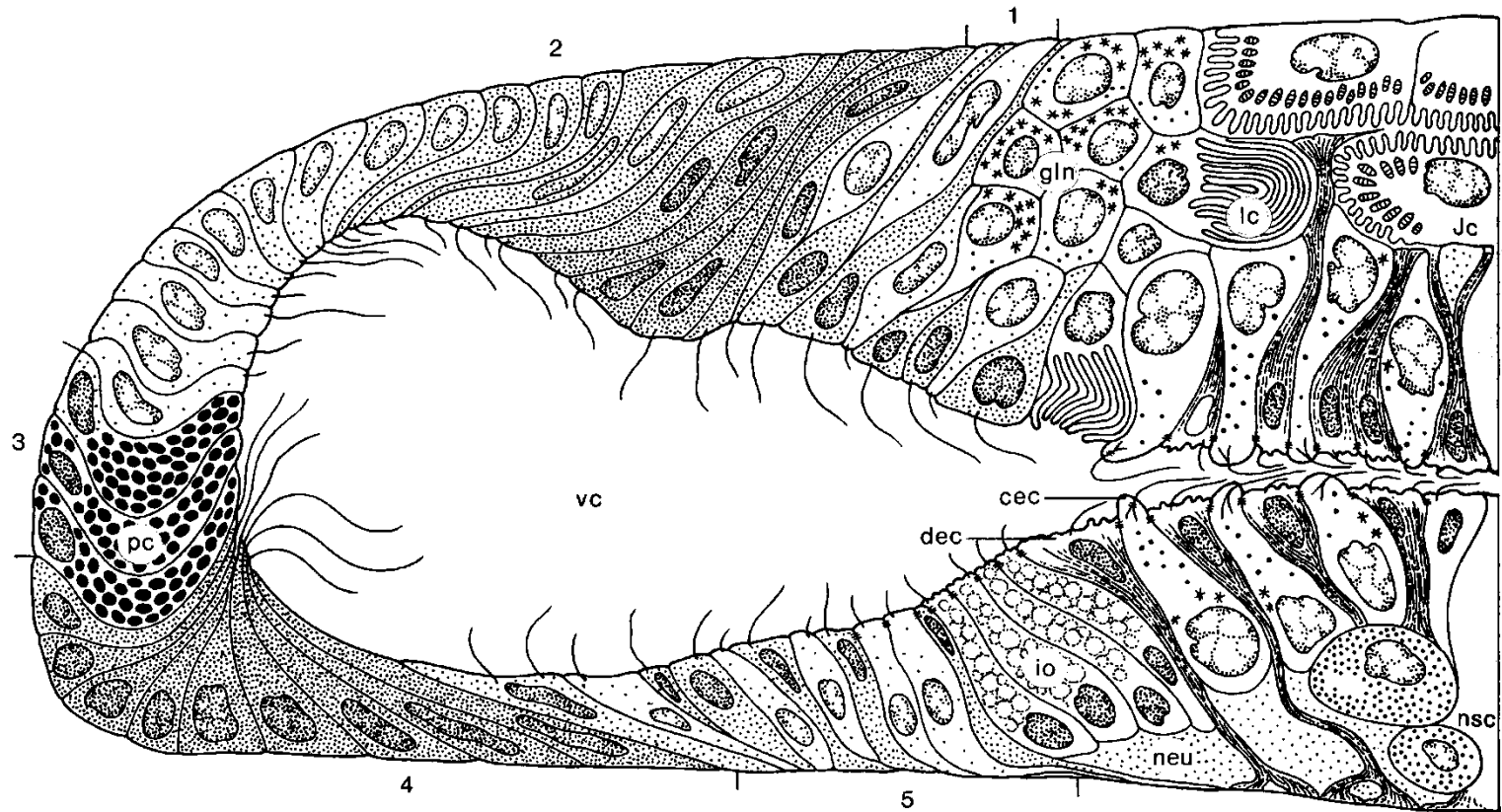
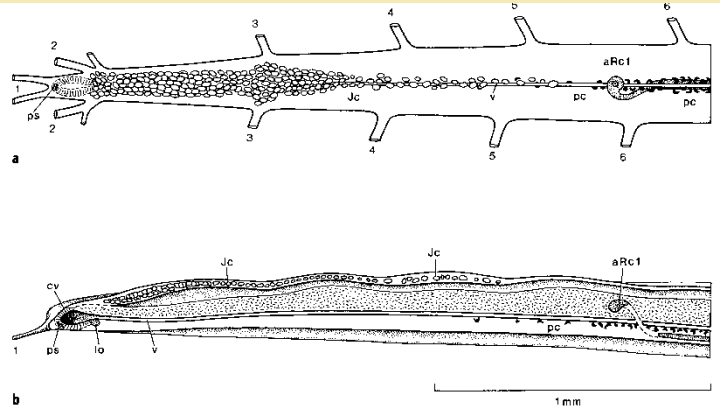


Fig. 9.24. Semidiagrammatic representation of a paramedian sagittal section through the most rostral part of the *Branchiostoma* CNS. *cec*, Clear epithelial cells; *dec*, dark epithelial cells; *gln*, glycogen containing neurons; *io*, infundibular

organ; *Jc*, Joseph cells; *lc*, lamellar cells; *neu*, neuropil; *nsc*, neurosecretory cells; *pc*, pigment cells; *vc*, ventricular cavity; 1, 2, 3, 4, 5, zones of different types of epithelial cells (redrawn from Meves 1973, Fig. 9)

Pláštěnci (Tunicata)

✓ **nervová trubice – pouze larvy**

larva sumky – CNS cca 100 neuronů

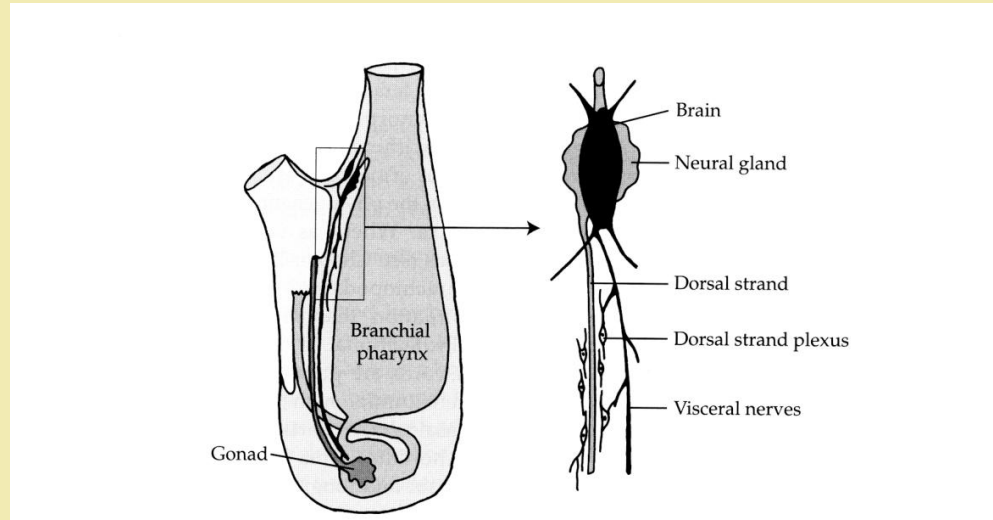
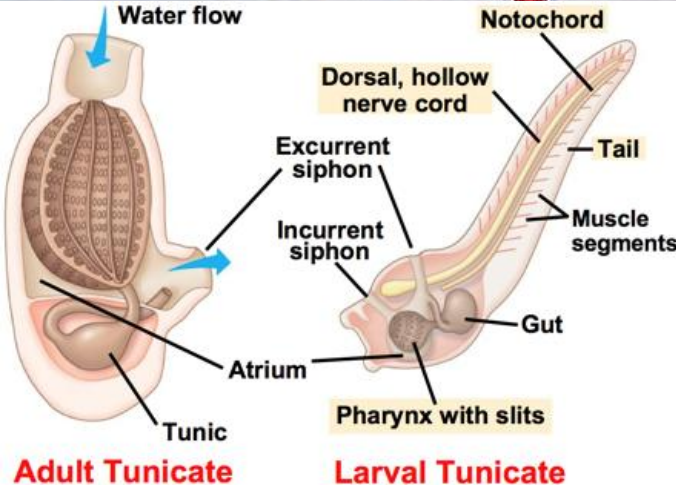
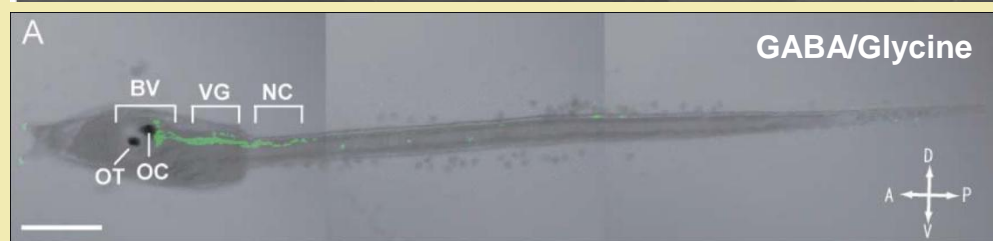
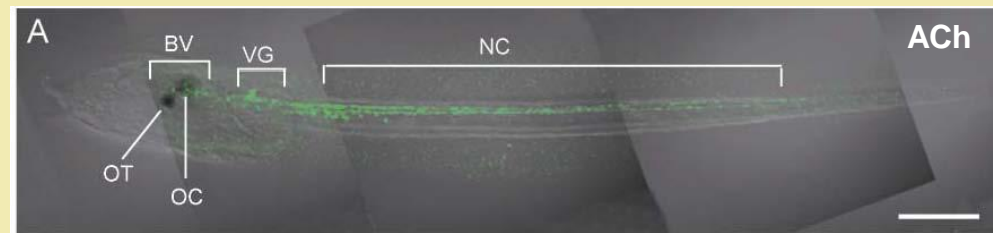


Fig. 6.15. Overview (left) and detail (right) of the nervous system in adult ascidians (Tunicata). The nervous system is shown in black. After Mackie (1995).



Obratlovci (Vertebrata)

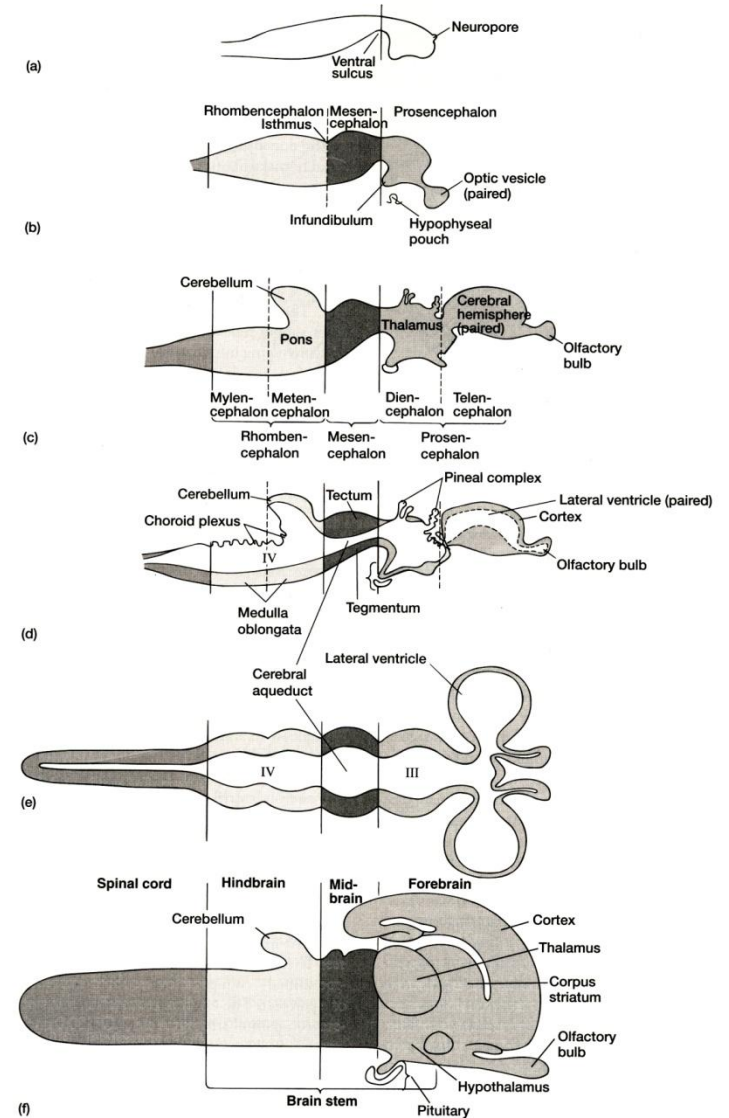
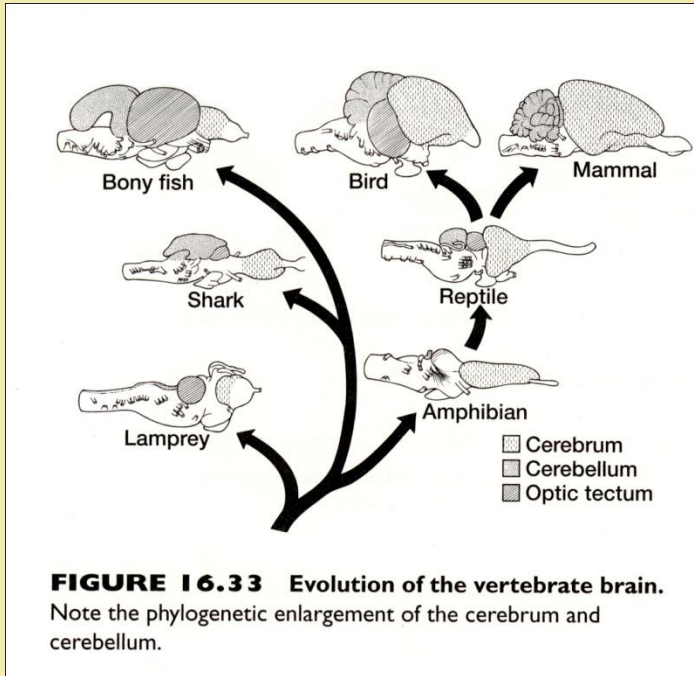
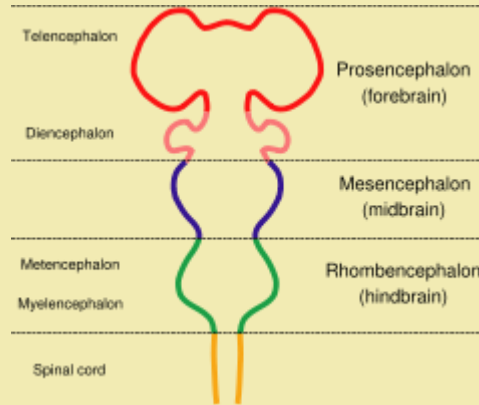


FIGURE 16.25 Development of the central nervous system. (a–d) Embryonic development. (e) Fluid-filled ventricles within the central nervous system. (f) Anatomical regions of the adult brain.

Obratlovci (Vertebrata)

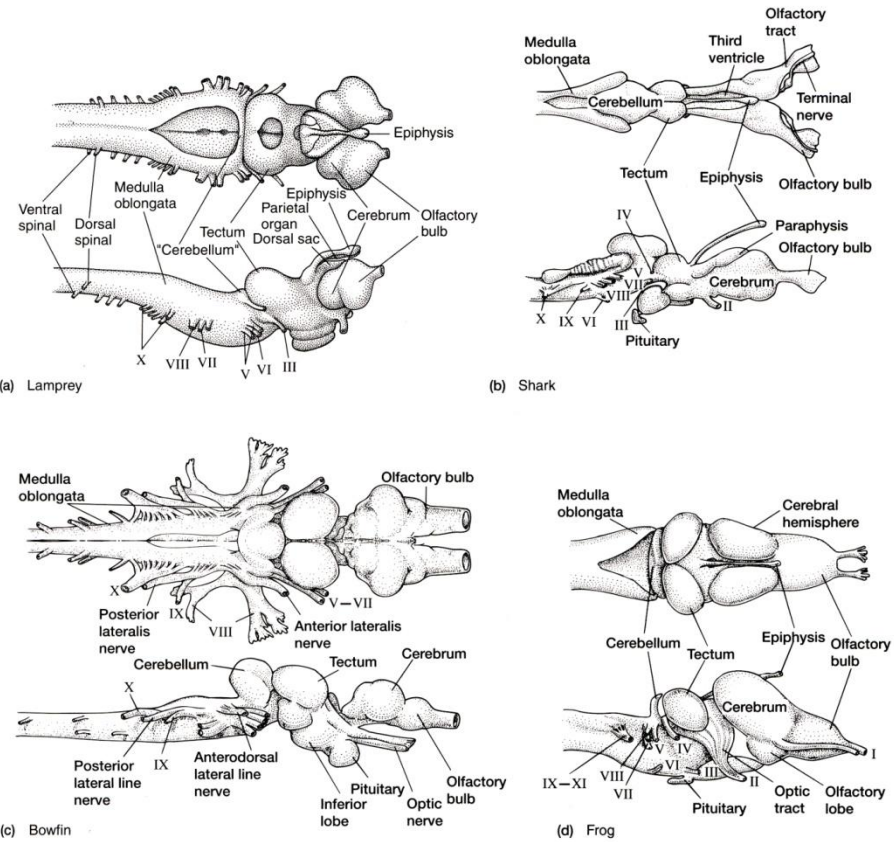


FIGURE 16.35 Vertebrate brains. Dorsal views are shown above, lateral views below. (a) Lamprey (*Lampetra*). (b) Shark (*Scymnus*). (c) Bowfin (*Amia*). (d) Frog (*Rana*). (e) Alligator (*Alligator*). (f) Insectivore (*Gymnura*). (g) Goose (*Anser*). (h) Horse (*Equus*).
 (a,b) (4-g) After Romer and Parsons; (c) after Davis and Northcutt; (h) after Getty.

