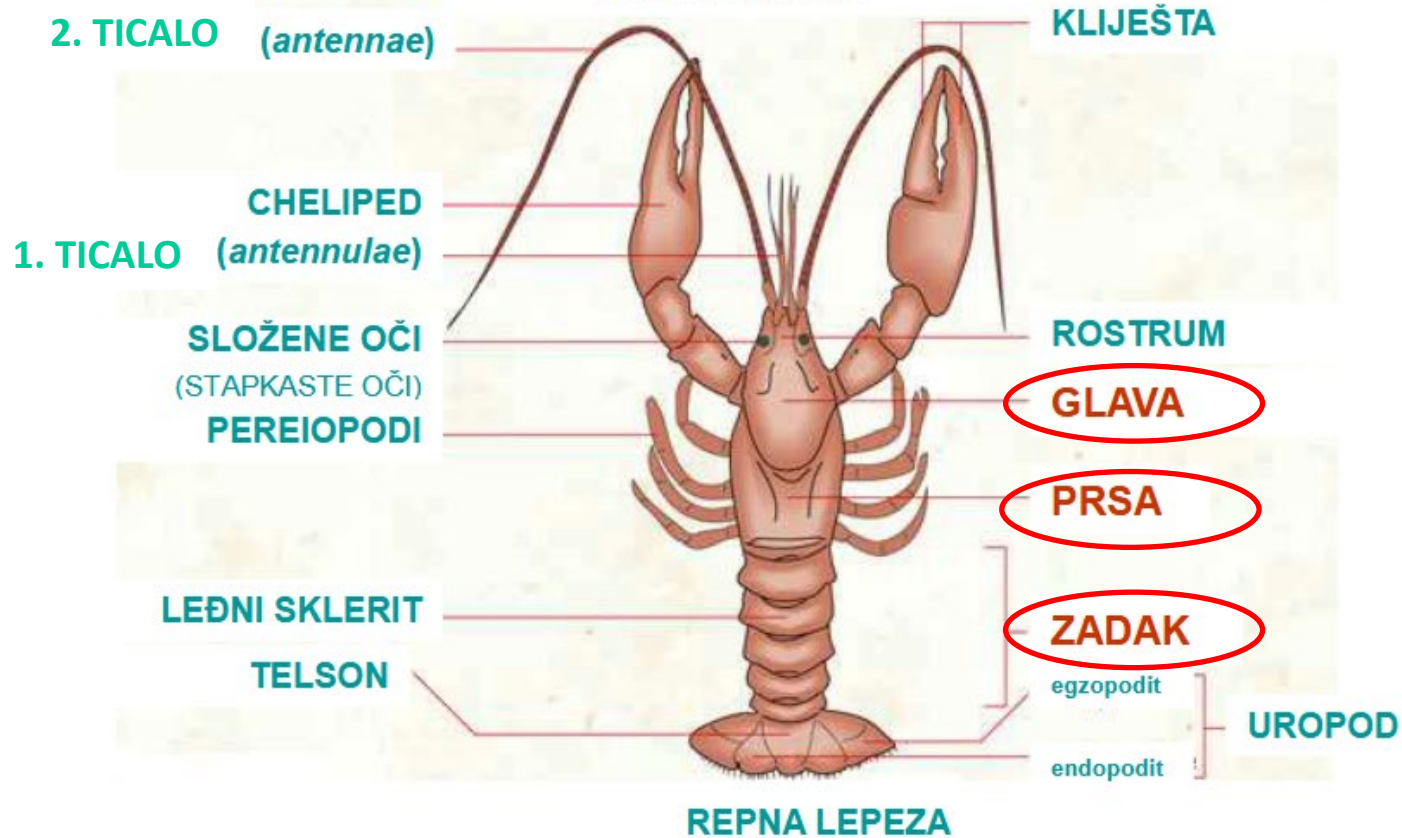


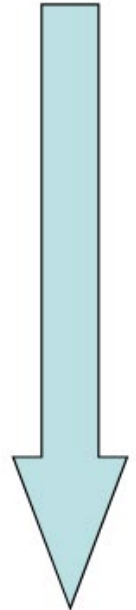
MALAKOLOGIJA I ASTAKOLOGIJA U NASTAVI BIOLOGIJE (208676) 2P+1V+0S 4 ECTS



Astacidae



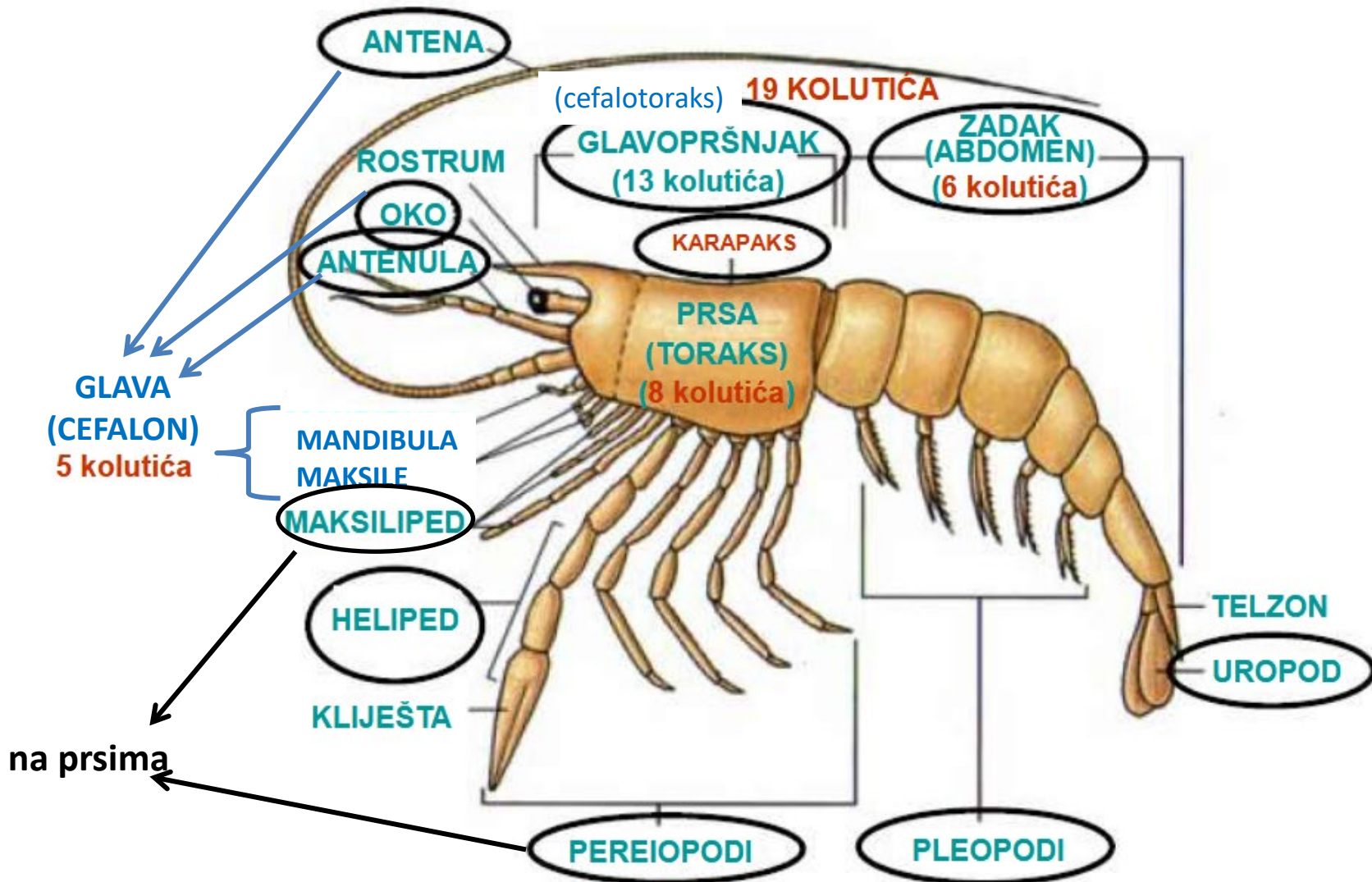
AKRON



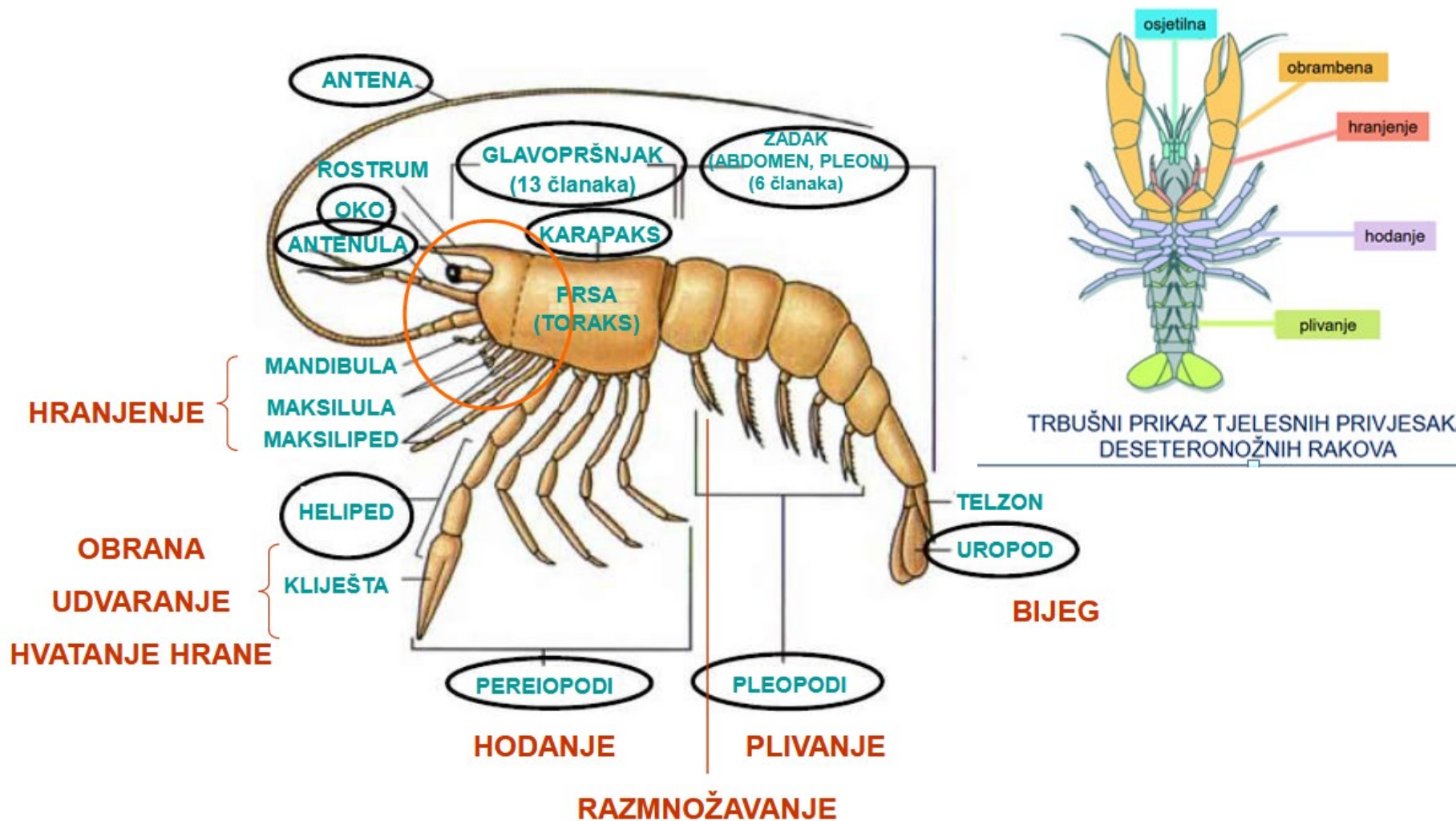
TELSON

CRUSTACEA – MALACOSTRACA - DECAPODA

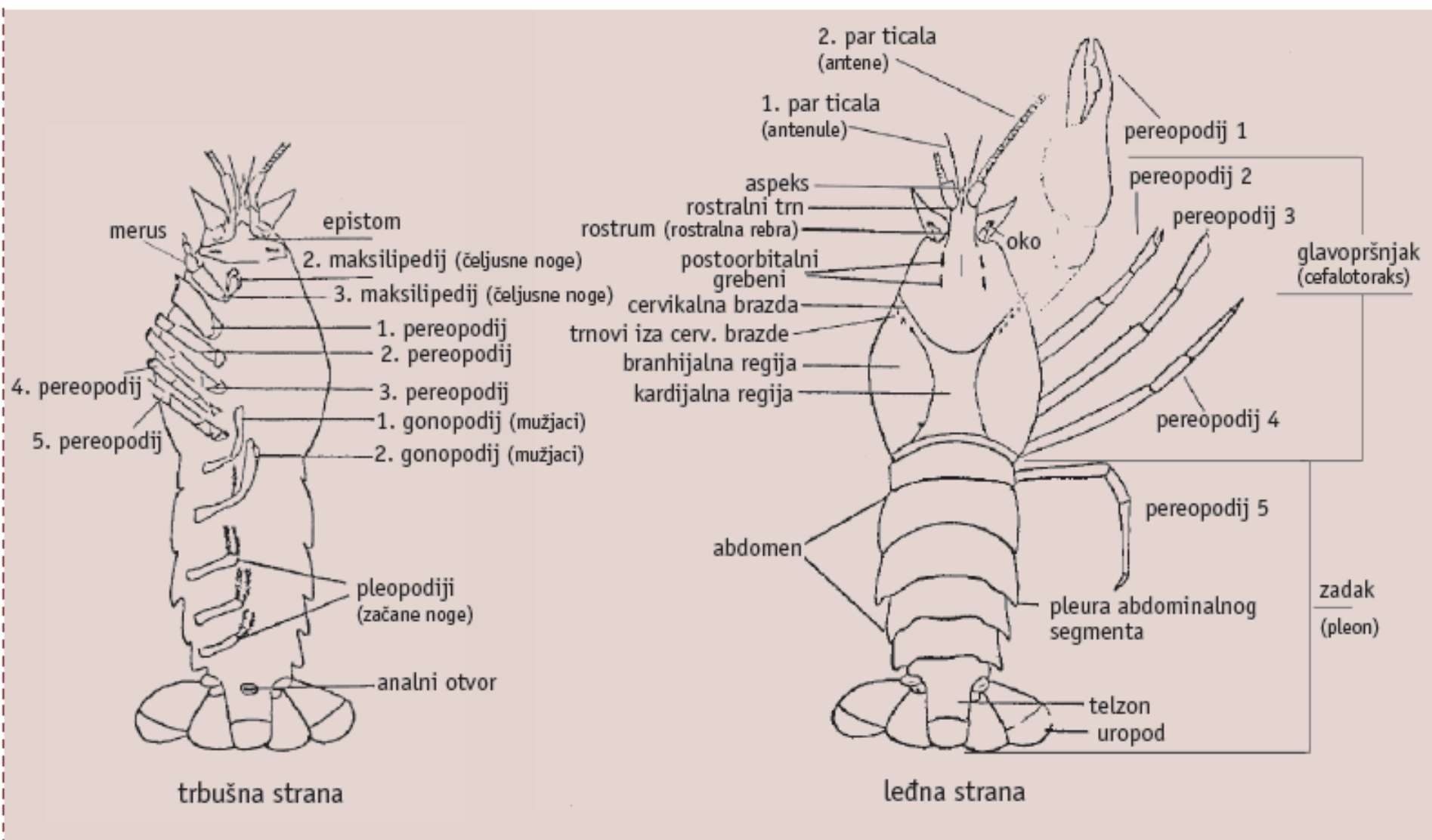
OSNOVNA MORFOLOGIJA



4. CRUSTACEA – DECAPODA – prilagodbe tjelesnih privjesaka



Dijelovi raka



Pokrovni sustav i Potporni sustav