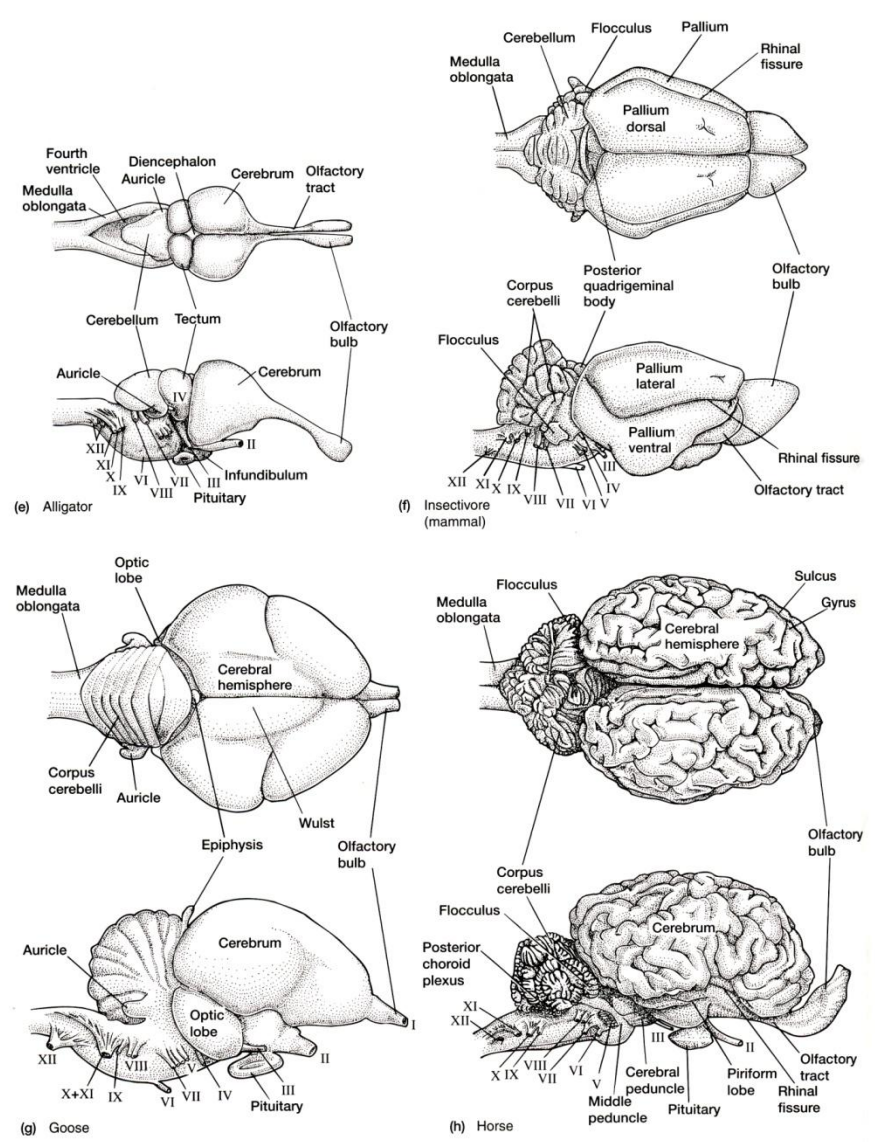


FIGURE 16.35 continued

Obratlovci (Vertebrata)

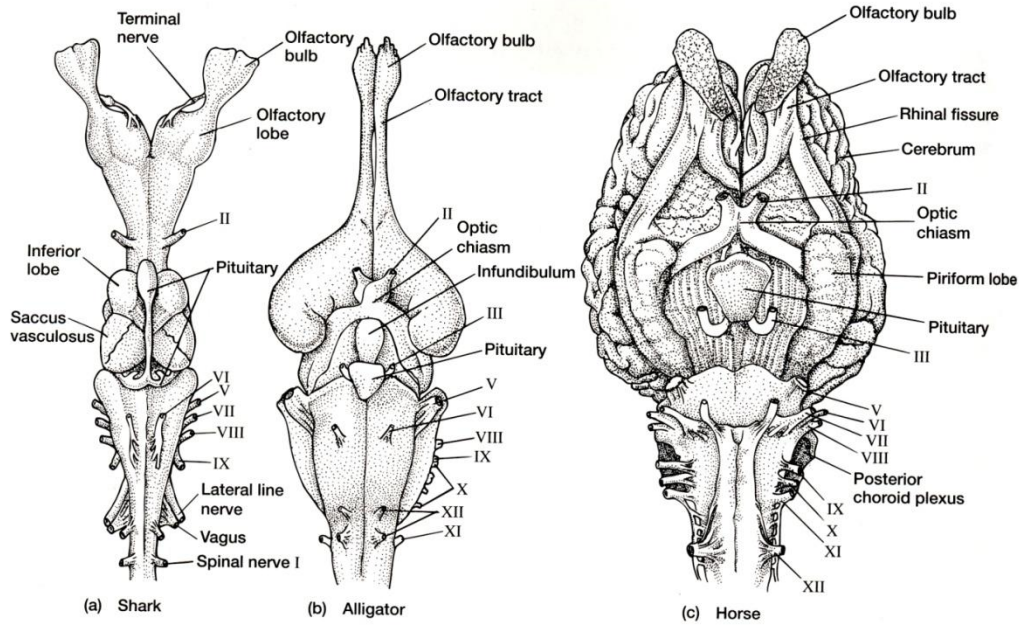


FIGURE 16.36 Vertebrate brains, ventral views. (a) Shark (*Scymnus*). (b) Alligator (*Alligator*). (c) Horse (*Equus*).
After Romer and Parsons.

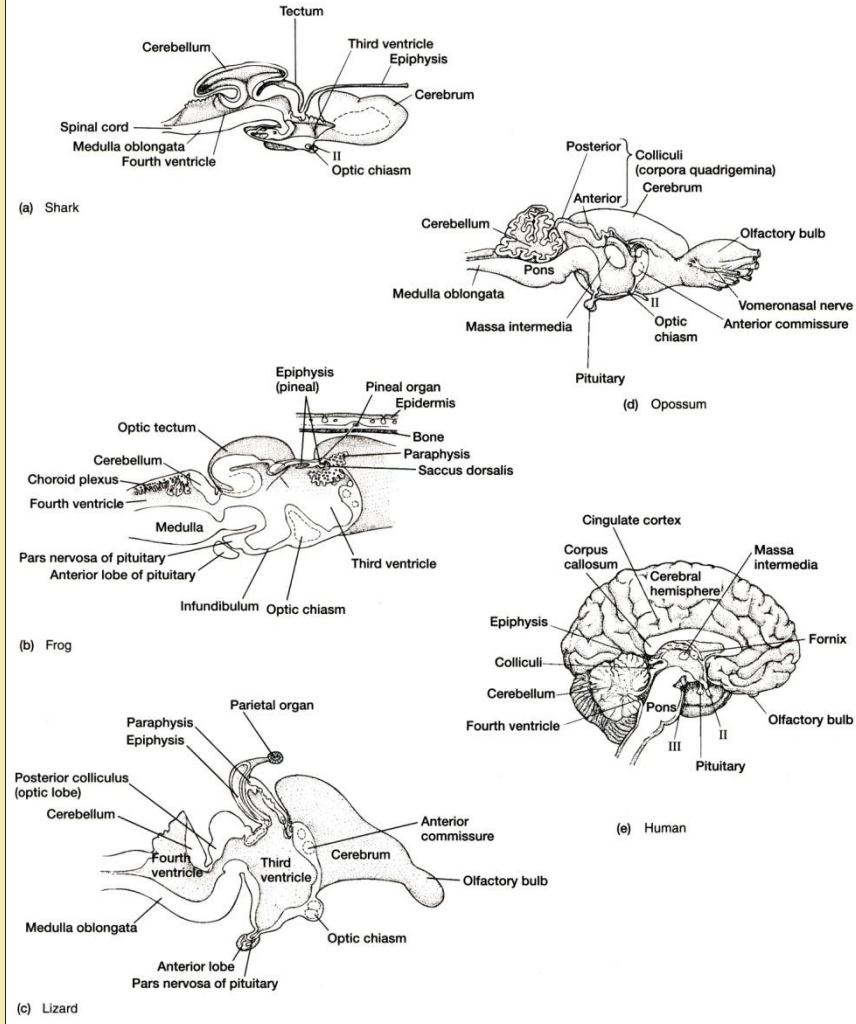
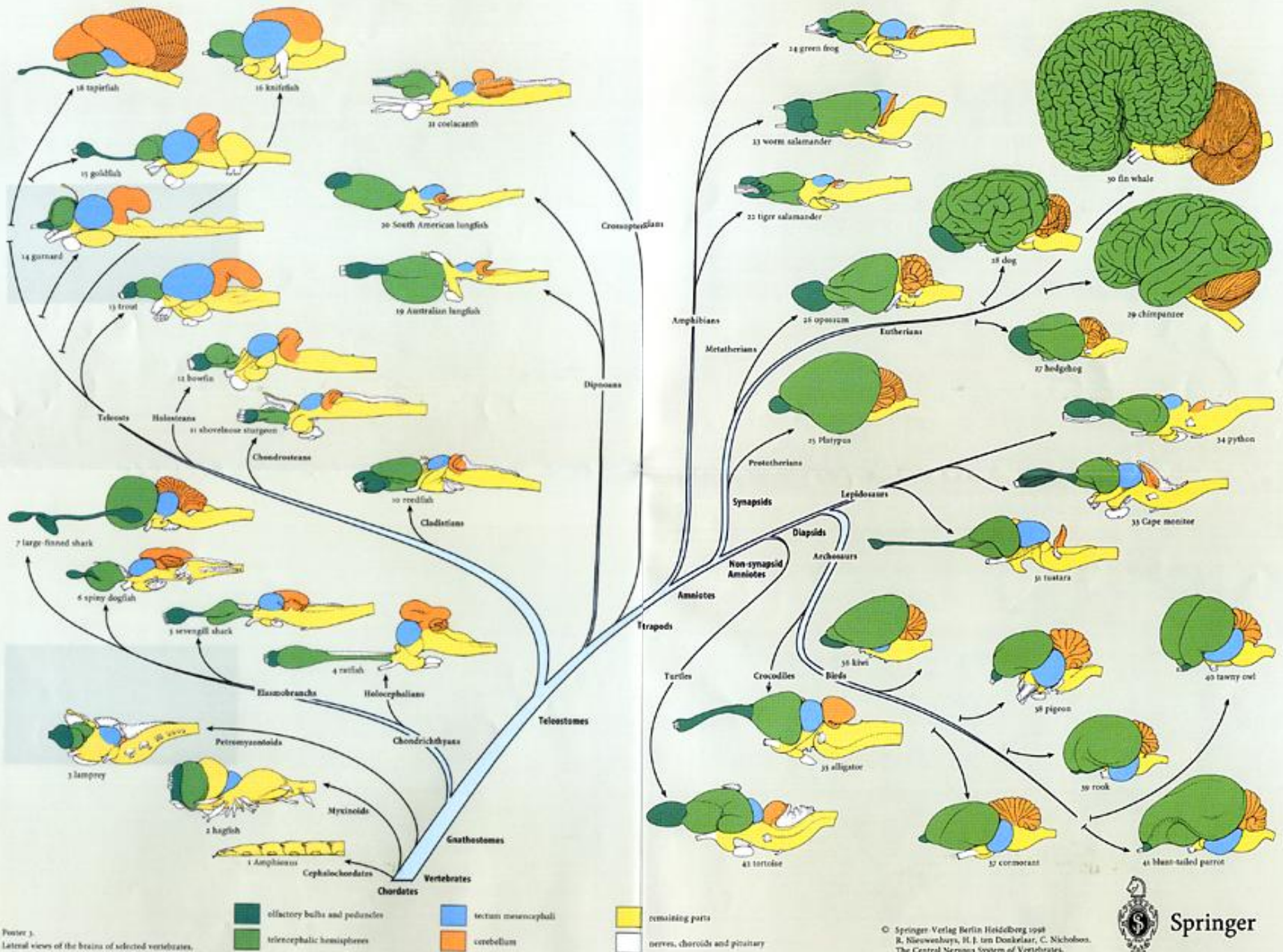
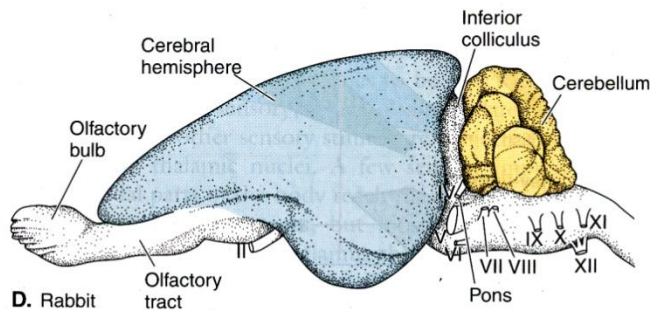
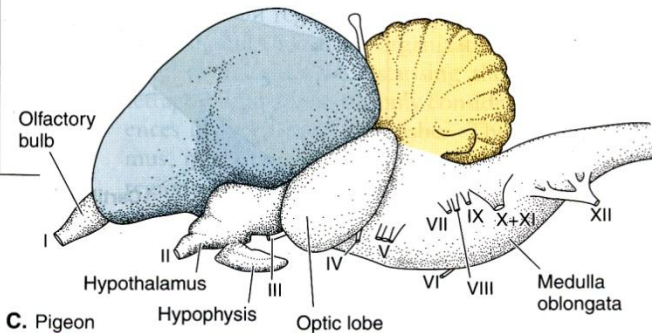
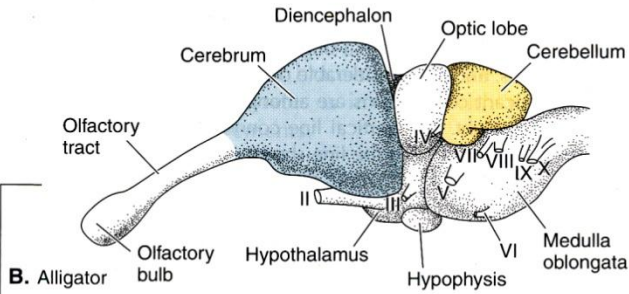
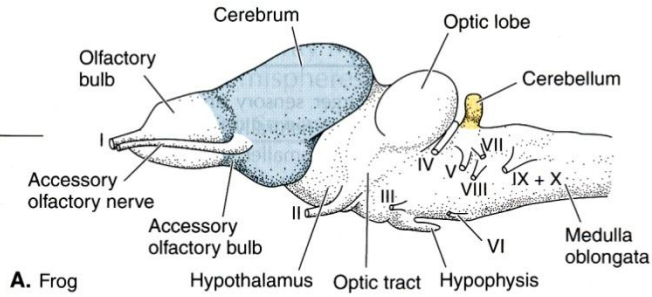


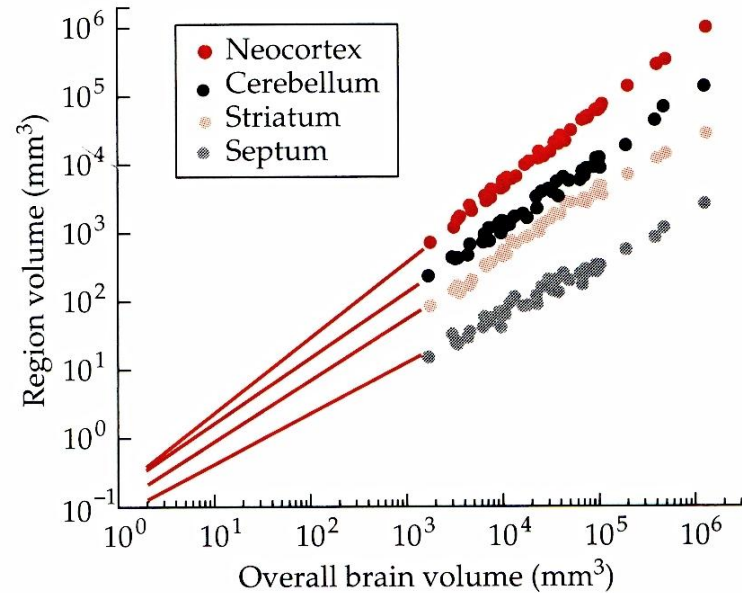
FIGURE 16.37 Vertebrate brains, sagittal views. (a) Shark (*Scyllium*). (b) Frog (*Rana*). (c) Lizard (*Lacerta*). (d) Opossum (*Didelphis*). (e) Human (*Homo*).
(a,d,e) After Romer and Parsons; (b,c) after Jollie.



Evolve velkých mozků zpravidla spjata se zvětšením koncového mozku a mnozečku



(D) Variations in allometric slope



Vývojová omezení

Velikost jednotlivých částí mozku lze predikovat z absolutní velikosti mozku jako celku (pro 11 částí mozků primátů, hmyzožravců a netopýrů – 96% pozorované variability)

Koncový mozek laminárního typu

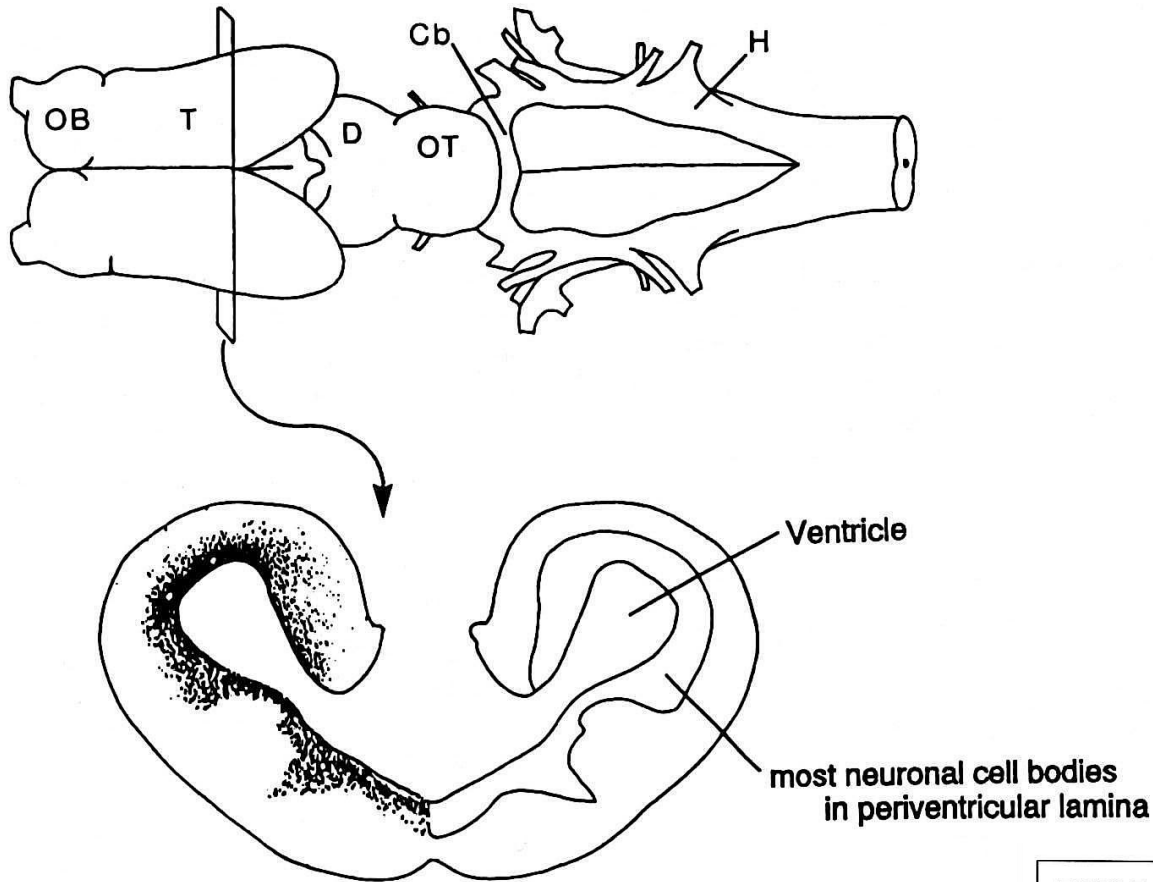


TABLE 4-1. Vertebrates with Laminar Brains (Group I)

Agnatha	Lampreys
Chondrichthyes	Squalomorph sharks Squantinomorph sharks Holocephalians (chimaeras)
Actinopterygii	Cladistians (bichirs, or reedfishes) Chondrosteans (sturgeons and paddlefishes) Ginglymodians (gars) Halecomorphans (bowfin)
Sarcopterygii	Actinistians (coelacanth) Dipnoans (lungfish) Amphibians

Velký koncový mozek u různých obratlovců několikrát nezávisle, avšak obdobným vývojovým mechanismem