▪ Jednoslojna epiderma (hipoderma)

- na površinu izlučuje čvrstu hitinsku kutikulu koja je u rakova impregnirana s CaCO_3

- kutikula od 2 sloja:

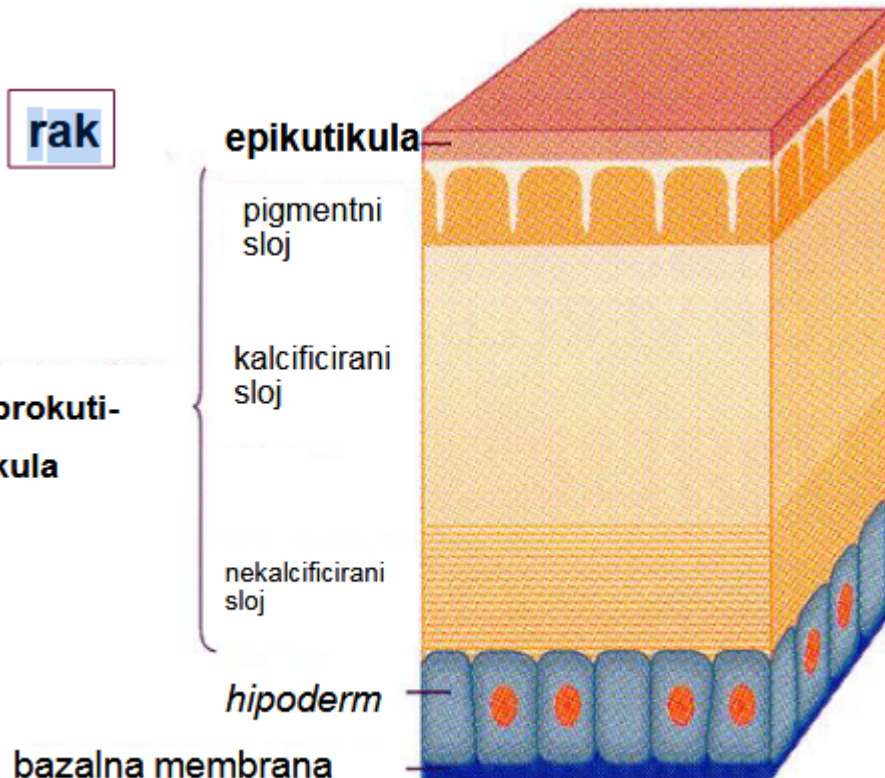
EGZOSKELET

(vanjski skelet)

- **epikutikula** - vanjski bezhitinski (proteini, lipidi i vosak)

- **prokutikula** - unutarnji (deblji), od više slojeva, uglavnom građena od hitina

- od epiderma do površine kutikule prolaze brojne cjevčice

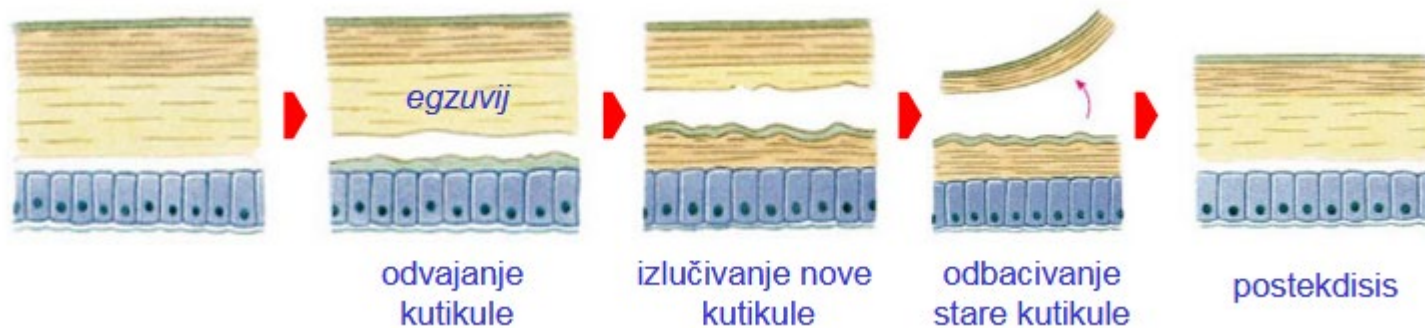


nedostaci: ograničava rast !!