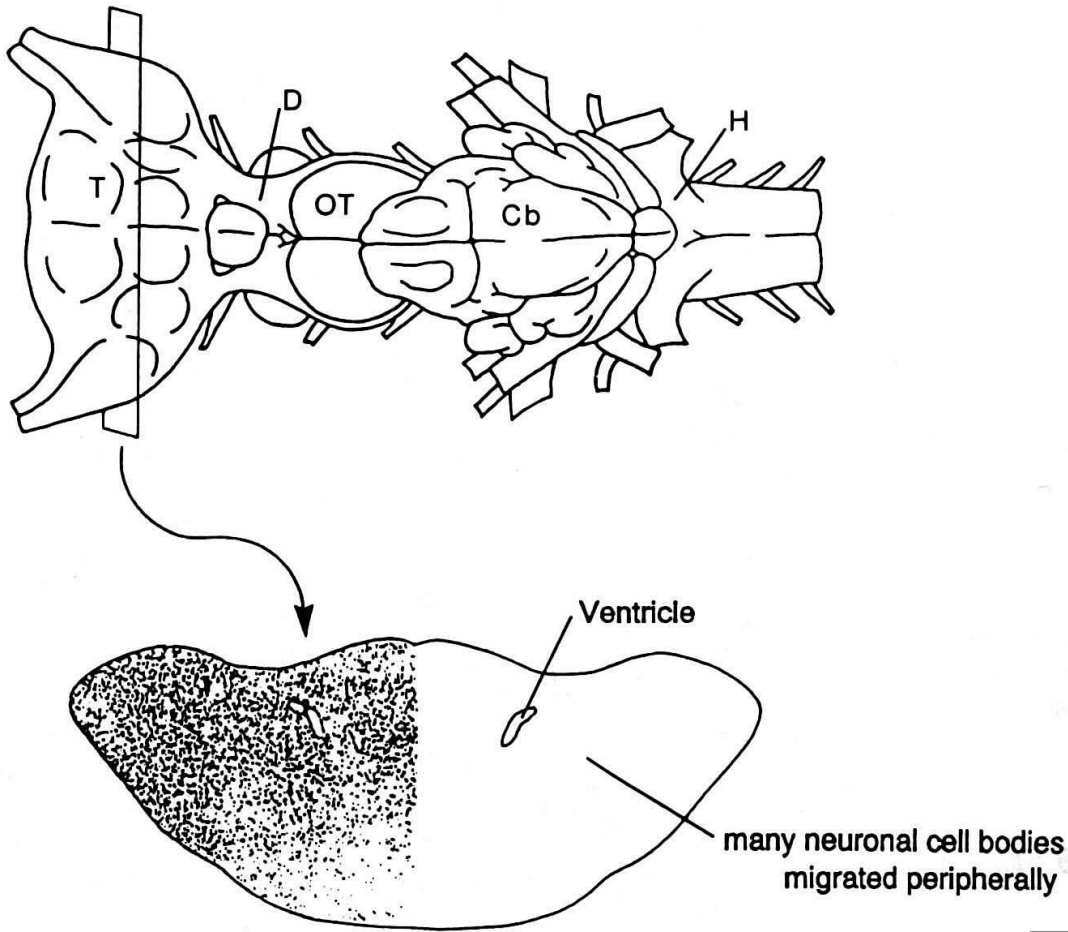
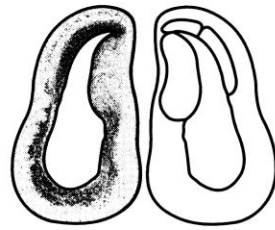


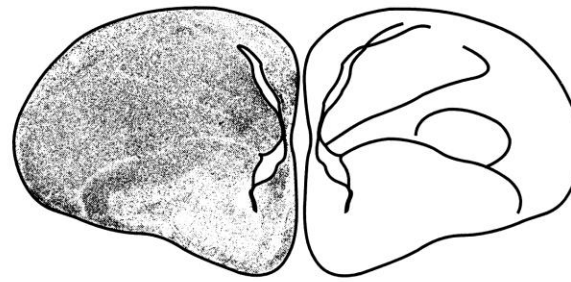
TABLE 4-2. Vertebrates with Elaborated Brains (Group II)

Agnatha	Hagfishes
Chondrichthyes	Galeomorph sharks Skates Rays
Actinopterygii	Teleosts
Sarcopterygii	Mammals Diapsid reptiles Birds Turtles

Sarcopterygian Radiation

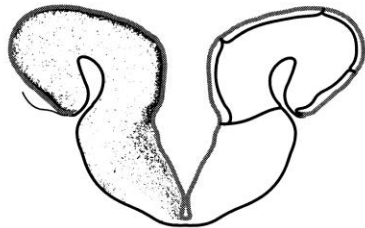


Lungfish

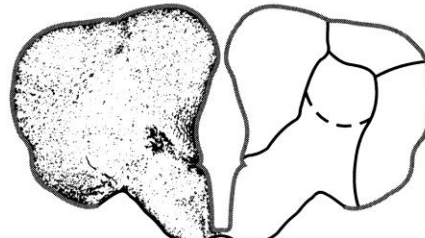


Bird

Ray-finned Fishes

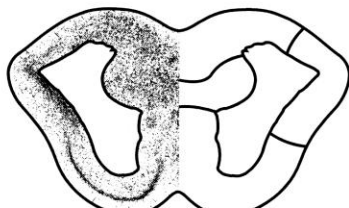


Cladistian

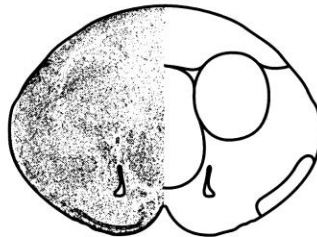


Euteleost

Cartilaginous Fishes

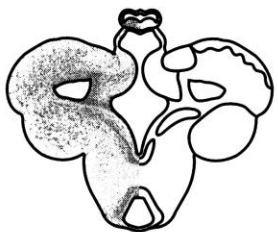


Squalomorph Shark

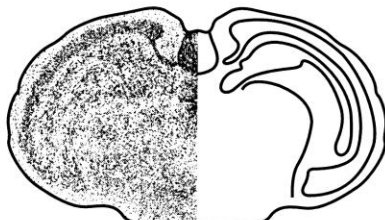


Galeomorph Shark

Cyclostomes

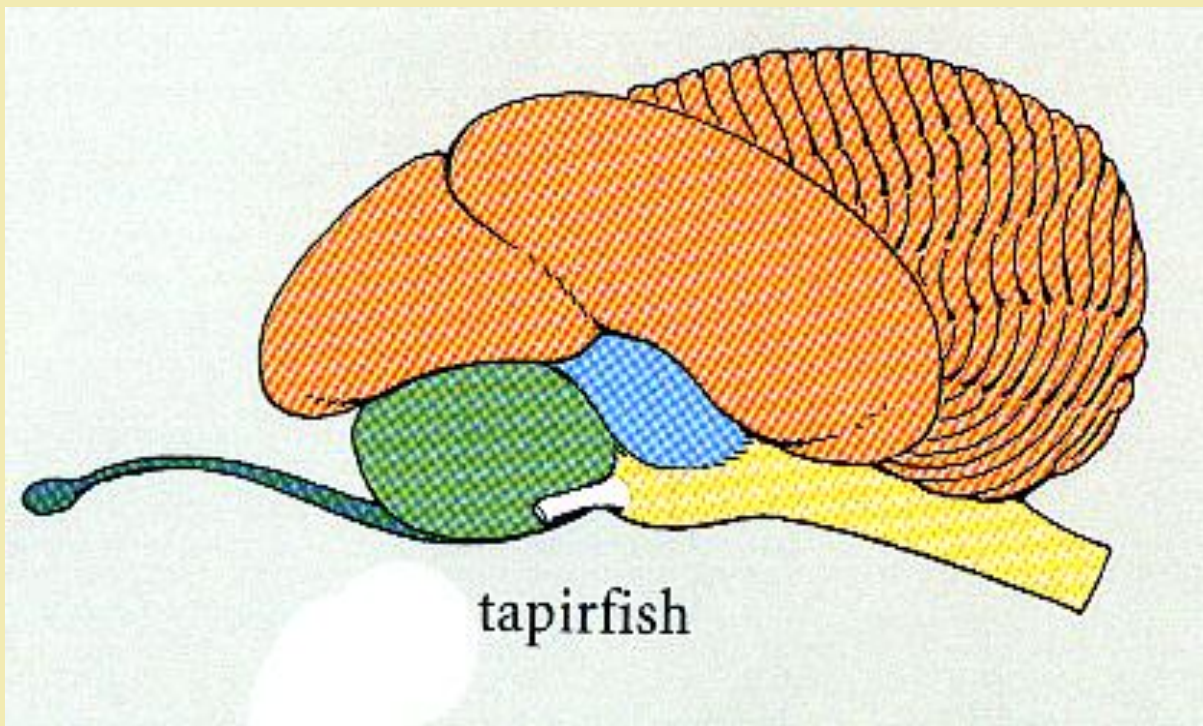
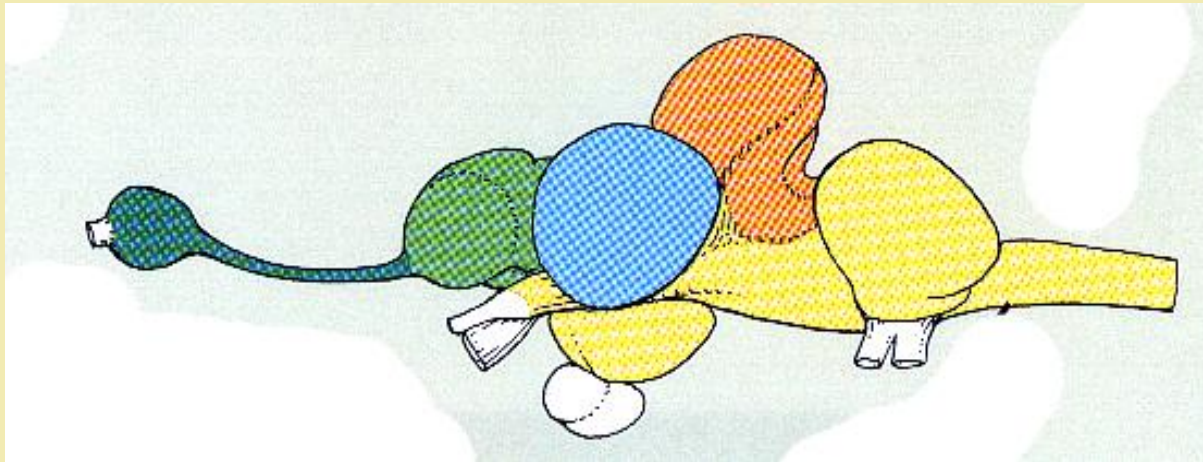


Lamprey

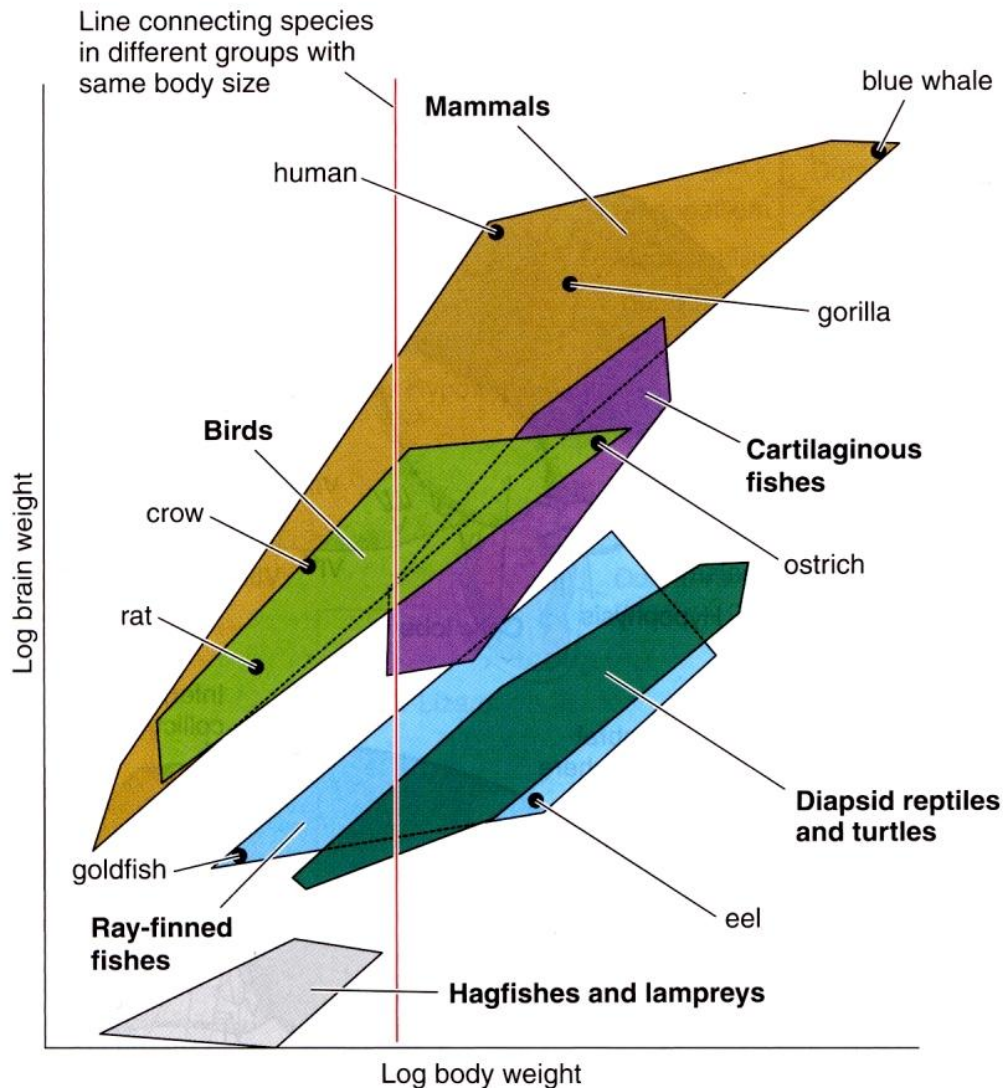


Hagfish

Velký mozek může vzniknout různě: příklad ryb čeledi Mormyridae

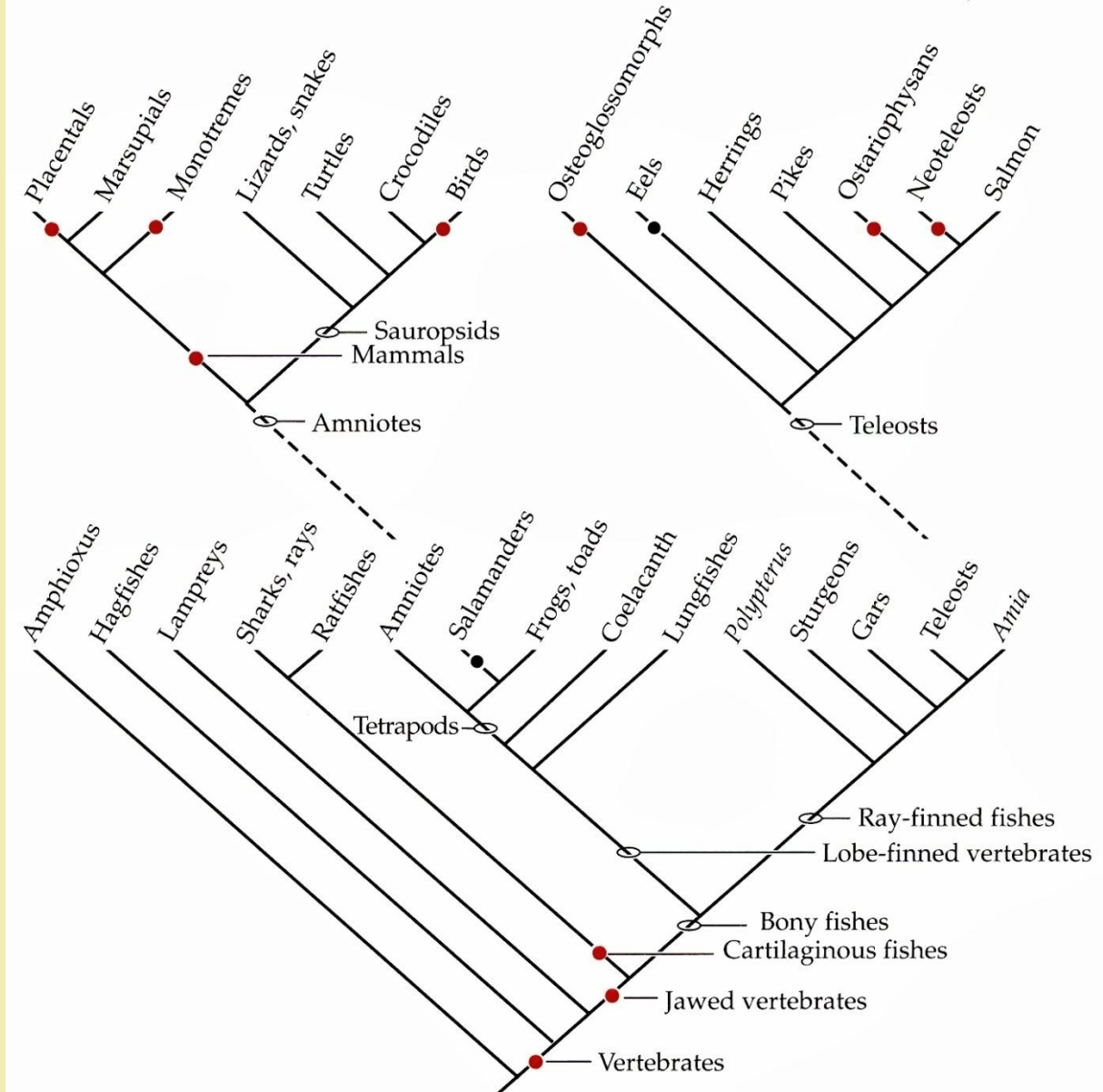


Relativní velikost mozku obratlovců



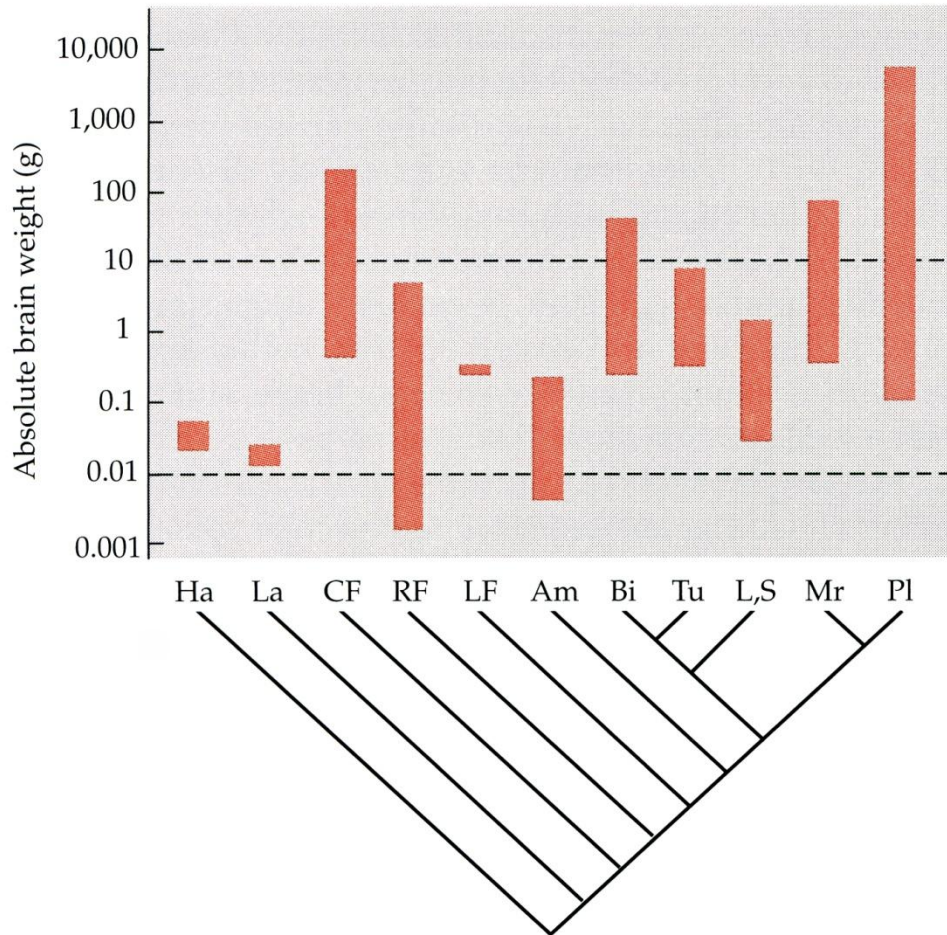
A. The logarithm of brain weight plotted as a function of body weight in approximately 200 species representing major craniate clades. (Modified from Butler and Hodos, after Northcutt.)