Presvlačenje kod rakova

- učestale mitotičke diobe epiderma (hipoderma)
- nabiranje epiderma (hipoderma) odvajanje kutikule (**apoliza**)
 - u šuplji prostor između nove i stare kutikule (**egzuvij**) epidermalne stanice izlučuju egzuvijalnu tekućinu
 - stari egzoskelet puca i životinja s tankom i mekanom kutikulom izlazi iz egzuvija
 - cijeli proces se zove **ekdisis** i reguliran je hormonima

• presvlačenjem upravljaju hormoni (ekdison)

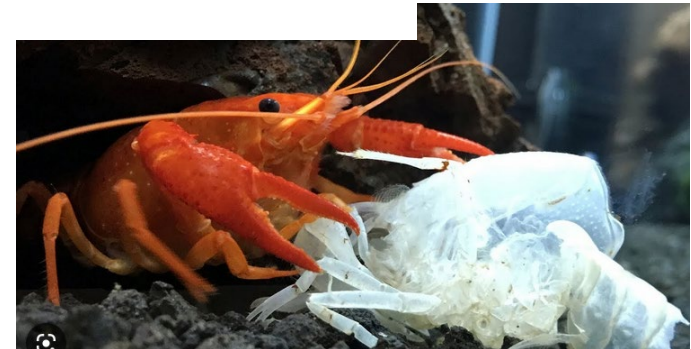


- hormoni izazivaju mitotičku diobu epidermalnih stanica što izaziva nabiranje epiderma i odvajanje kutikule (**apoliza**),
- u nastale šuplje prostore (između tijela i stare kutikule - **egzuvij**) epidermalne stanice luče egzuvijalnu tekućinu

- presvlačenje i izlaženje iz *egzuvija* nazive se **ekdisis** (mladi stadiji imaju tzv. presvlačni šav na leđnoj strani po kojem egzoskelet pukne i iz njega životinja izlazi iz egzuvija)

izlučuje se nova kutikula

<https://www.youtube.com/watch?v=WZP1fFKZ2Fs>



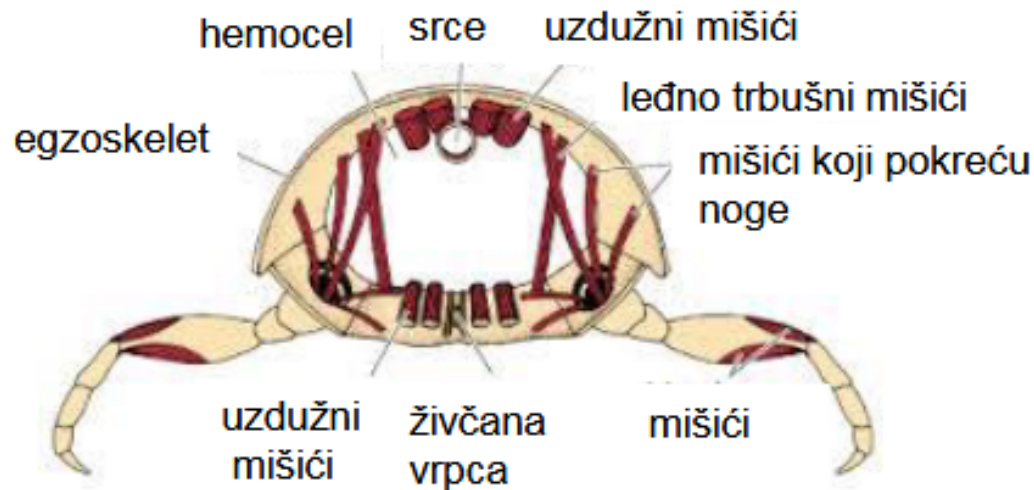
Mišićni sustav

GLATKO MIŠIĆNO TKIVO

- gradi stijenke unutrašnjih organa (dišnih, probavnih, krvnih žila, izvodnih cijevi žlijezda, mokraćovoda, spolnih organa i dr.)

POPREČNO PRUGASTO MIŠIĆNO TKIVO

- skeletni i utrobni mišići

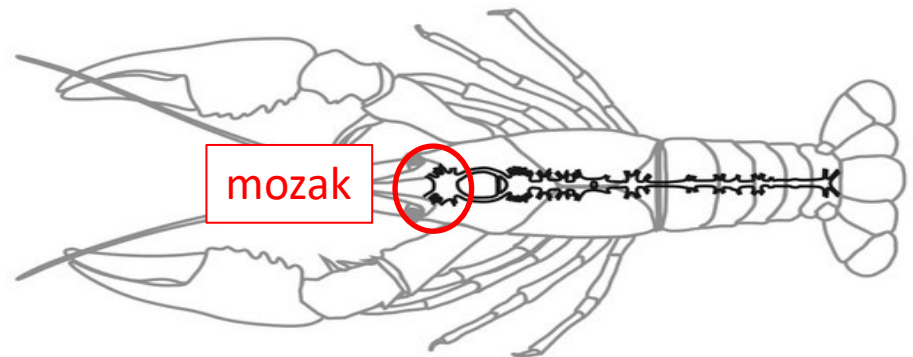
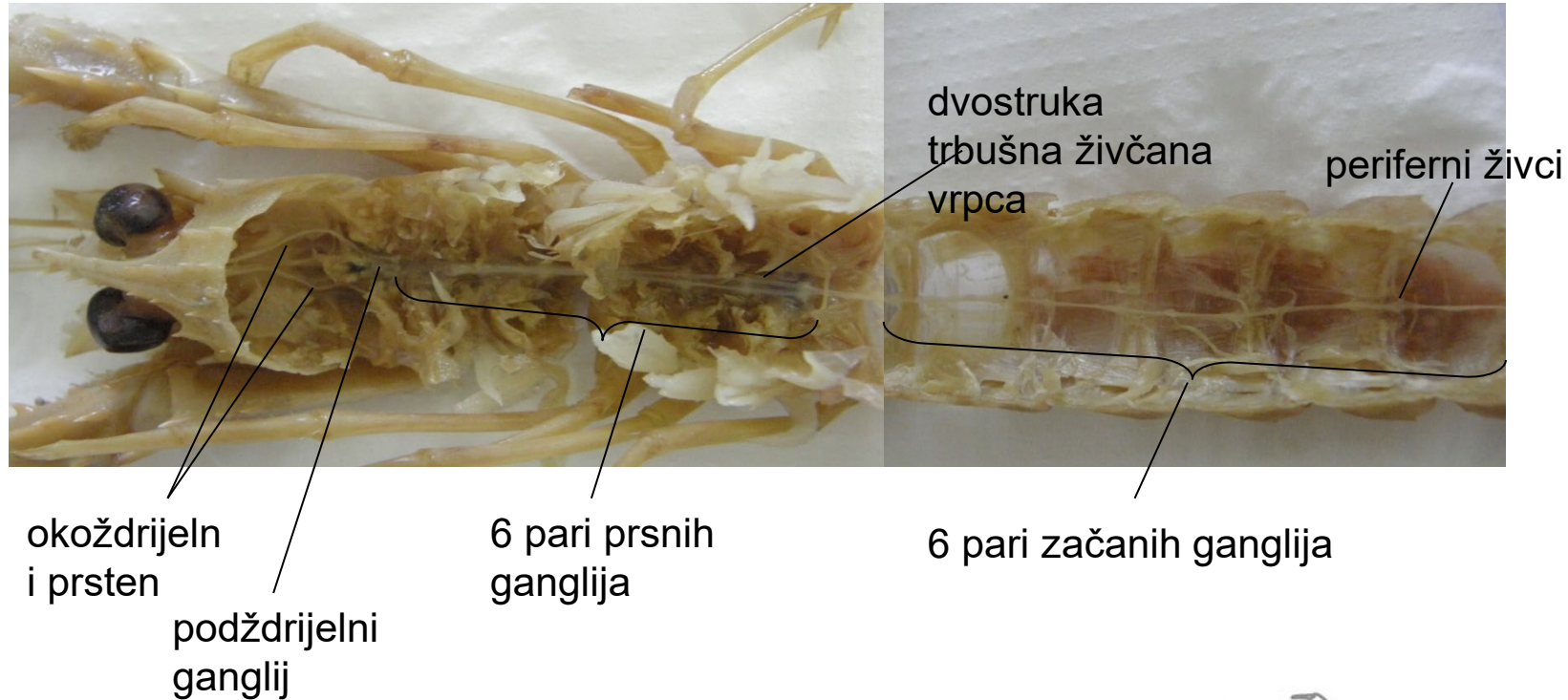