Relativní velikost mozku obratlovců: shrnutí



Příklad extrémní redukce:
mločící čeledi Pletodontidae

Na velikosti záleží



Analogie:

Možek jako firma – pokud se firma rozroste je nutné ji reorganizovat

Abbreviations: Ha = hagfishes; La = lampreys; CF = cartilaginous fishes; RF = ray-finned fishes; LF = lungfish; Am = amphibians; Bi = birds; Tu = turtles; L = lizards; S = snakes; Mr = marsupials; Pl = placental mammals.

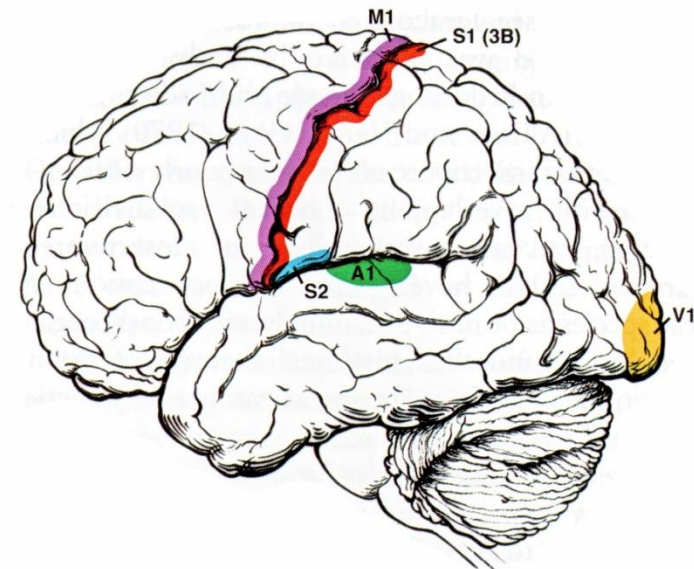
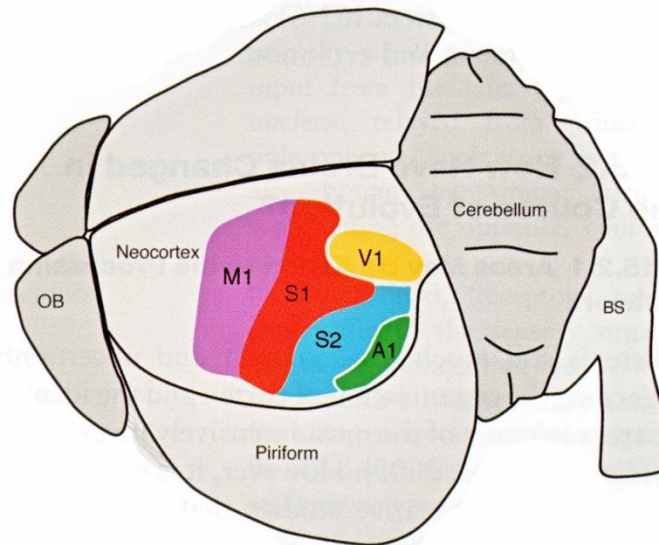
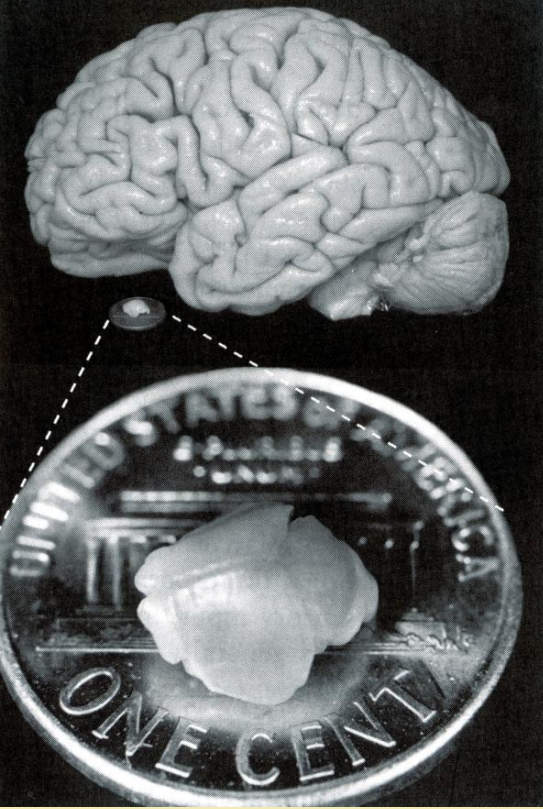
Vznik nových funkčních korových oblastí

Množství funkčních korových oblastí koreluje s velikostí mozku resp. plochou isokortexu

rejsek – 0,15 cm²

makak – 72 cm² tj. cca 480x více

člověk – cca 800 cm², tj. 5000x více než rejsek



Stavba koncového mozku

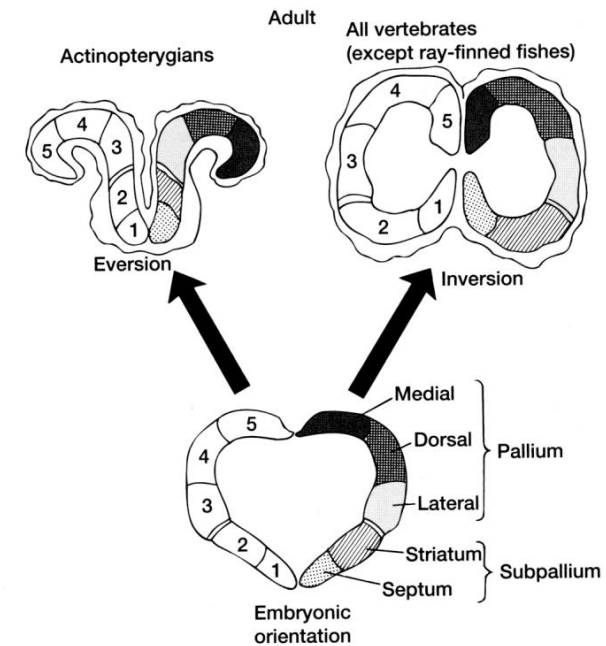
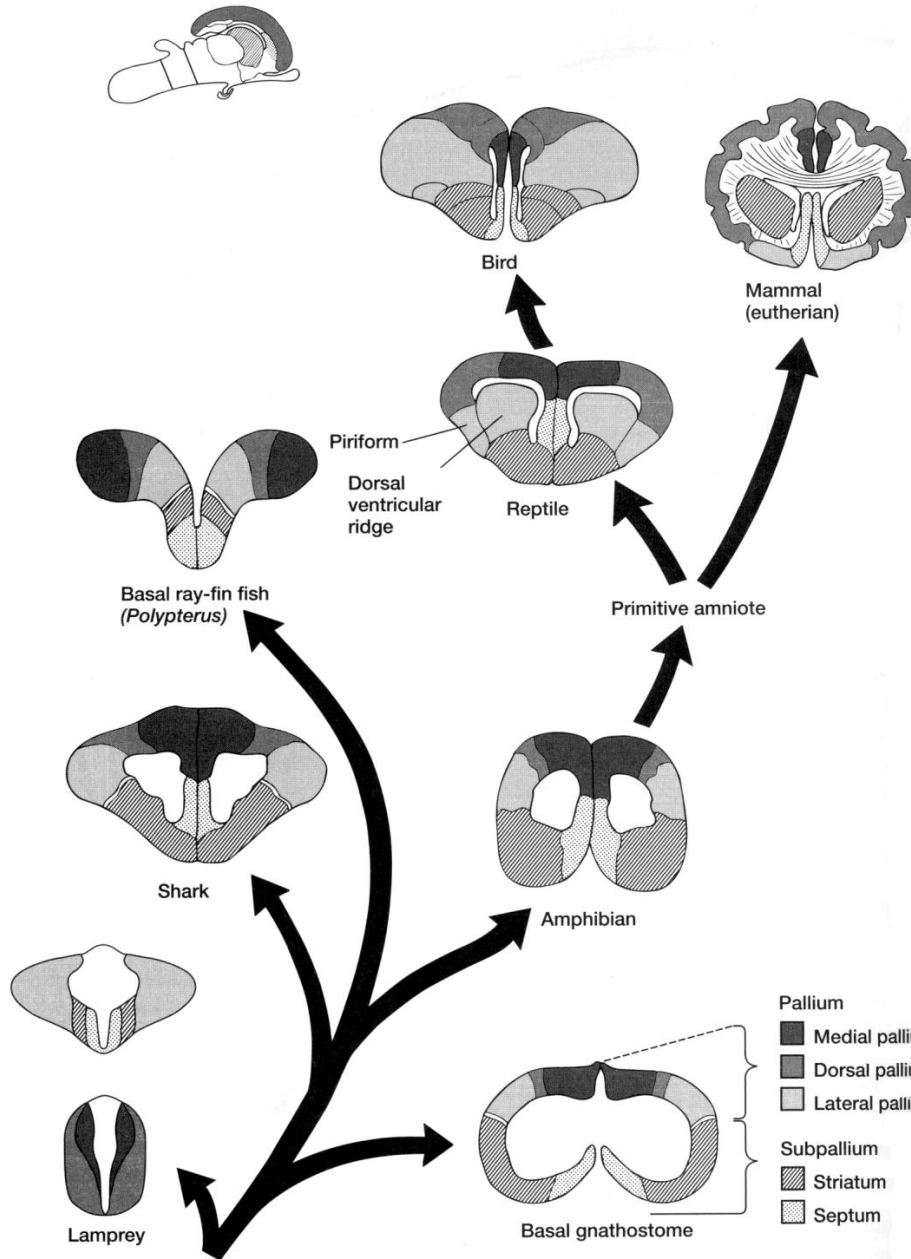
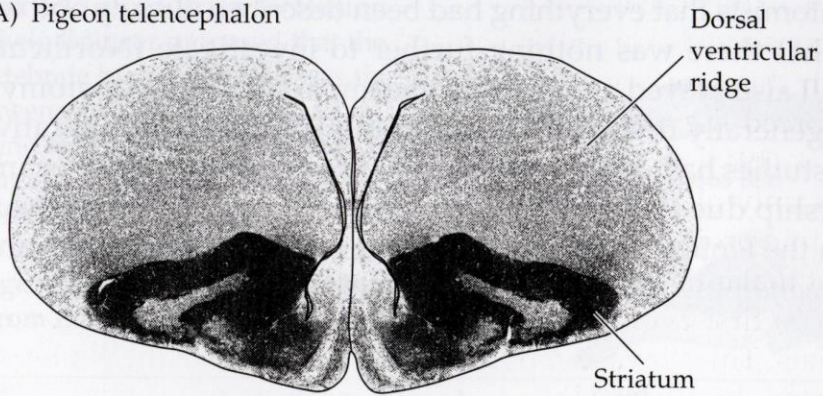


FIGURE 16.42 Embryonic development of the telencephalon. In actinopterygians, the telencephalon becomes everted during development, the pallium swings outward. In all other vertebrates, it becomes evaginated and inverted; walls of the hemispheres inflate outward (evagination) and the medial pallium and septum roll inward (inversion).

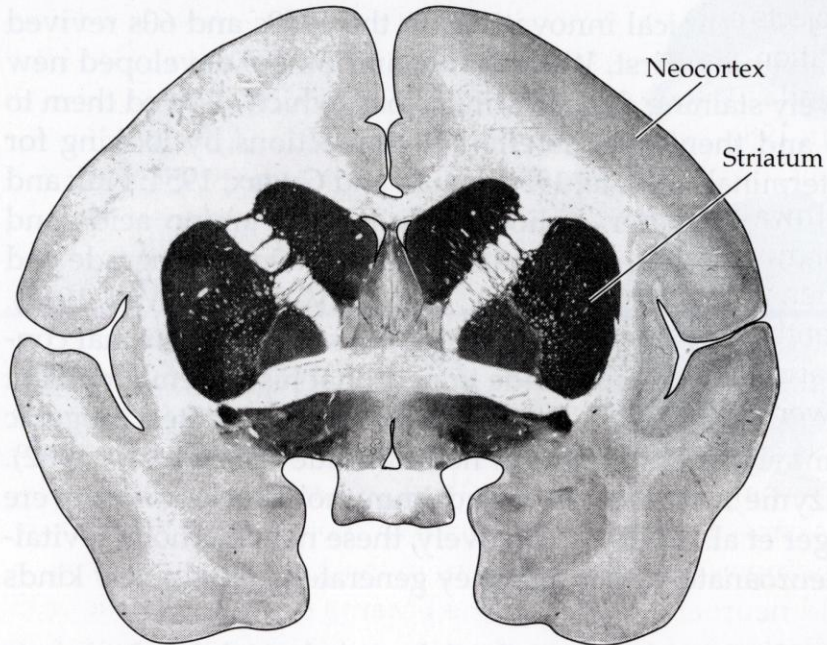
Stavba koncového mozku

Bazální ganglia

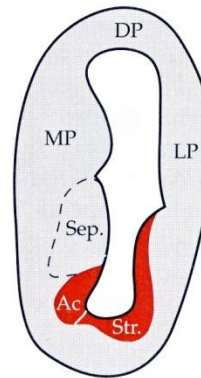
(A) Pigeon telencephalon



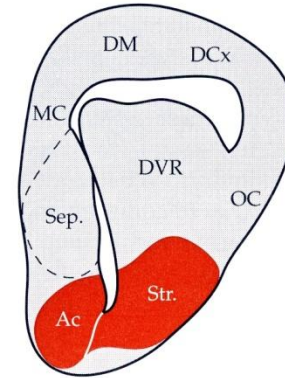
(B) Squirrel monkey telencephalon



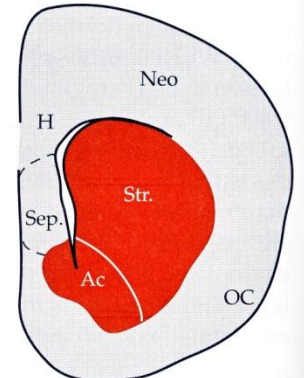
(A) Amphibians



(B) Reptiles

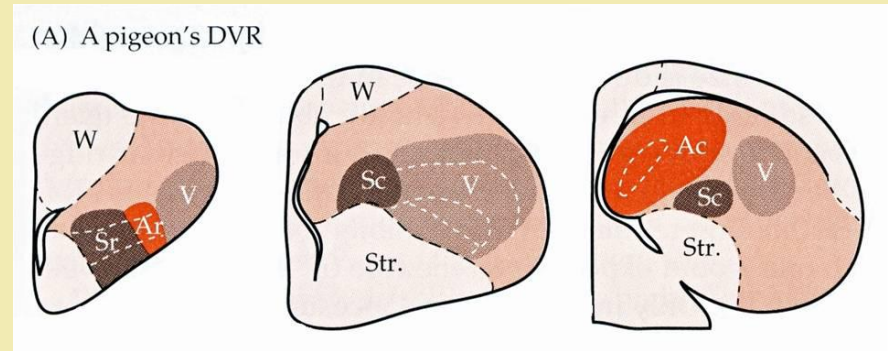
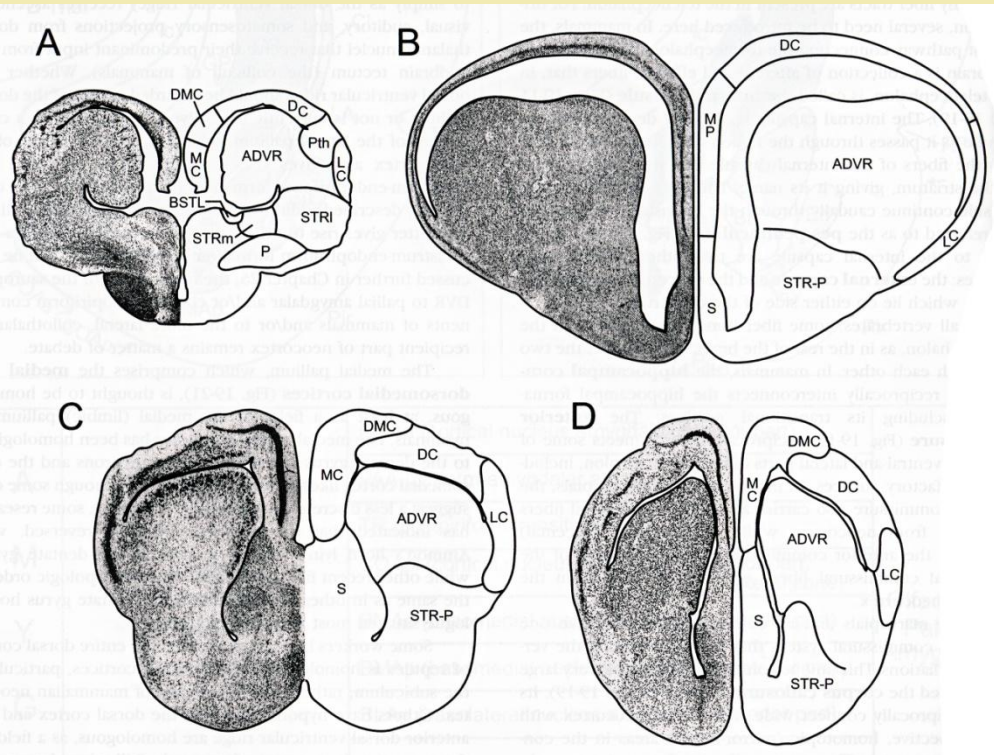