Živčani sustav

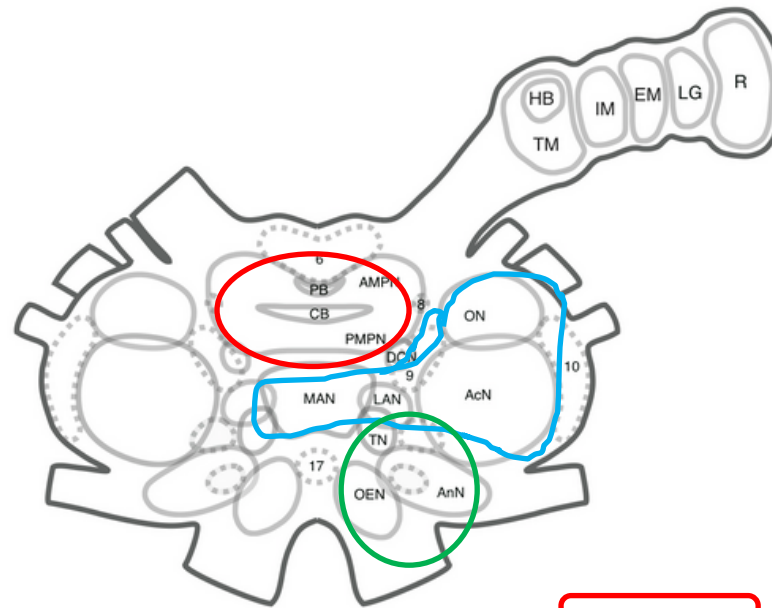
- postupno sjedinjavanje živčanog sustava u uzdužnom i poprečnom pravcu
- Gangliji u parovima (poprečno povezani komisurama, uzdužno konektivama)

Živčani sustav - položen trbušno/ventralno

- postupno sjedinjavanje živčanog sustava u uzdužnom i poprečnom pravcu
- Gangliji u parovima (poprečno povezani komisurama, uzdužno konektivama)



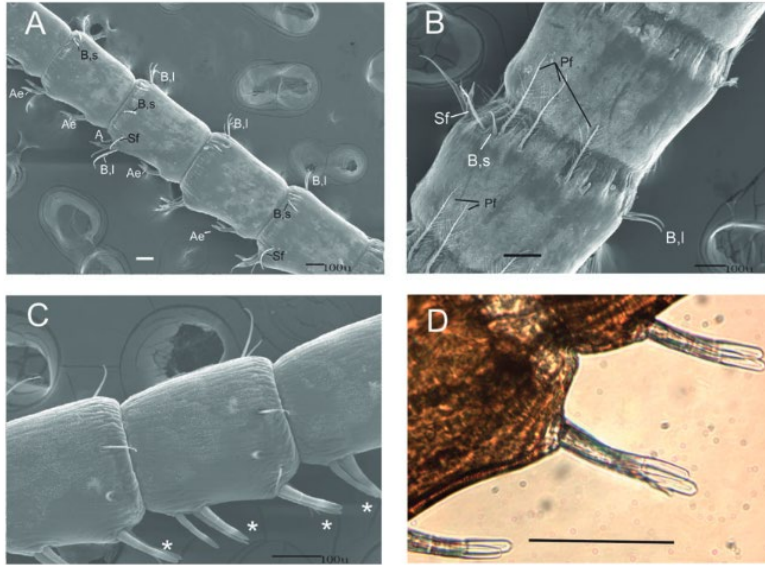
- Mozak (nakupine ganglija): protocerebrum, deutocerebrum, tritocerebrum



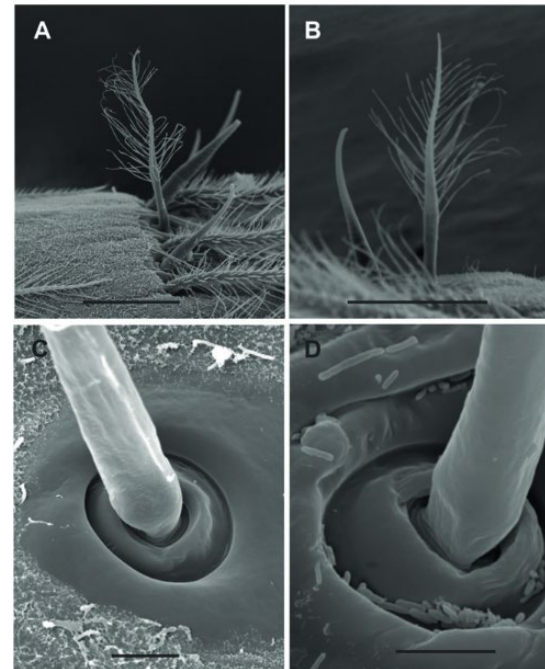
		lateral protocerebrum	
		R	retina
		LG	lamina ganglionaris
		EM	external medulla
		IM	internal medulla
		HB	hemiellipsoid body
		TM	terminal medulla
	medial protocerebrum		
	PB	protocerebral bridge	
protocerebrum	AMPN	anterior medial protocerebral neuropil	
	CB	central body	
	PMPN	posterior medial protocerebral neuropil	
	ON	olfactory lobe	
deutocerebrum	DCN	deutocerebral commissure neuropil	
	MAN	median antenna I neuropil	
	LAN	lateral antenna I neuropil	
	AcN	accessory lobe	
	TN	tegumentary neuropil	
tritocerebrum	AnN	antenna II neuropil	
	OEN	oesophageal neuropil	

Osjetni sustav

- Mnoštvo osjetni dlaka/setea po tijelu (antene, antenule) za kemijske i mehaničke podražaje



Osjetne dlake na antenama

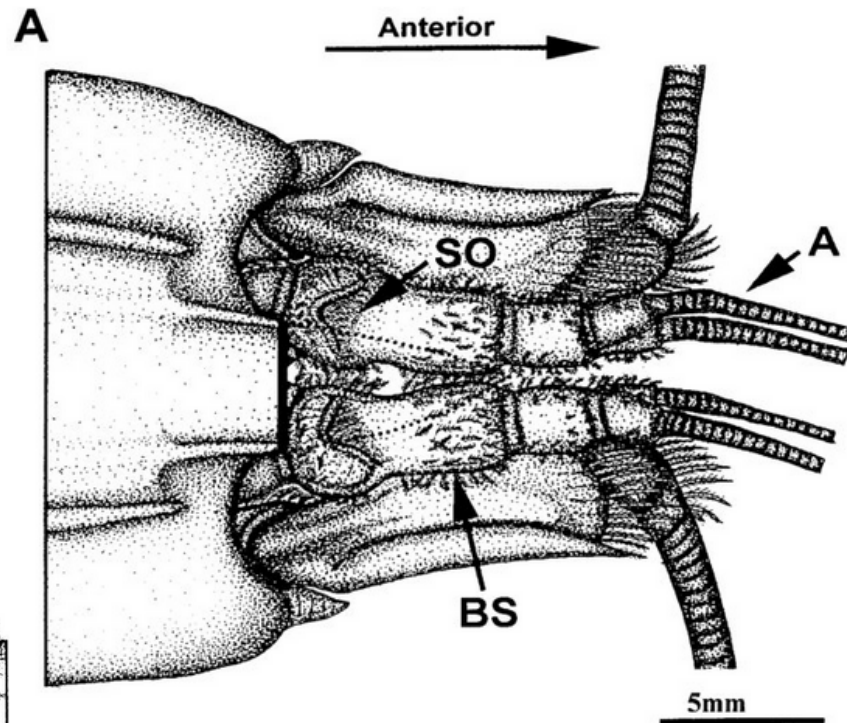
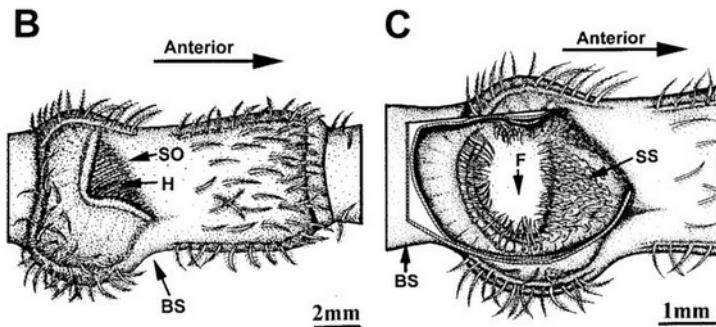
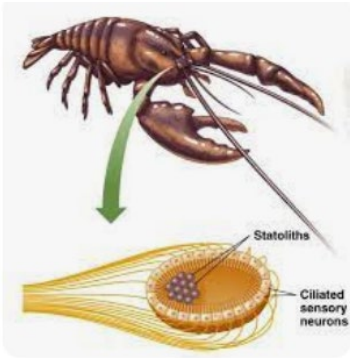


Smelling, feeling, tasting and touching: behavioral and neural integration of antennular chemosensory and mechanosensory inputs in the crayfish

J Exp Biol. 2012 ;215(Pt 13):2163-72

[DeForest](#)

- Statociste za ravnotežu (u bazi antenula)



Morfologija antenularne regije i statociste raka *Cherax destructor*. (A) Dorzalni pogled na **bazalni segment (BS) antenule** i mjesto **otvora statociste (SO)**. Rostrum i oči su uklonjeni. Položaj koji zauzima rostrum označen je točkastim linijama. (B) Veće povećanje bazalnog segmenta (BS) antenule prikazuje gustu mrežu četina (H) koja prekriva otvor statociste (SO). (C) **Kapsula statociste gledana kroz prozor izrezan u dorzalnoj kutikuli bazalnog segmenta (BS) antenule kako bi se otkrile četine (SS)** koje strše prema gore iz ventralnog dna (F) kapsule. Statolit, s kojim sve osim prednjih četina dolaze u kontakt, je uklonjen.

The Structure and Growth of the Statocyst in the Australian Crayfish *Cherax destructor*
2001 [Biological Bulletin](#) 199(3):251-6
Finley & MacMillan

OČI (fotoreceptori)

složene oči na stapkama (od mnoštva omatidija)

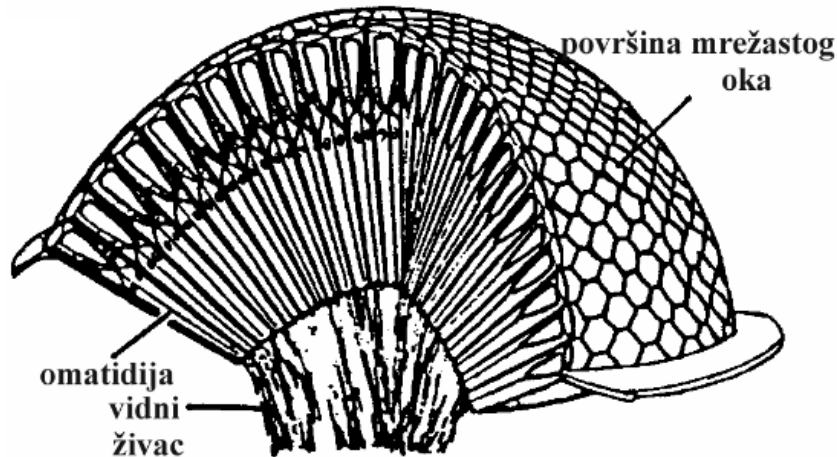
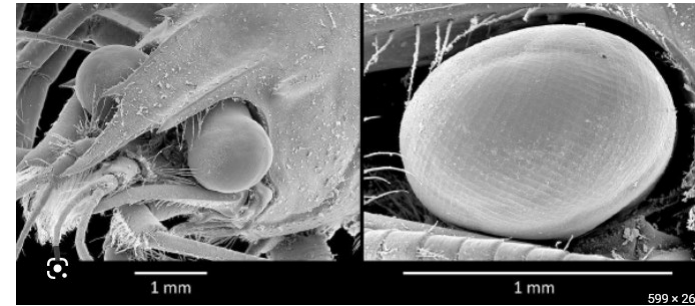
A) apozicijske oči - raci koji su aktivni danju

B) superpozicijske oči - raci aktivni noću

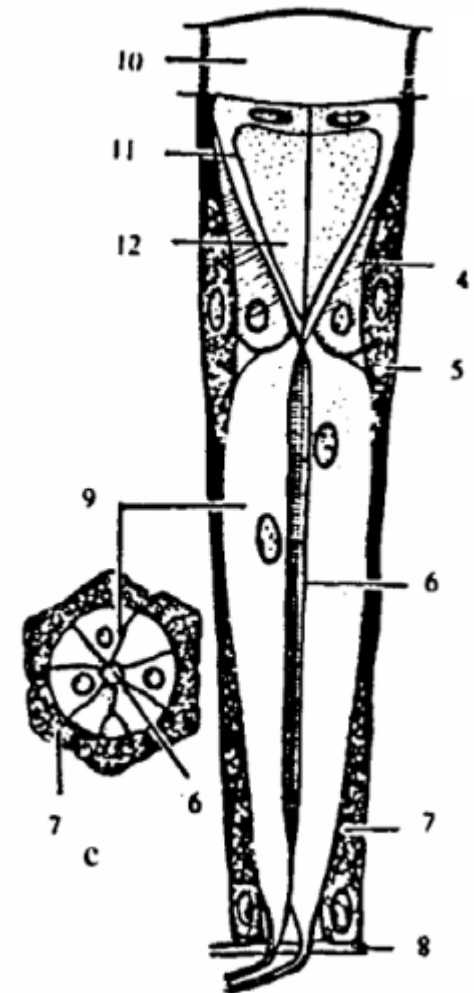
sastavljeno od velikog broja (do 30 000)

pojedinačnih očiju (omatidija) –

mozaičko gledanje (vide crvenu i plavu boju)



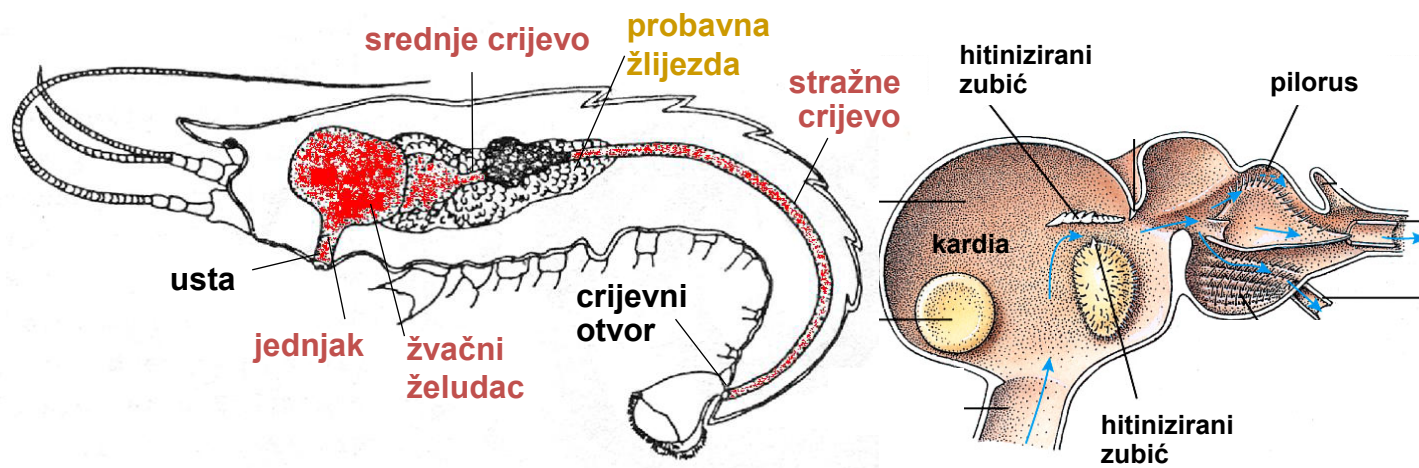
4 - matriksna stanica, 5 - pigmentna stanica, 6 - rabdom, 7 - pigmentna stanica, 8 - bazalna membrana, 9 – retinularna stanica, 10 - rožnica, 11 – kristalna stanica, 12 - kristalni čunj



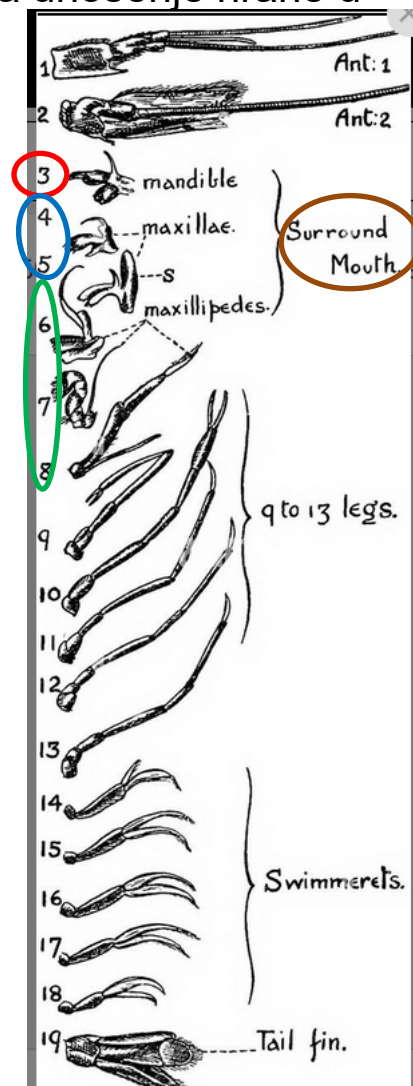
Probavni sustav

- Prohodno probavilo (prednje crijevo - **stomodeum** (sadrži: usta, jednjak i želudac), srednje crijevo – **mezenteron**, stražnje crijevo – **proktodeum**)

- uz usta imaju više pari **usnih organa** za primanje hrane: **mandibula** (gornja čeljust)(drobljenje hrane), **maxille** (donja čeljust) (2 para) i **maxillipedi** (čeljusne noge)(3 para) za unošenje hrane u usta

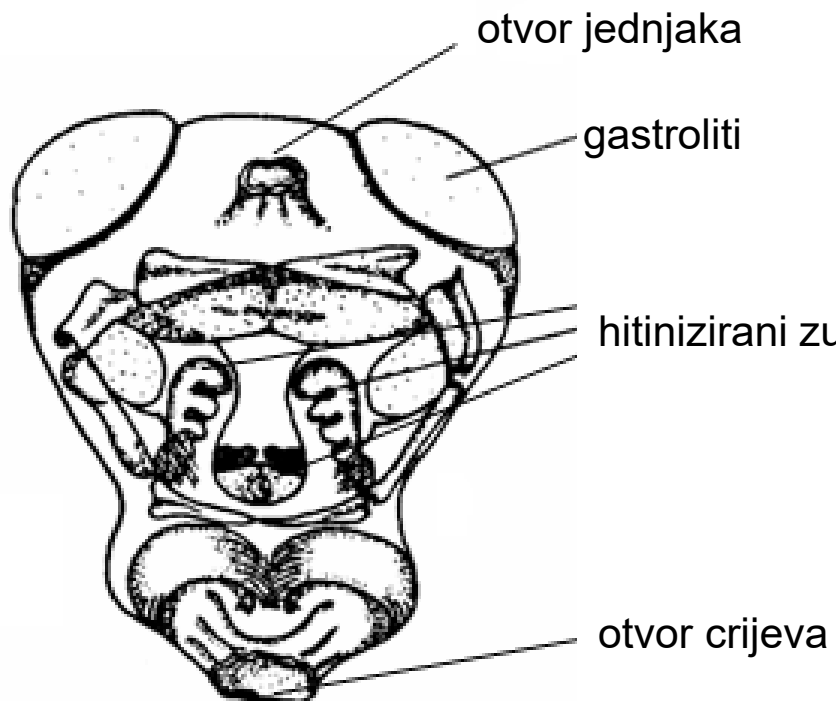


- u **žvačnom želucu** razlikujemo **kardijačni dio** (usitnjavanje hrane) i **pilorički dio** (sortiranje hrane) – u njega se ulijevaju probavni sokovi iz **probavne žlijezde** (hepatopankreas)