(C) Mammals



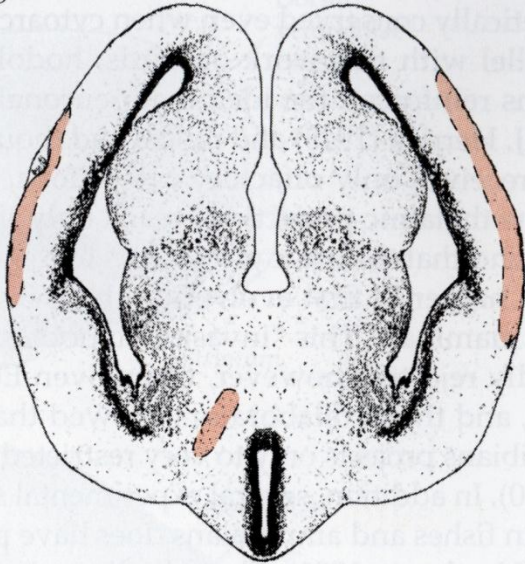
Stavba koncového mozku

dorsal ventricular ridge (dorzální komorový hřebínek) u plazů a ptáků

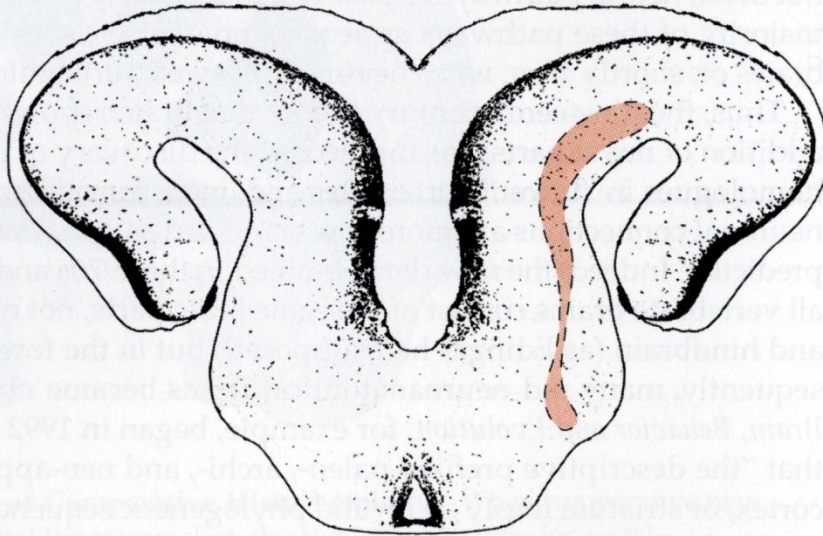


(A) *Pseudemys scripta*, (B) *Alligator mississippiensis*, (C) *Gekko gekko*, (D) *Tupianambis teguixin*

(A) Bullfrog

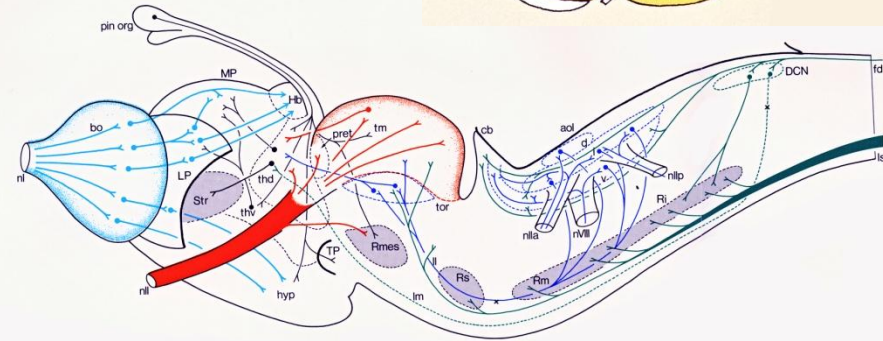
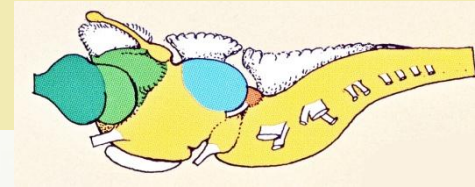


(B) Polypterus



Koncový mozek ryb a obojživelníků není výhradně čichový

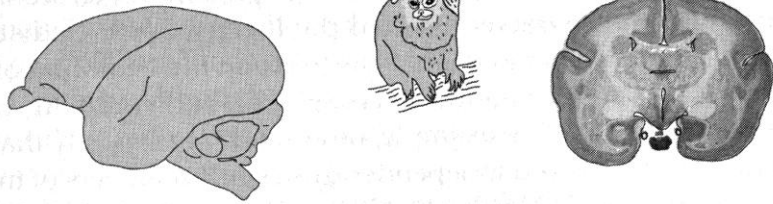
Čichový lalok inervuje jen omezenou část koncového mozku ryb a obojživelníků



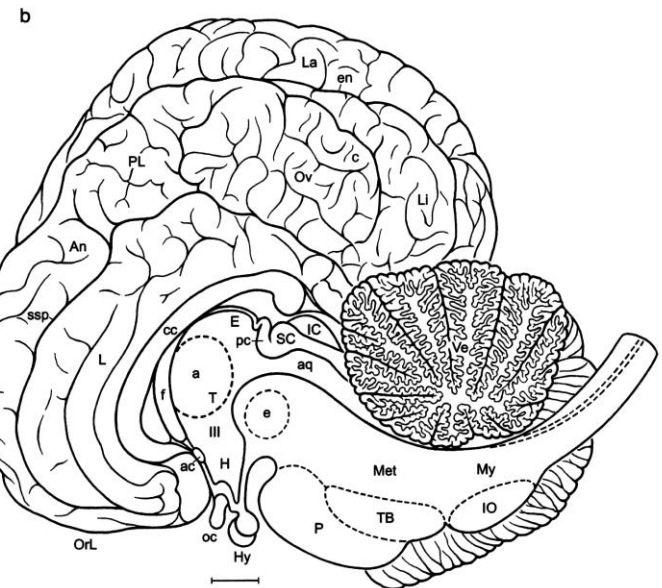
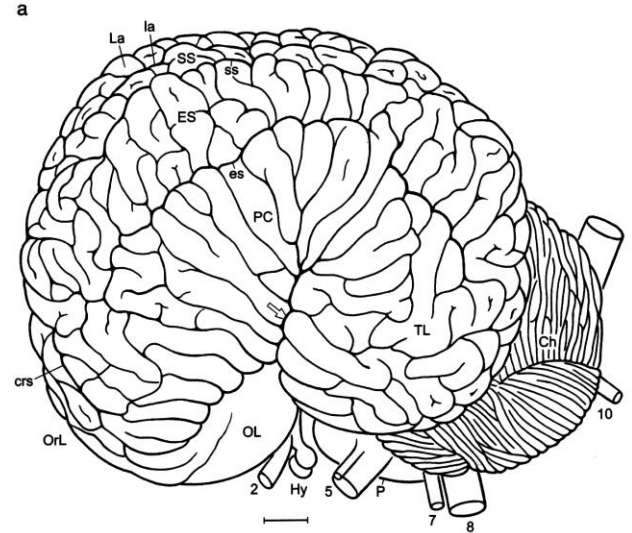
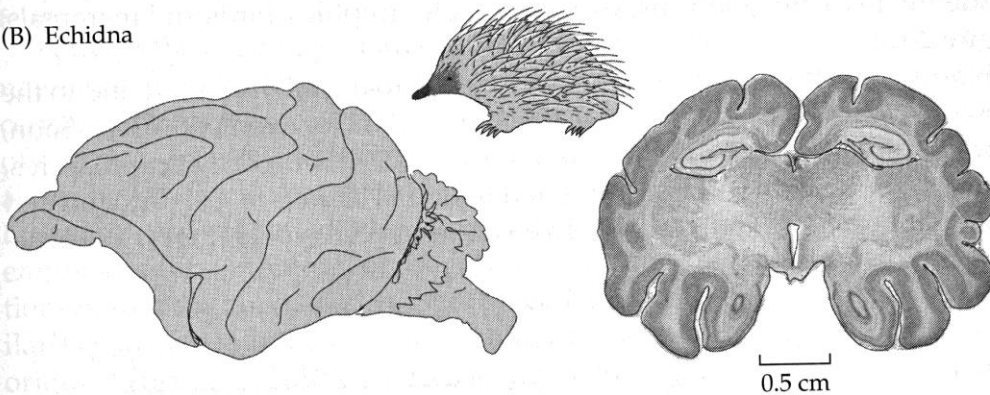
mihule

Gyrifikace nezávisí na evoluční pokročilosti, ale na absolutní velikosti mozku

(A) Marmoset



(B) Echidna



Mícha – Medula spinalis

Ontogeneze a princip organizace

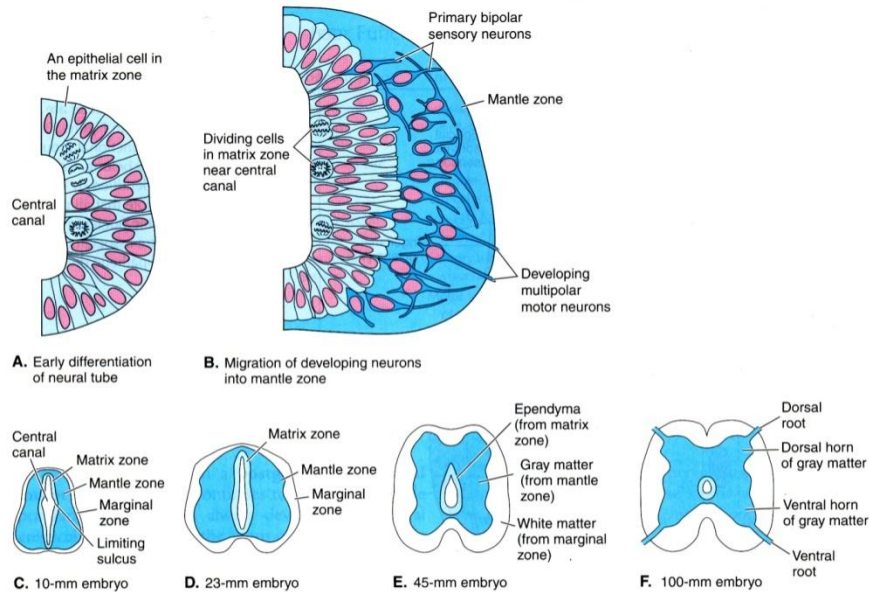
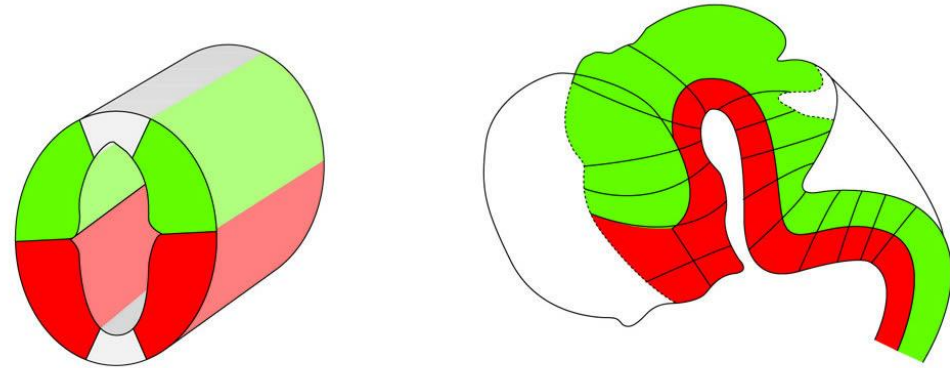
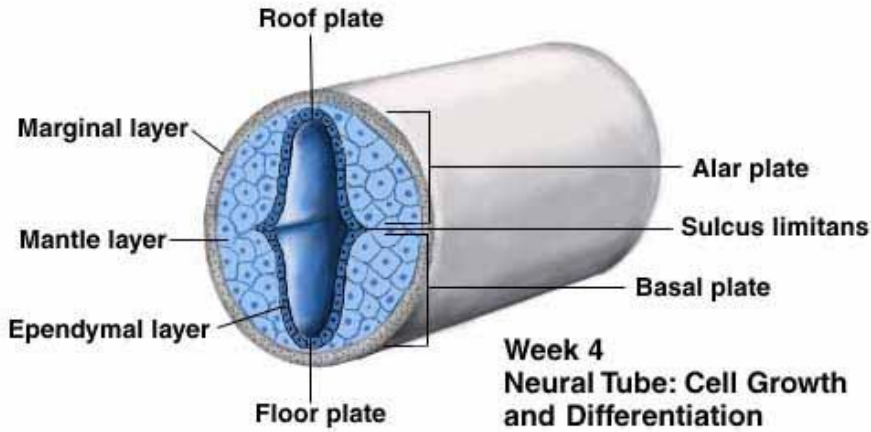
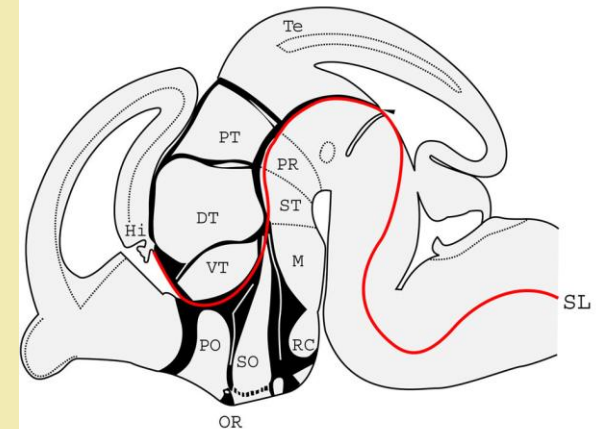


FIGURE 13-9 Development of the spinal cord. *A*, Early differentiation of the neural tube, showing proliferation of cells in the pseudostratified epithelium of the matrix zone. *B*, Migration of developing neurons into the mantle zone. Primary bipolar sensory neurons and multipolar motor neurons can be seen already. *C*, Transverse section through the spinal cord of a 10-mm pig embryo. A very thin marginal zone, which is fated to form the white matter, now can be seen. *D*, Schematic transverse section through spinal cord of a 23-mm pig embryo. *E*, Transverse section through spinal cord of a 45-mm pig embryo. *F*, Transverse section through spinal cord of a 100-mm pig embryo. (Modified from Balinsky.)



Epigenetic population matching hypothesis

„Hypotéza epigenetického populačního párování“

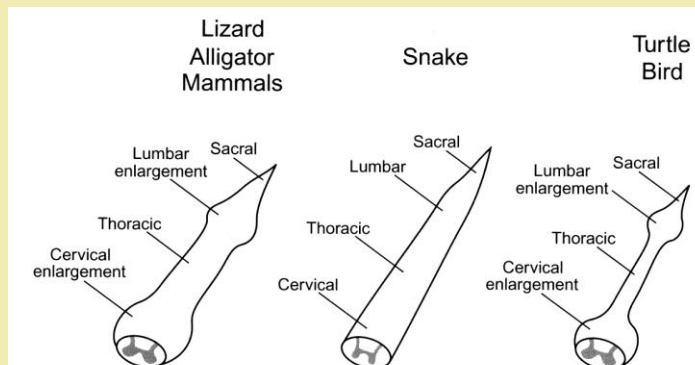
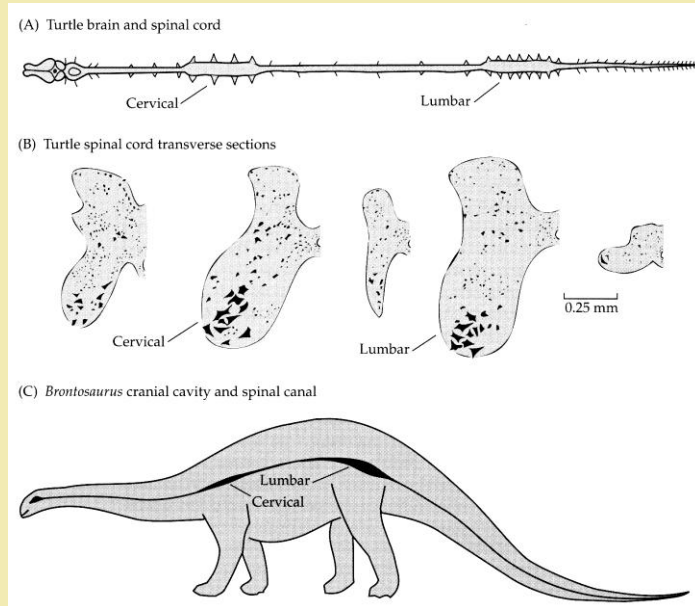


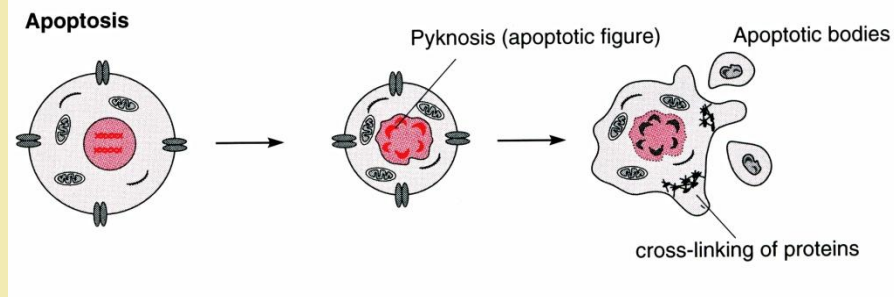
FIGURE 8-6. Schematic representations of three types of spinal cord. Left: Typical tetrapod spinal cord with cervical and lumbar enlargements and a thick thoracic region. Center: A snake spinal cord that is thick throughout its length and lacks cervical or lumbar enlargements. Right: A spinal cord characteristic of turtles and birds that has cervical and lumbar enlargements but is thin in the thoracic region.

Neurogeneze obratlovců – 20-80% nadprodukce neuronů

(např. v lumbální míše degeneruje 40% motoneuronů)

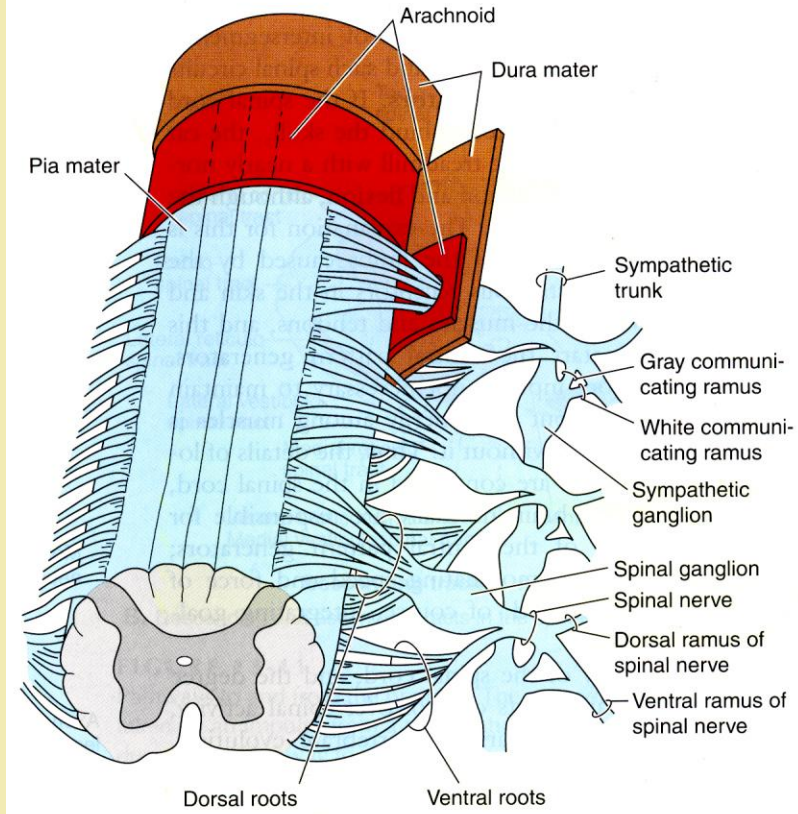
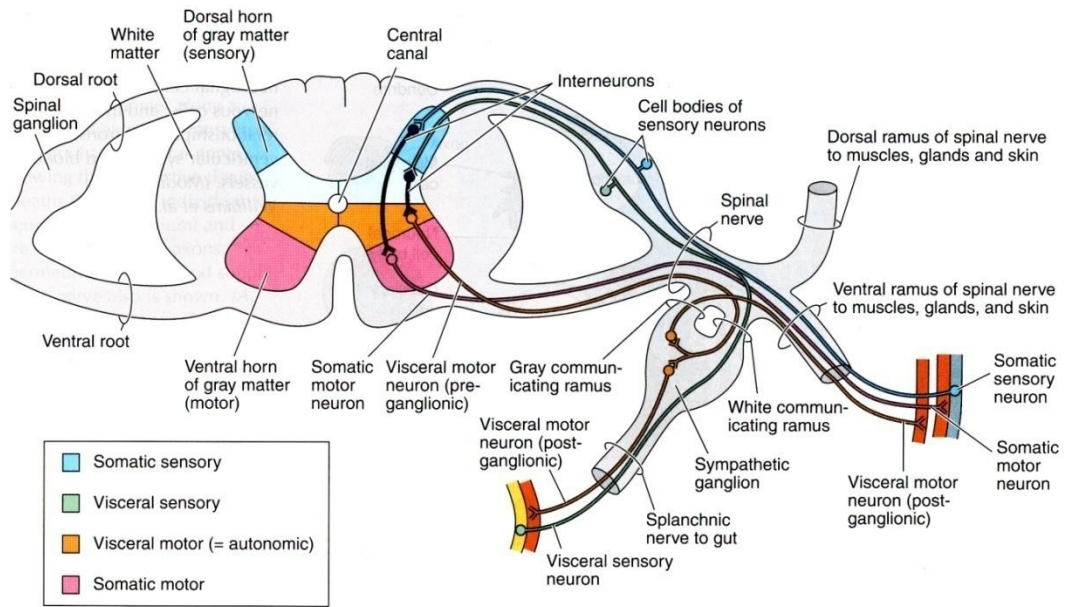
Přežívání neuronů závisí na:

- trofických faktorech produkovaných cílovými tkáněmi (NGF, některé cytokiny)
- aferentní synaptické aktivitě
- hormonálních signálech atd.