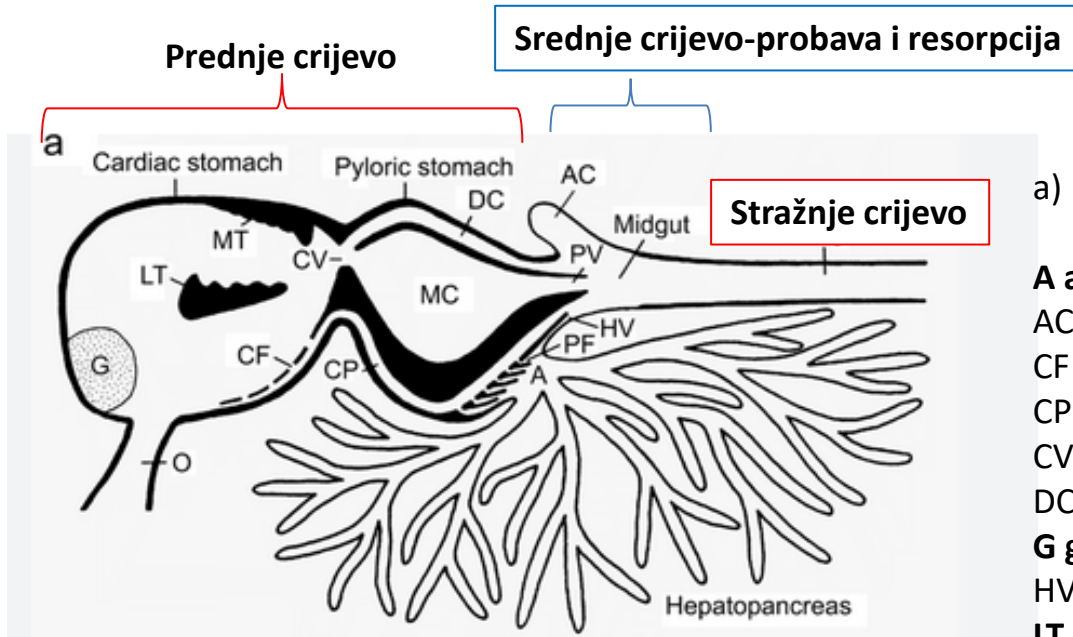
Žvačni želudac

- u **kardiačnom dijelu želuca** se nalaze tri hitinizirana zubića za drobljenje i usitnjavanje hrane, te gastroliti ("račje oči") koji predstavljaju zalihu CaCO_3 u organizmu (važno za presvlačenje rakova)



Žvačni želudac

- u piloričkom dijelu želuca se hrana sortira i u njega ulaze i probavni sokovi probavne žlijezde (hepatopankreasa)



- a) Prednje (jednjak, kardiačni i pilorički želudac) i stražnje crijevo) **su presvučeni kutikulom.**

Atrij hepatopankreasa

AC anterior dorsal caecum,

CF cardiac filter,

CP cardiopyloric filter channel,

CV cardiopyloric valve,

DC dorsal pyloric chamber,

G gastrolit,

HV hepatopancreatic-intestinal valve,

LT lateralni zubić,

MC pilorički dio,

MT središnji zubić,

O jednjak (oesophagus),

PF pilorički filter (sortiranje hrane),

PV pyloro-intestinal valve (modified after Vogt 2002).

Structure, function and development of the digestive system in malacostracan crustaceans and adaptation to different lifestyles

Springer

September 2019 · Cell and Tissue Research 377(3)

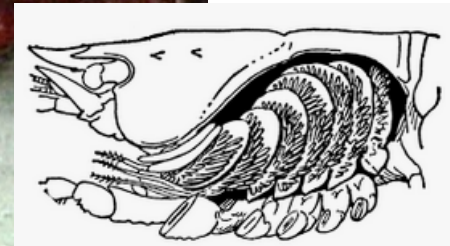
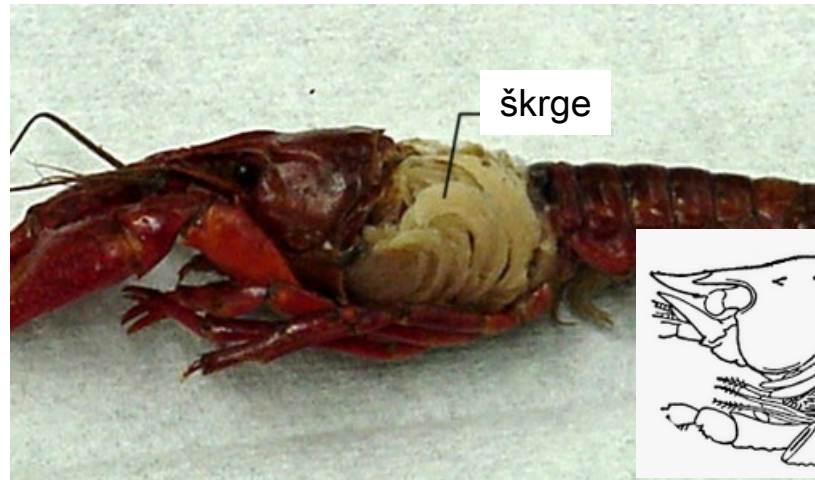
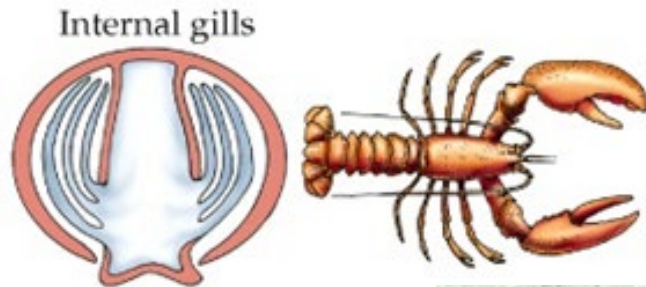
DOI: 10.1007/s00441-019-03056-0

Lab: Jasna Strus's Lab

Jasna Strus · Nada Znidaršič · Polona Mrak · Show all 5 authors · Günter Vogt

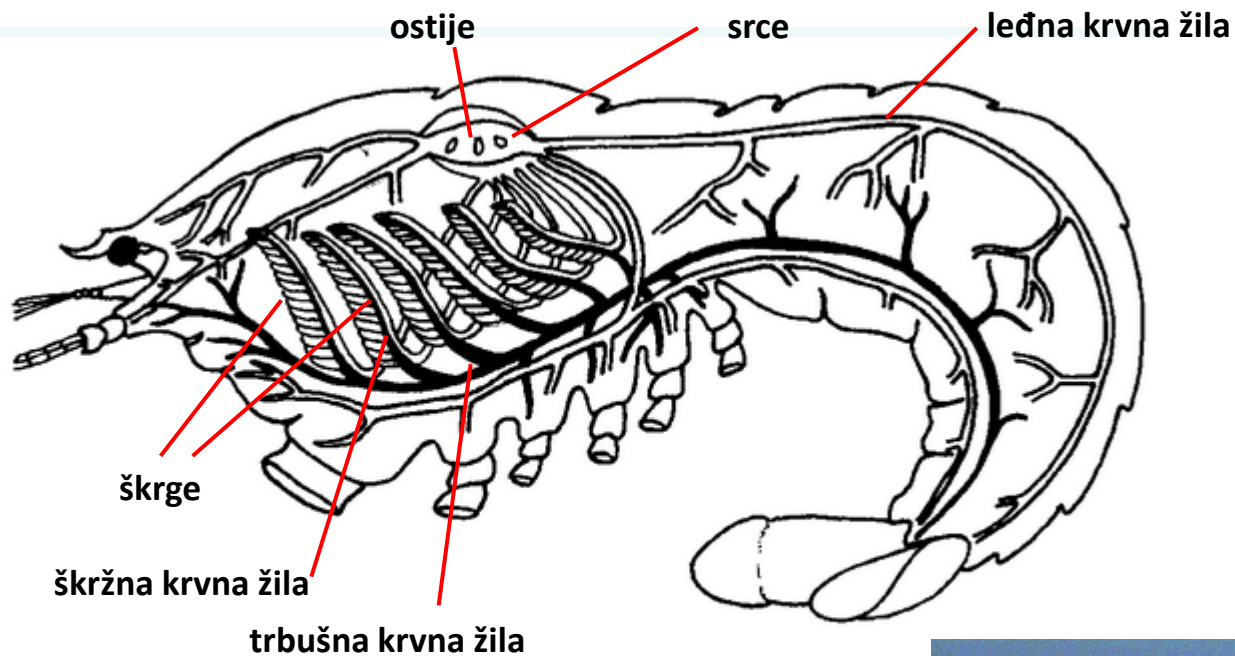
Dišni sustav

- unutrašnje škrge
- Škrge trihobranhijatne -mnoštvo radijalnih nerazgranatih tubularnih filamenata

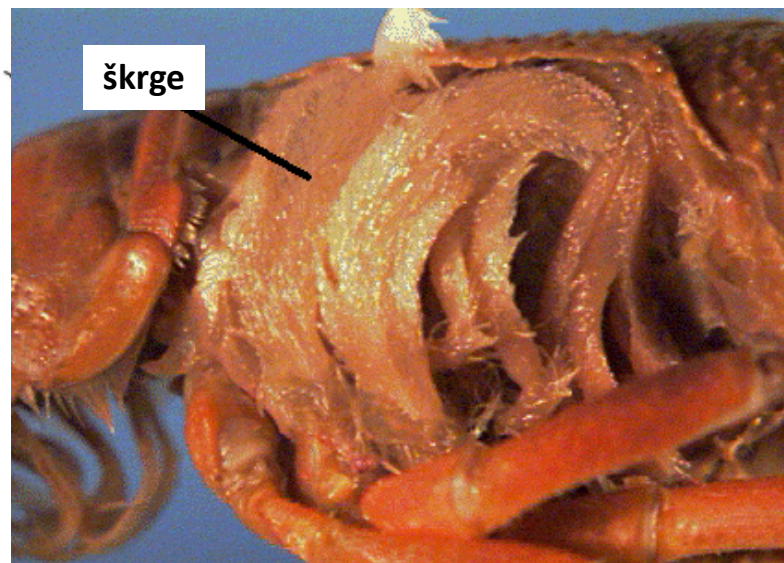
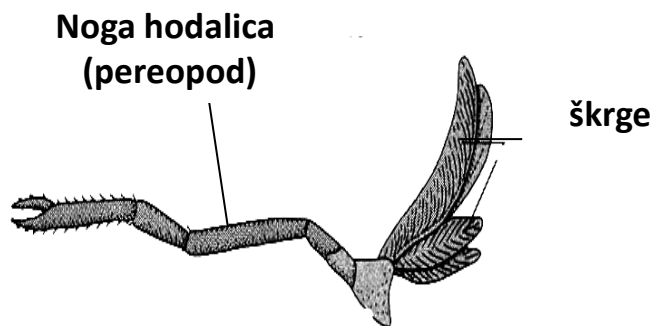


Rasperjane (resaste) škrge

- ispod karapaksa, na osnovici svih nogu hodalica



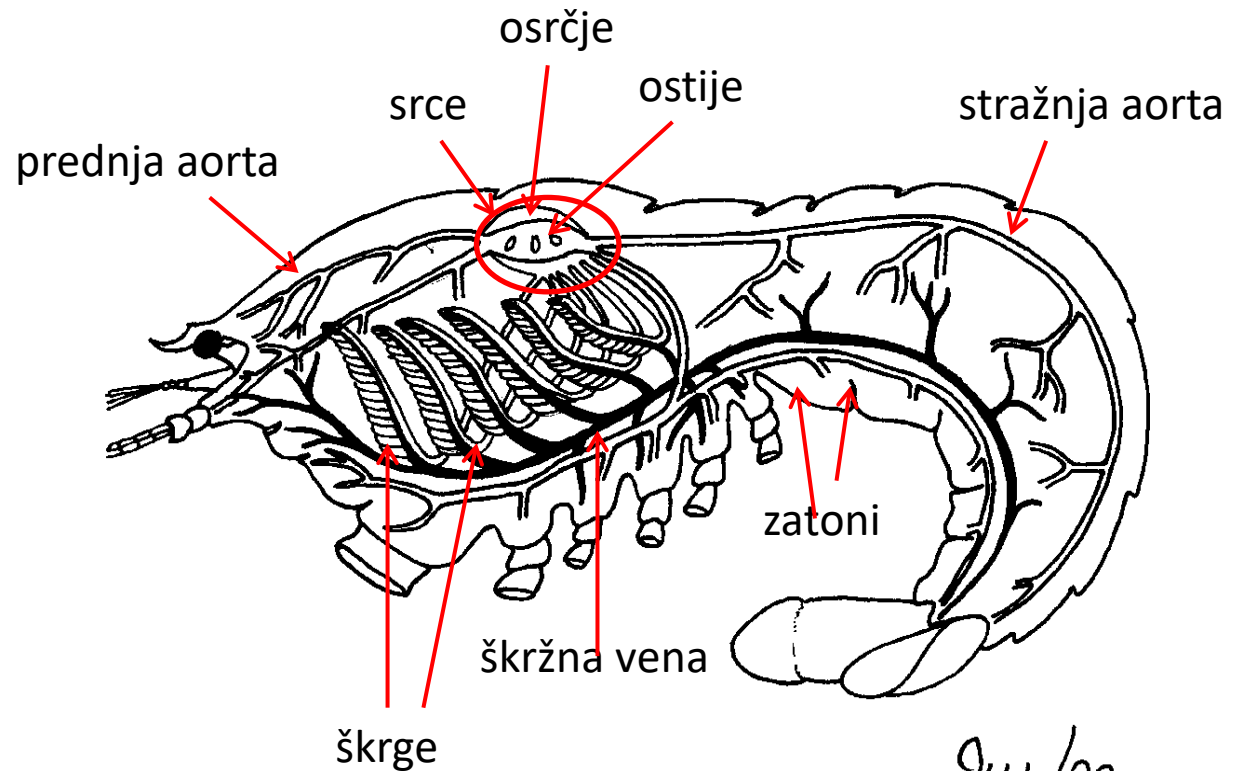
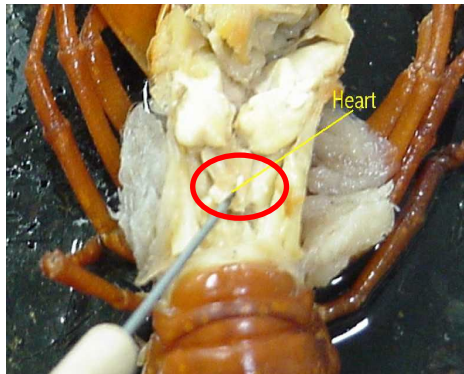
I.Livingstone © BIODIDAC



Optjecajni sustav

- OTVOREN OPTJECAJNI SUSTAV – nema kontinuiteta žila
- Hemolimfa
- Hemocel (sinusi ili zatoni (veći) i lakune (manje))

Oksigenirana hemolimfa u srce (arterijsko) kroz ostije (položeno dorzalno)



94/99

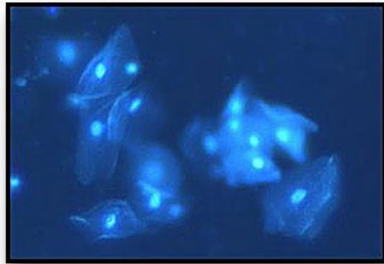
RESPIRATORNI PIGMENTI (KROMOPROTEIDI)

- složene (konjugirane) **bjelančevinaste tvorbe** koje sadrže jednu ili više **prostetičkih skupina** s metalnim ionom koji veže **plinove**

- **vezani za posebne stanice**

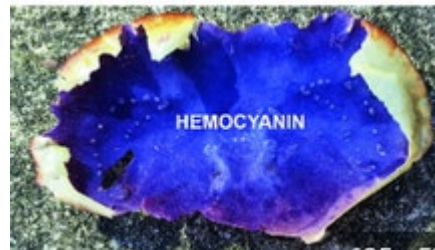


hemociti - beskralježnjaci



rakovi

► **hemocijanin (bakreni ion)** - pri zasićenju s kisikom - plave boje



Ekskrecijski sustav

amonijak

NH_3

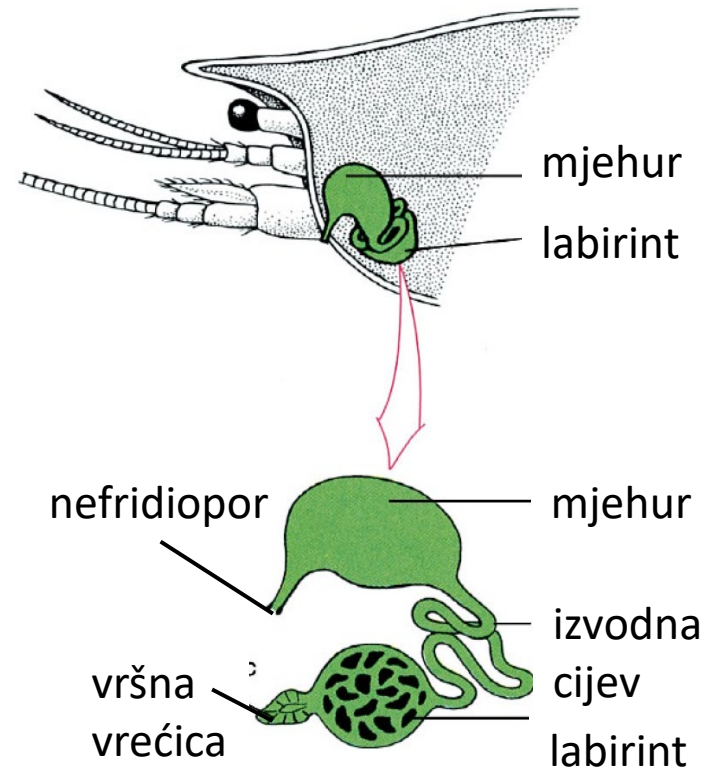
AMONIOTELIČNE životinje

- amonijak je vrlo toksičan (smrtonosan 1:20 000), mora se brzo razrijediti na neotrovnu konc.
- životinje koje žive u vodi

otvoreni nefridiji - metanefridiji

(Izvrat mezodermalne stijenke prema van)