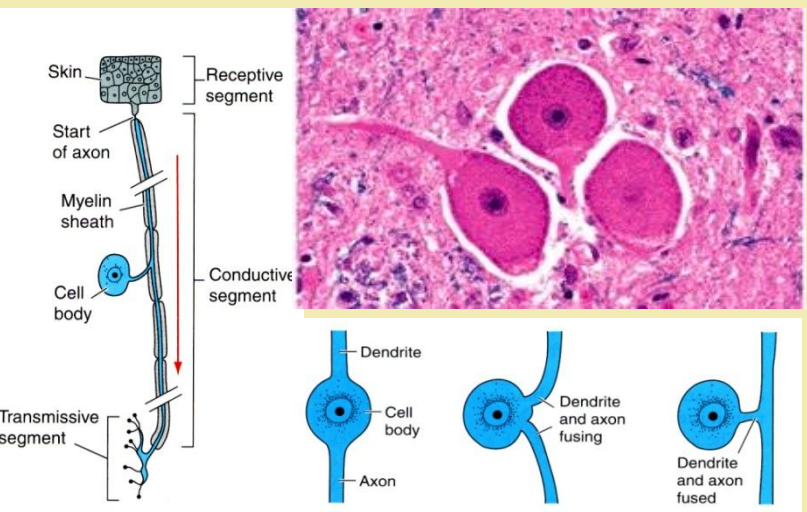


Mícha – Medula spinalis

Princip organizace



B. Organization of spinal roots, ganglia, and nerves in trunk



C. Pseudounipolar sensory neuron D. Stages in development of a pseudounipolar sensory neuron

Mícha – Medula spinalis

Princip organizace

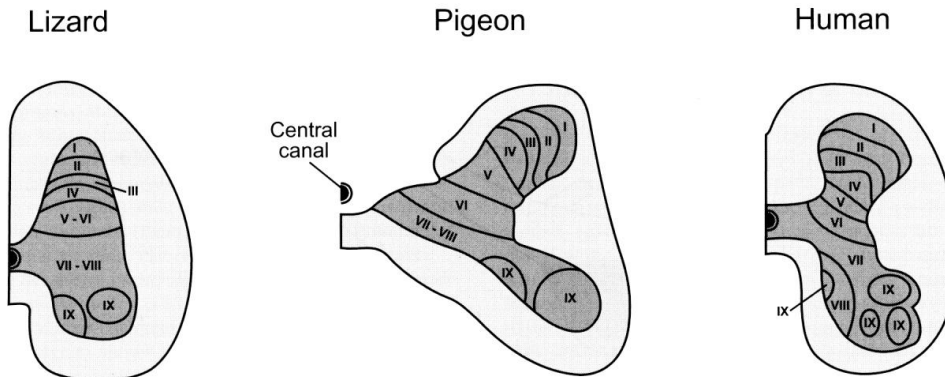
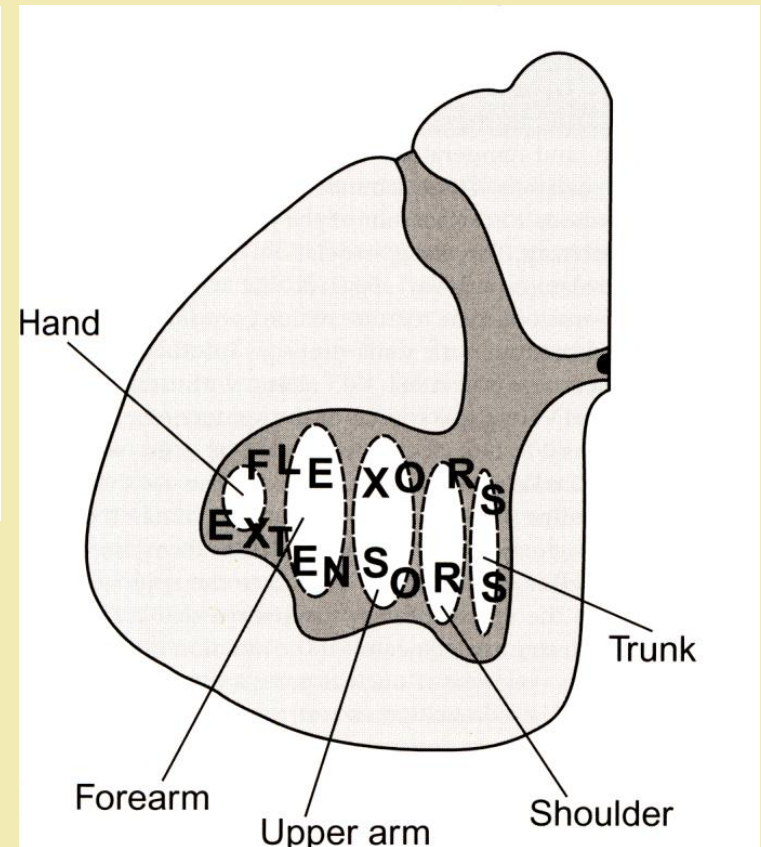


FIGURE 8-8. Lamination in the gray matter of three tetrapods: a lizard, a pigeon, and a human. Laminae I–VI constitute the dorsal horn. Laminae VIII and IX are the ventral horn. Many axons of descending pathways terminate in lamina VIII. Lamina IX neurons are the motor neurons.



Mícha – Medula spinalis

Evoluce u obratlovců

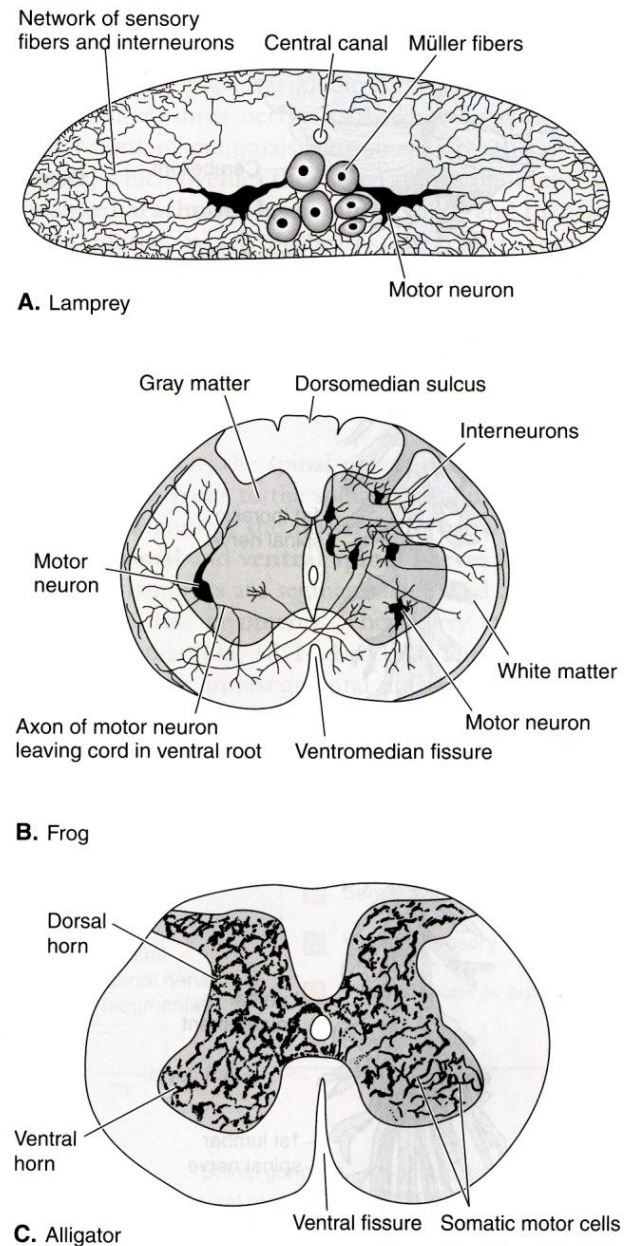


FIGURE 13-12
 Transverse sections of the spinal cord of representative vertebrates. *A*, A lamprey. *B*, A frog. *C*, An alligator. (*A*, After Tretjakoff; *B*, after Gaupp.)

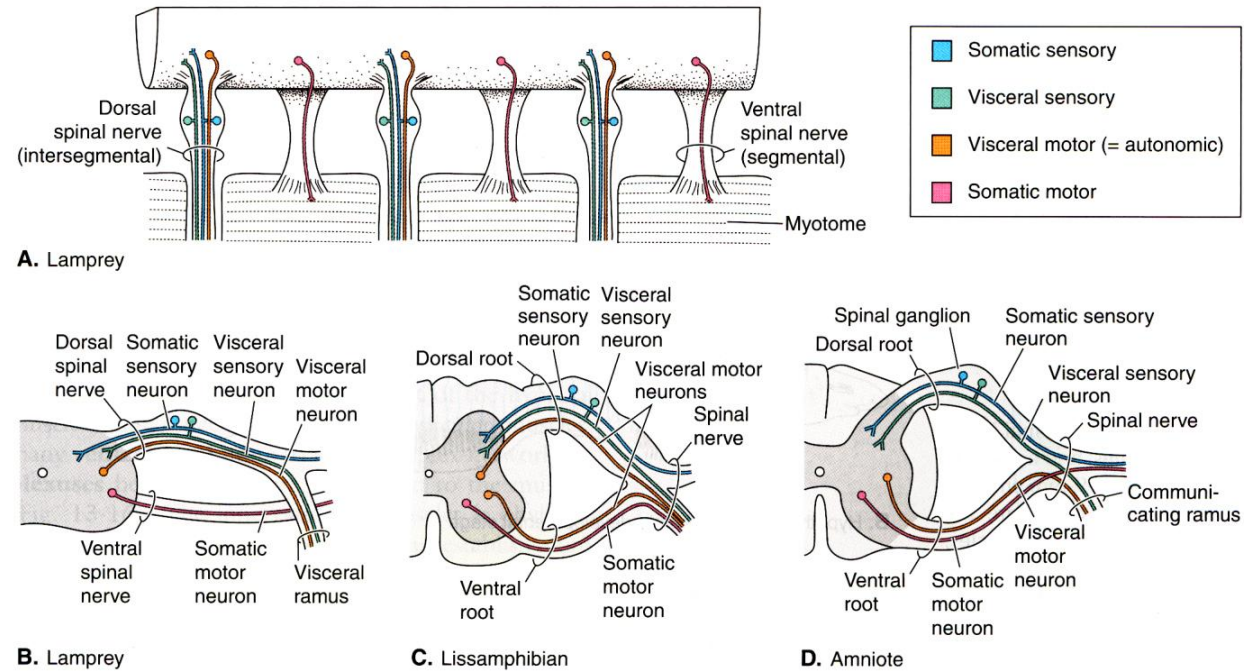
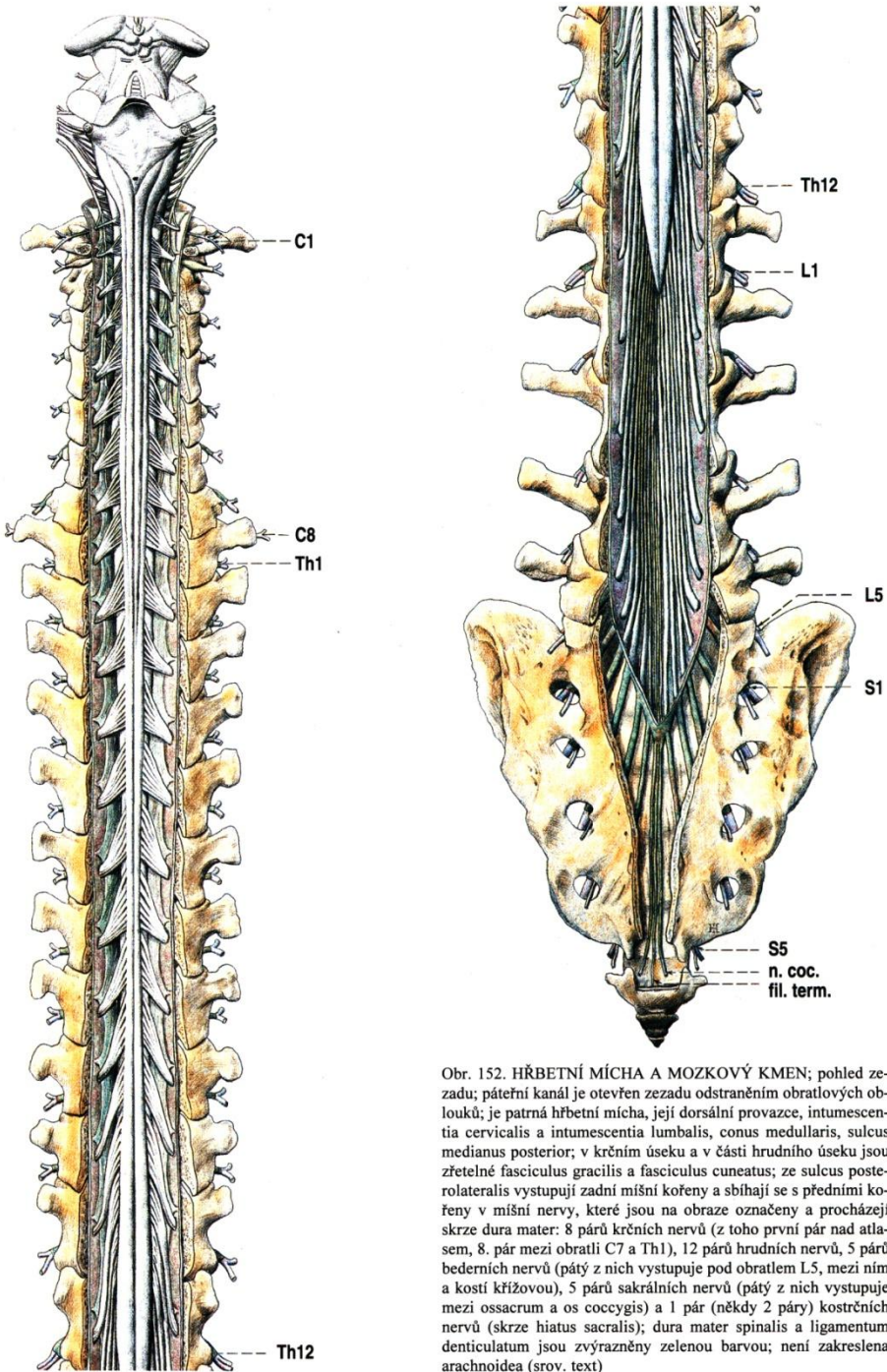


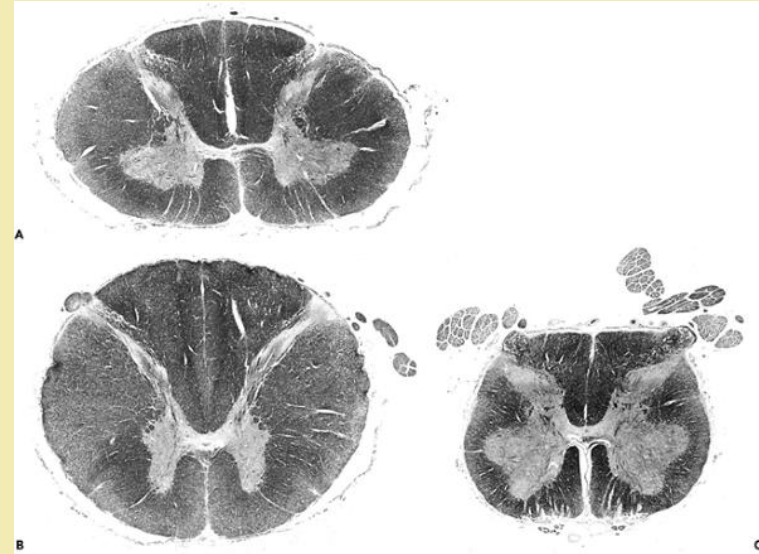
FIGURE 13-14
 Evolution of spinal nerves. *A*, A dorsal view of the spinal cord and nerves of a lamprey. *B*, Transverse section through the spinal cord and nerves of a lamprey. *C*, Transverse section through the spinal cord of a lissamphibian. *D*, Transverse section through the spinal cord of an amniote. The neurons are color coded to indicate the functional groups to which they belong. (*Modified from Romer and Parsons.*)

Mícha – Medulla spinalis

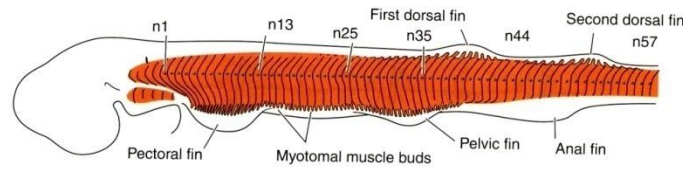
Anatomie



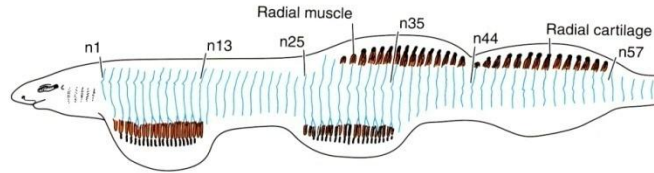
Obr. 152. HŘBETNÍ MÍCHA A MOZKOVÝ KMEN; pohled ze zadu; páteřní kanál je otevřen ze zadu odstraněním obratlových oblouků; je patrná hřbetní mícha, její dorsální provazce, intumescencia cervicalis a intumescencia lumbalis, conus medullaris, sulcus medianus posterior; v krčním úseku a v části hrudního úseku jsou zřetelné fasciculus gracilis a fasciculus cuneatus; ze sulcus posterolateralis vystupují zadní míšní kořeny a sbíhají se s předními kořeny v míšní nervy, které jsou na obraze označeny a procházejí skrze dura mater: 8 párů krčních nervů (z toho první pár nad atlasem, 8. pár mezi obratli C7 a Th1), 12 párů hrudních nervů, 5 párů bederních nervů (pátý z nich vystupuje pod obratlem L5, mezi ním a kostí křížovou), 5 párů sakrálních nervů (pátý z nich vystupuje mezi ossacrum a os coccygis) a 1 pár (někdy 2 páry) kostrčních nervů (skrze hiatus sacralis); dura mater spinalis a ligamentum denticulatum jsou zvýrazněny zelenou barvou; není zakreslena arachnoidea (srov. text)



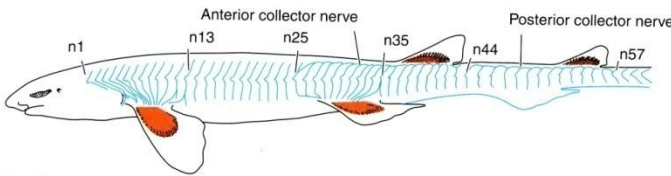
Průběh míšních nervů



A. Spinal nerves, somites, and associated structures of a 19-mm embryo of *Squalus*

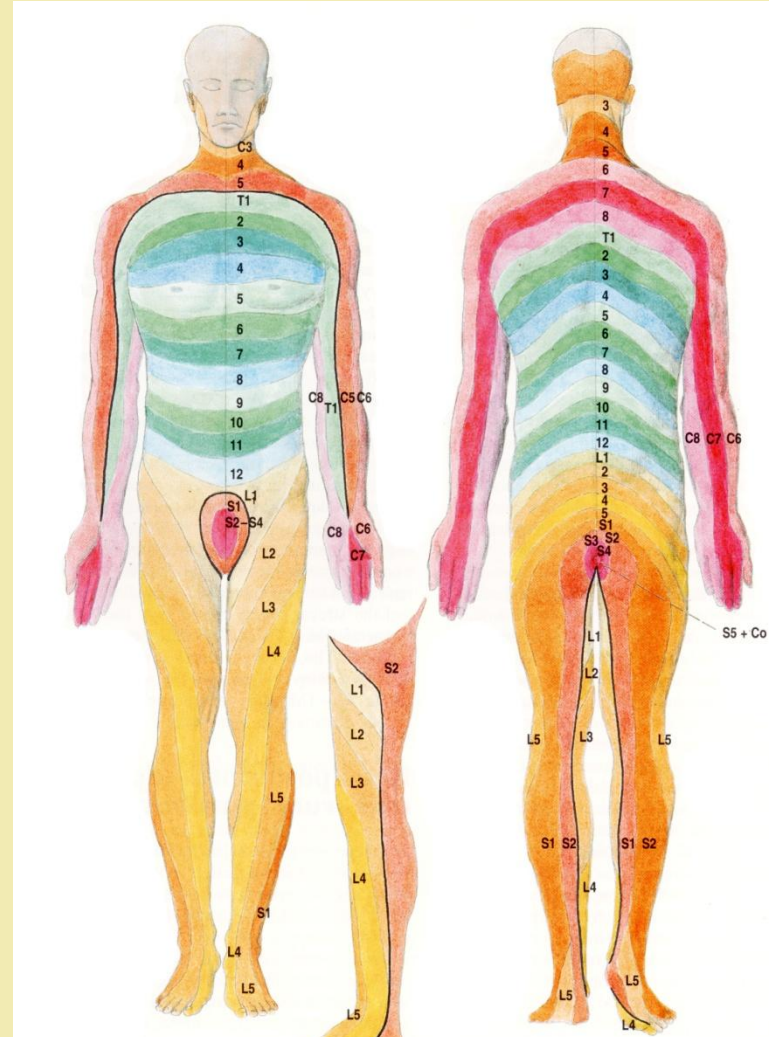


B. Hypothetical intermediate developmental stage

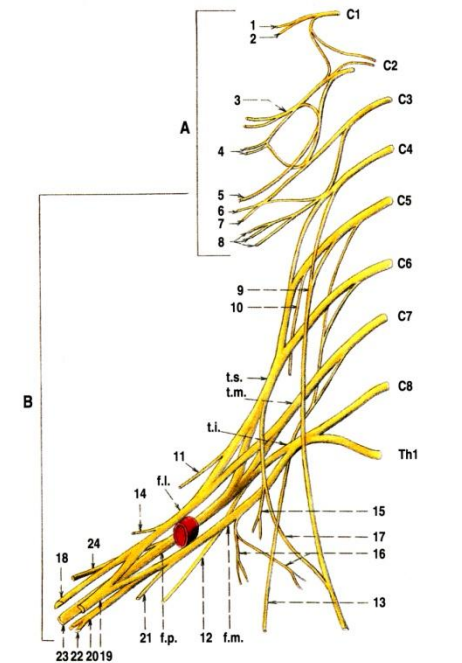
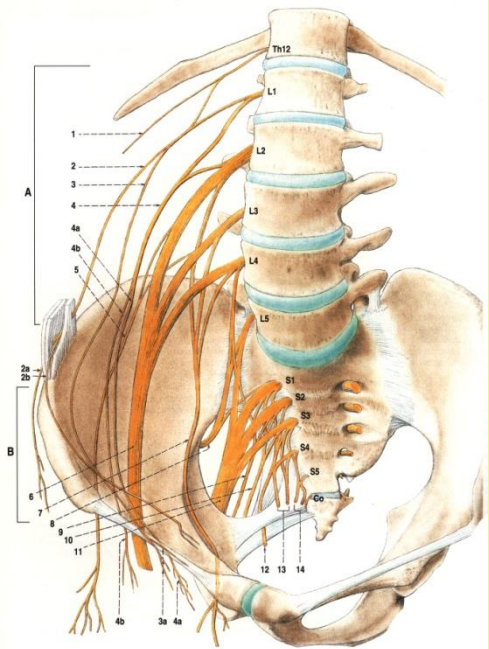


C. Spinal nerves of an adult *Squalus*

FIGURE 13-15
Nerves to fins of an elasmobranch. A, Spinal nerves, somites, and associated structures of a 19-mm embryo of *Squalus*. The nerves are indicated in blue; the muscles, in red. B, Hypothetical intermediate developmental stage. The nerves are indicated in blue; only the portions of the musculature in the fins are indicated in red. C, Spinal nerves of an adult *Squalus*. Note how the nerves bend toward the bases of the pectoral and pelvic fins. (Modified from Goodrich.)



Obr. 282. AREAE RADICULARES KŮŽE; podle Keegana a Garretta (1948) z Gray's Anatomy (1980) – modifikováno; okrsky jednotlivých míšních nervů jsou označeny písmenem a číslem nervu a odlišeny barevně



Prodloužená mícha – Medula oblongata

Princip organizace

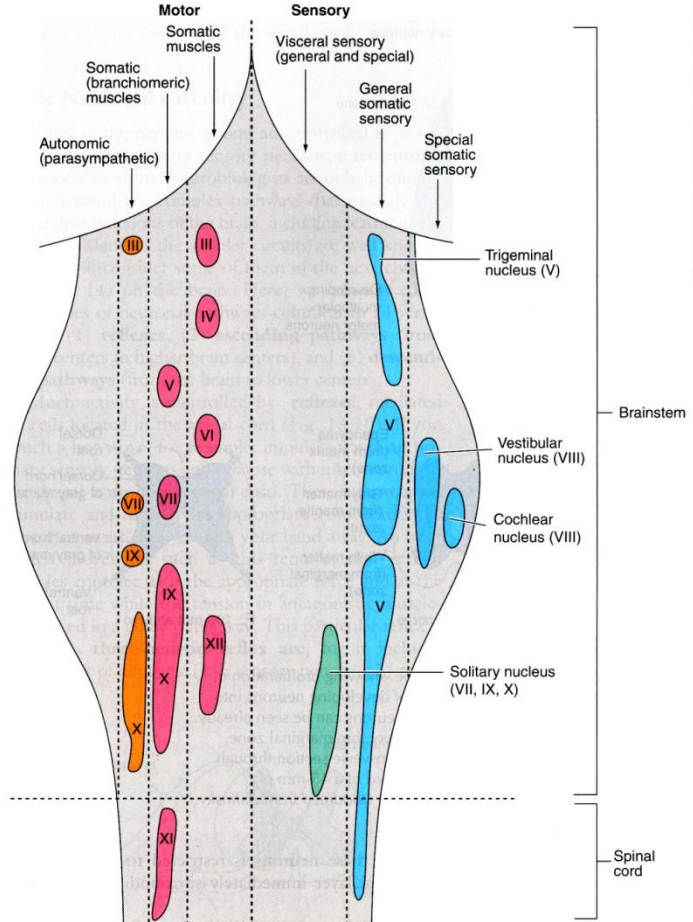
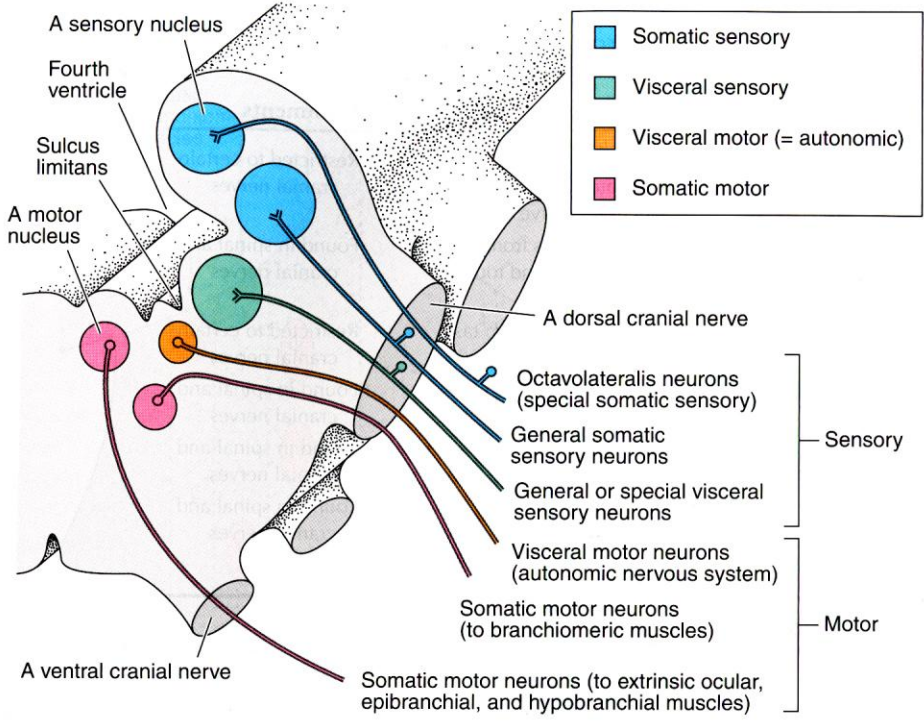
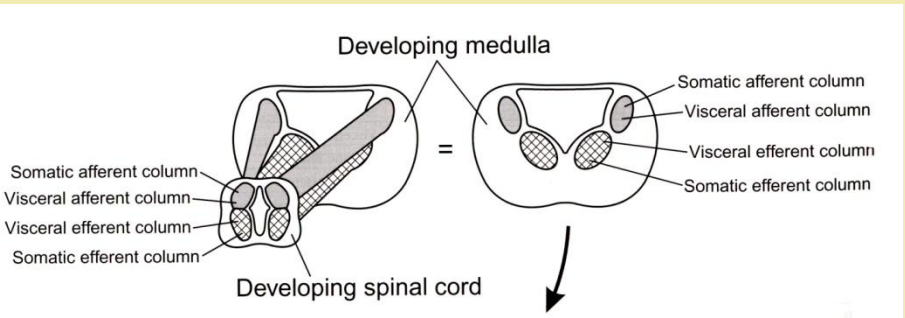
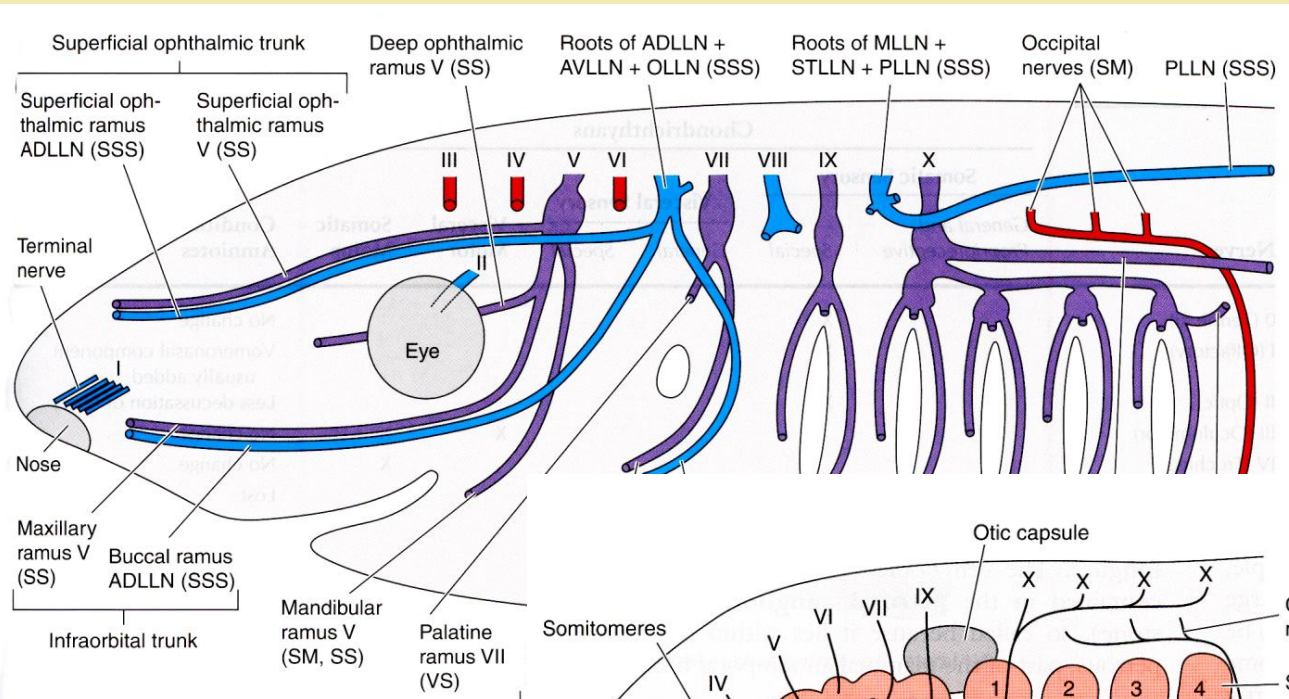


FIGURE 13-8
Dorsal view of cranial nerve nuclei in the brainstem of a mammal. Motor nuclei are shown on the left; sensory ones on the right. The nuclei are color coded as in Figure 13-6 to indicate the functional group to which they belong. Cranial nerves are identified by Roman numerals. Note that all of the autonomic nuclei in the brainstem are associated with the parasympathetic division.



Hlavové nervy – ancestrální uspořádání

Demonstrováno na modelu žraloka



A. General plan of cranial nerves of a gnathostome

FIGURE 13-18

The cranial nerves and their major branches in a spiny dogfish (*Squalus*) and coelacanths (*Latimeria*) omits others in order to emphasize general pattern abbreviations; see Table 13-4. A, General plan of treat the six lateral line nerves (ADLLN, AVLLN, C other cranial nerves, but we have adopted the res ontogenetically and phylogenetically distinct cran C, Detail of the major r. arrangement of the pharyngeal, pretrematic, and p motor, SS = somatic sensory, SSS = special soma VS = visceral sensory. (See Northcutt and Bemis,

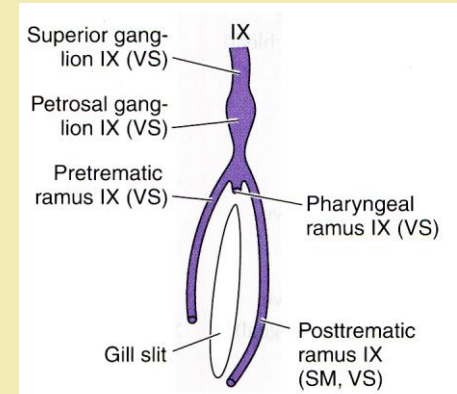
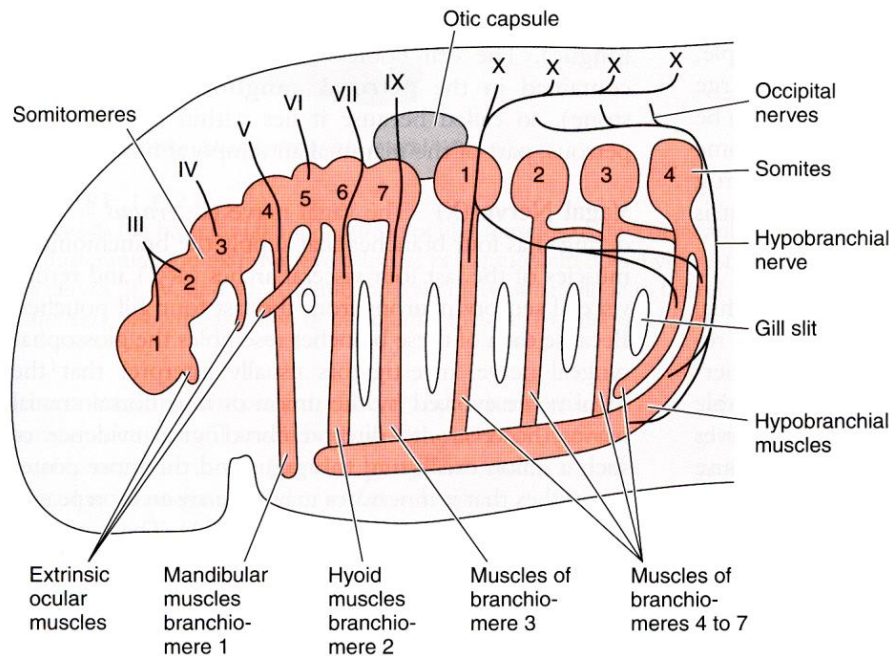


FIGURE 13-20

Relationship between cranial nerves, somitomeres, somites, and visceral arches during the development of the head of an early vertebrate. Nerves are identified by Roman numerals, and somitomeres and somites, by Arabic numerals. (Modified from Northcutt.)



Hlavové nervy

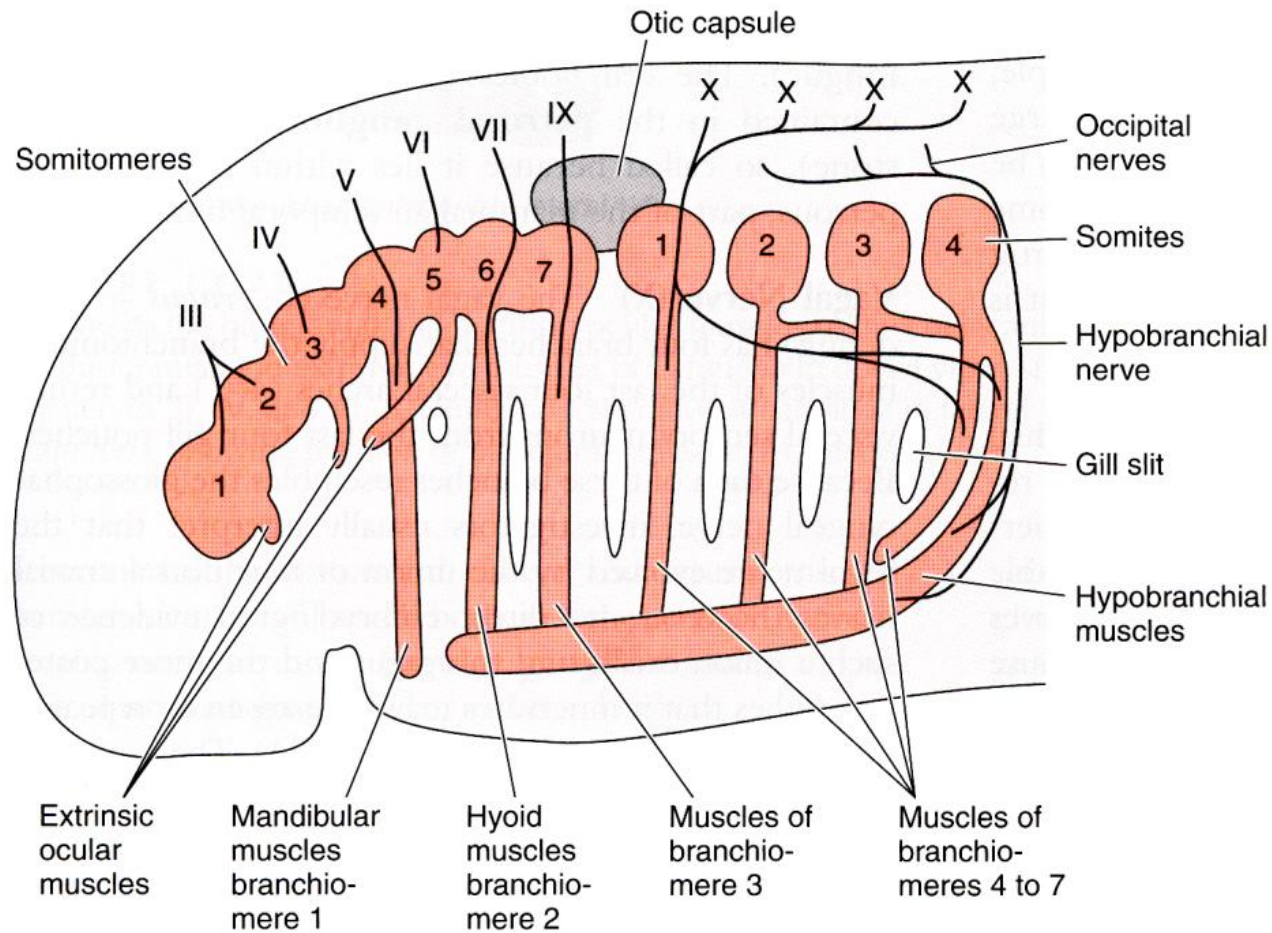
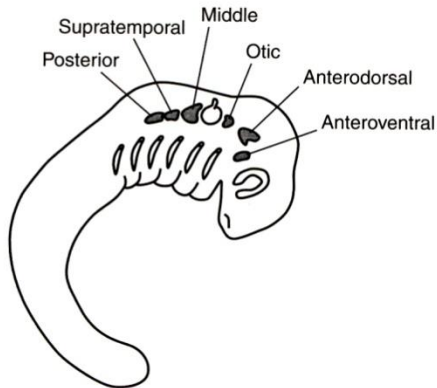


FIGURE 13-20

Relationship between cranial nerves, somitomeres, somites, and visceral arches during the development of the head of an early vertebrate. Nerves are identified by Roman numerals, and somitomeres and somites, by Arabic numerals. (Modified from Northcutt.)

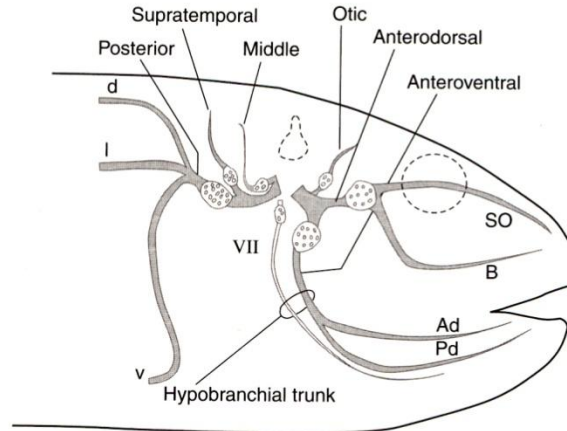
Hlavové nervy – původ nervů boční čáry a situace u amniot

Dorsolateral Placodes

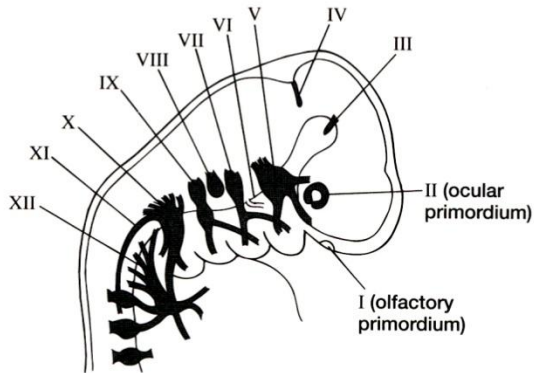


(a)

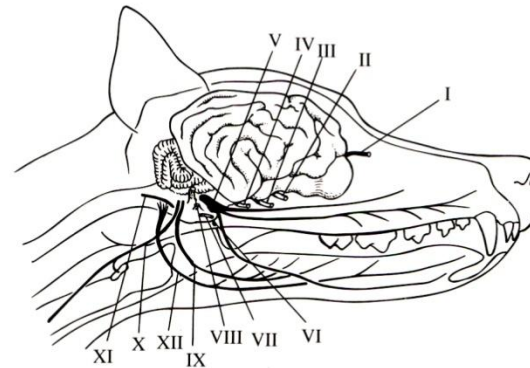
Lateral Line Nerves



(b)



(c) Fetal dog

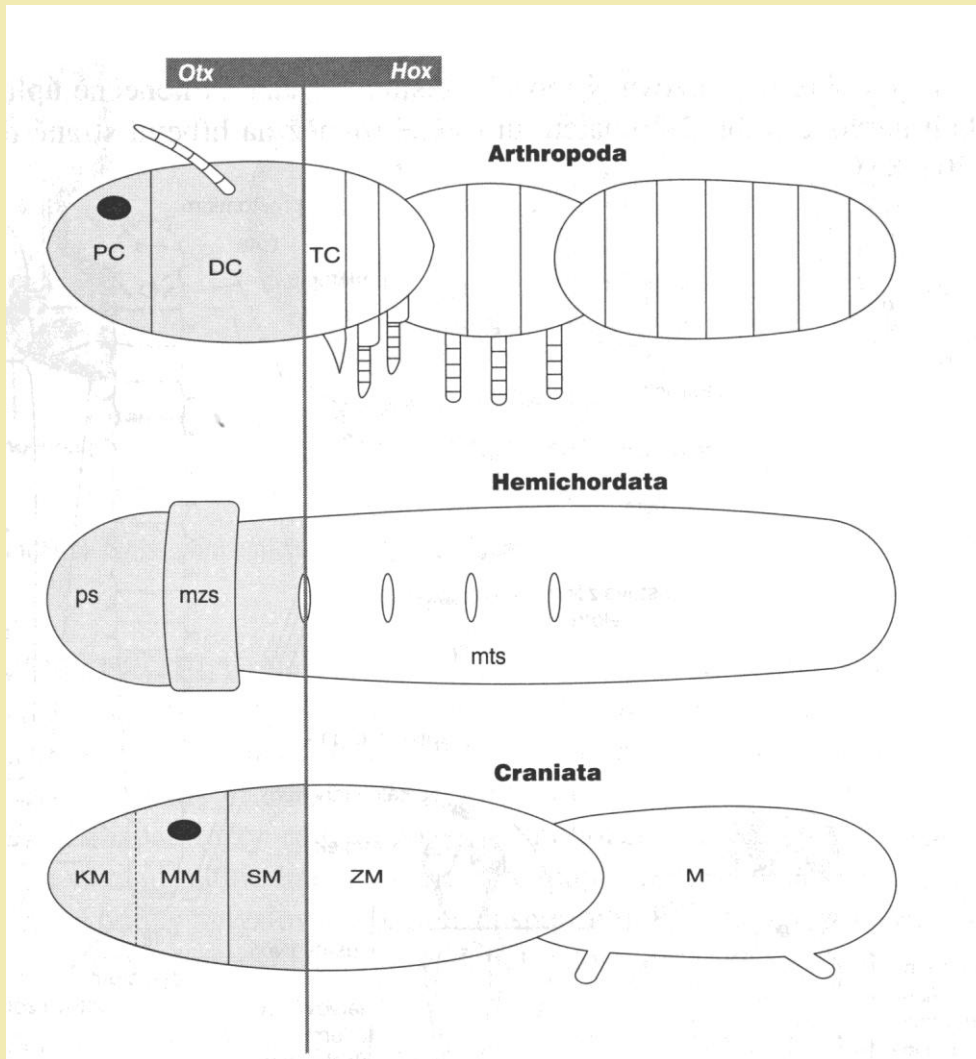


(d) Adult dog

FIGURE 16.13 Embryonic development of cranial nerves. (a) The lateral line cranial nerves arise from the dorsolateral placodes. (b) Generalized number and innervation pattern of lateral line nerves in jawed fishes. Ganglia are represented by expanded areas with small circles inside. Relative position of eye (dashed circle) and otic vesicle (dashed pear-shape) are indicated. Hypobranchial trunk includes the lateral line nerve and the facial cranial nerve VII. (c) Fetal dog. (d) Adult dog. The posterior lateral line nerve has three rami: dorsal (d), lateral (l), and ventral (v). The anterodorsal lateral line nerve has two major rami: the superficial ophthalmic (SO) and buccal (B). The anteroventral lateral line nerve produces two major rami: the anterior (Ad) and posterior (Pd) divisions.

(b) After Northcutt.

Aktivita regulačních genů a homologie mozku členovců a obratlovců



Hranice Otx/Hox:

odpovídá hranici

deuterocephalum / tritocerebrum

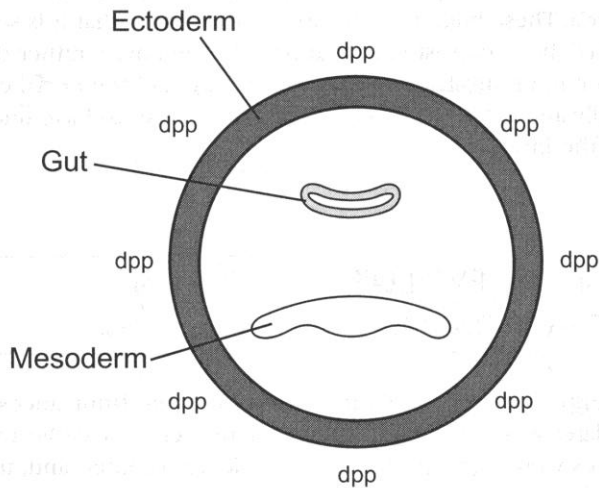
střední mozek / zadní mozek



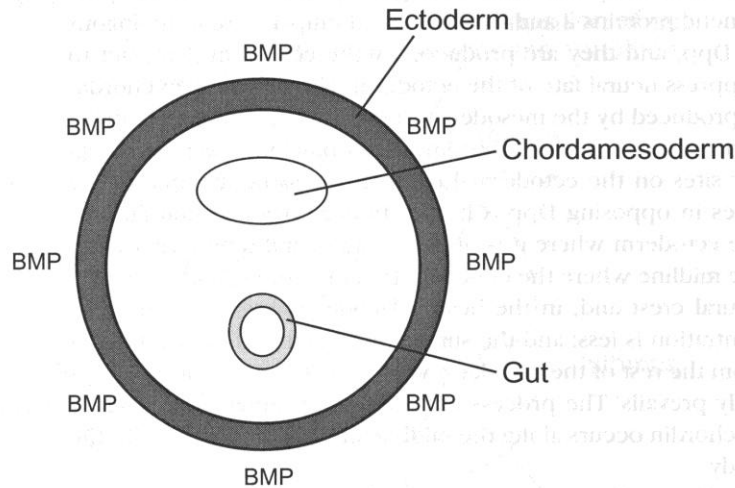
Aktivita regulačních genů a homologie mozku členovců a obratlovců

Indukce diferenciaci nervové tkáně

Drosophila



Vertebrate



Moucha:

dpp
(decapentaplegic)

+

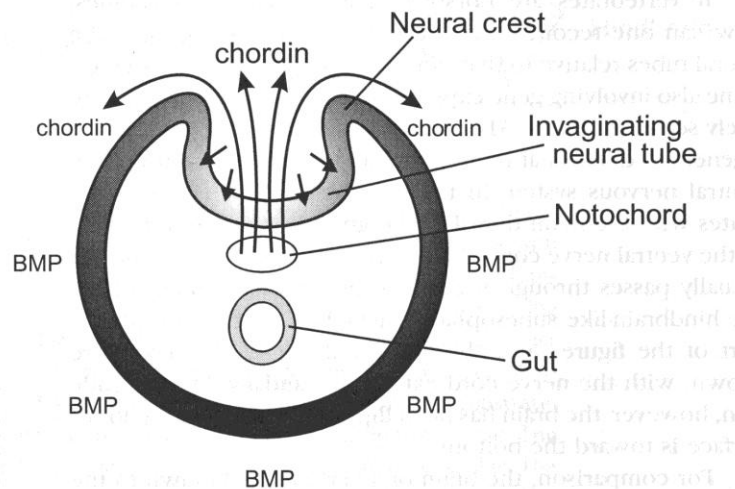
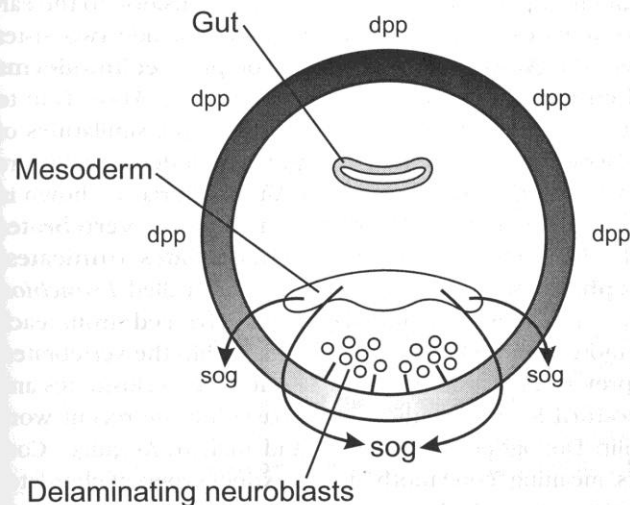
sog
(short gastrulation)

Myš:

BMP2 a 4

(bone morphogenic protein)

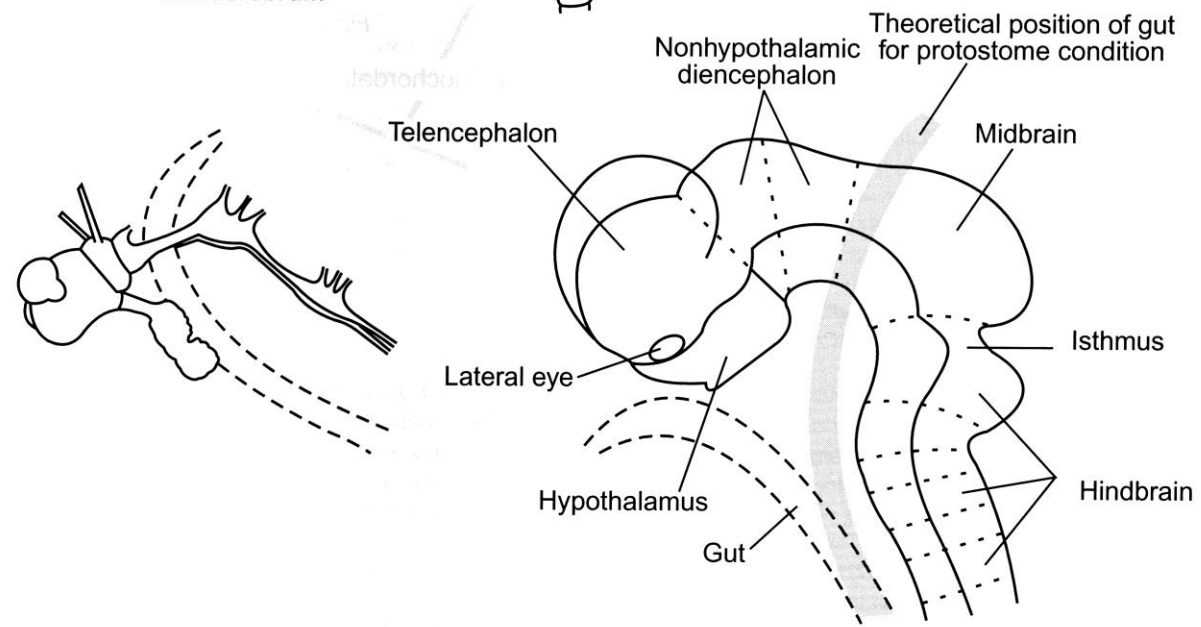
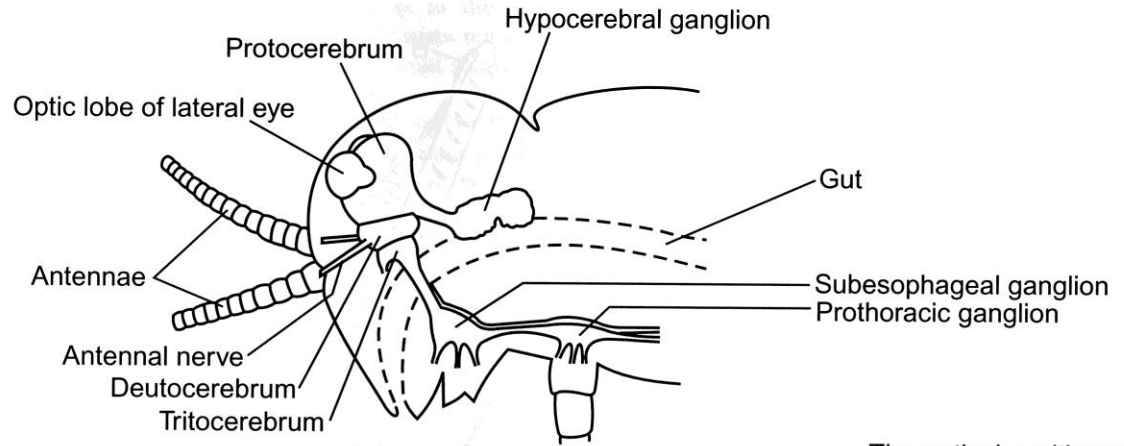
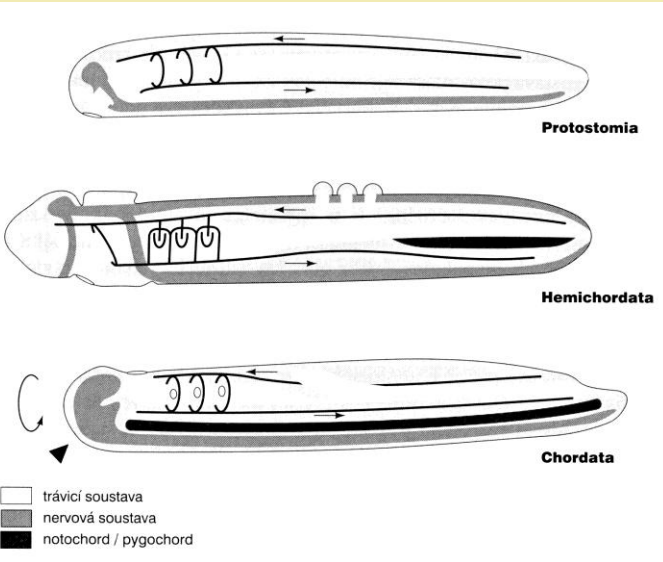
Chordin



Aktivita regulačních genů a homologie mozku členovců a obratlovců

Dorsoventrální inverze

Etienne Geoffroy Saint-Hilaire, 1822



dpp – hřbetní strana prvoústých

homologický BMP – břišní strana strunatců