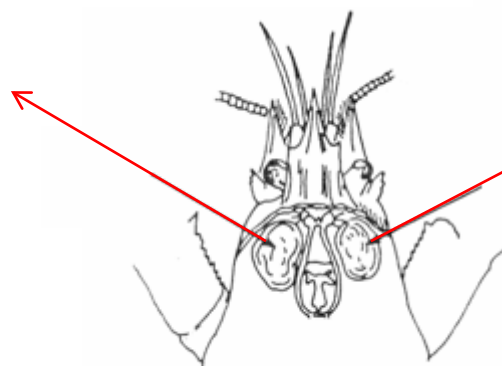
- ticalne (antenalne ili zelene) žlijezde - otvaraju se pri dnu stražnjeg dijela drugog para ticala (antena)



Ticalne (antenalne) žlijezde

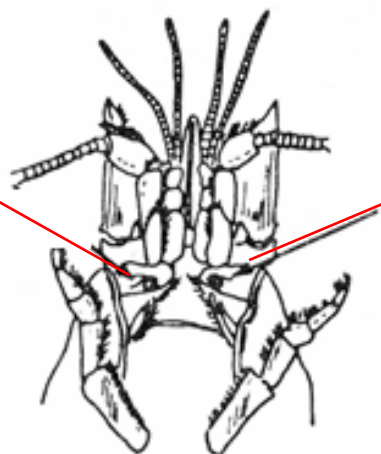
- u glavi životinje nalazi se jedan par ticalnih žlijezda
- izmetni otvori smješteni su ventralno na bazi drugog para ticala (antena)

ticalna žlijezda



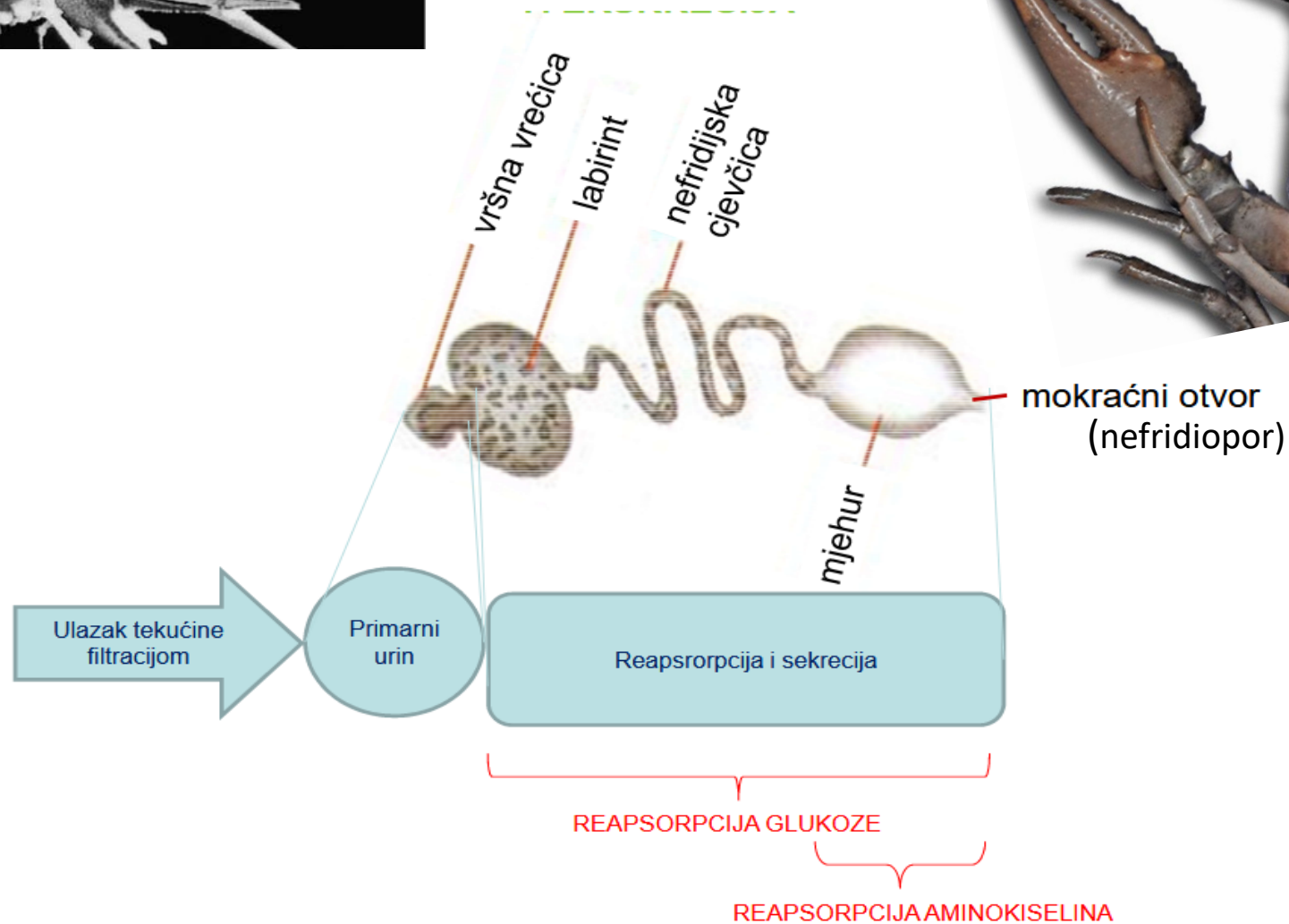
ticalna žlijezda

otvor ticalne žlijezde



otvor ticalne žlijezde

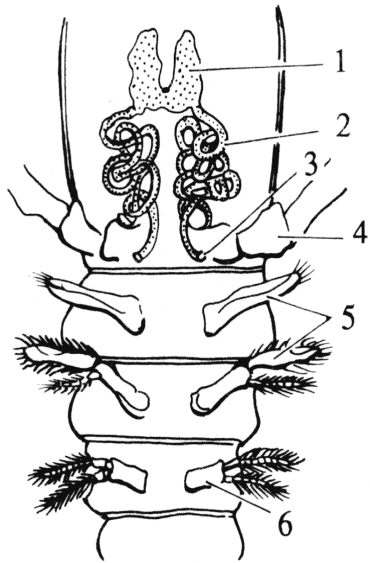
Ekskrecijski sustav



Rasplodni sustav

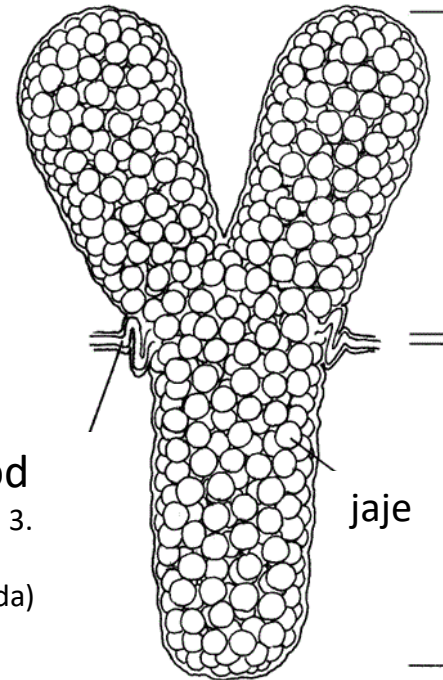
razdvojena spola

gonade su položene dorzalno s parnim izvodnim cjevčicama



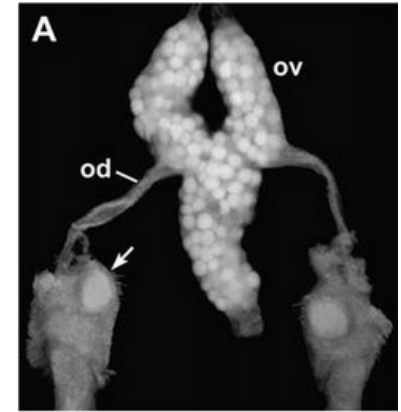
Slika 10.300. Rasplodni sustav mužjaka riječnog raka (*Astacus astacus*): 1 — sjemenik, 2 — sjemenovod, 3 — spolni otvor, 4 — peti par prsnih nogu, 5 — organ za parenje od prvog para začanih nožica, 6 — začane nožice

(Otvor sjemenovoda na 5. paru pereopoda)



Jajovod
(otvor na 3. paru pereopoda)

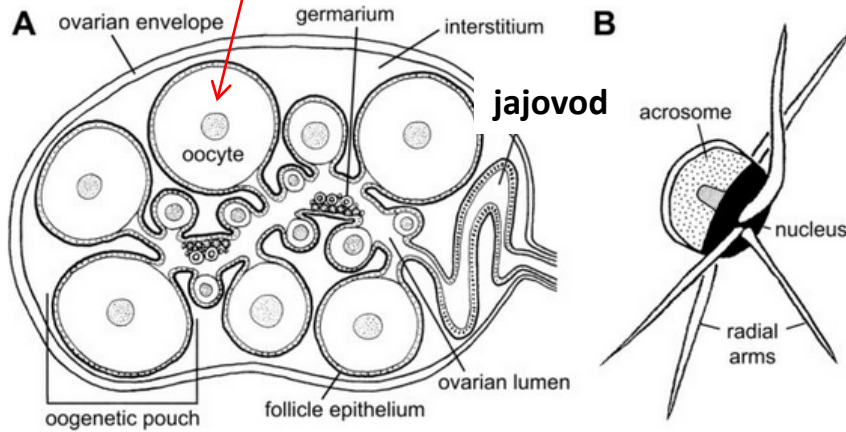
ženka



Prednji dio jajnika

Stražnji dio jajnika

Zrelo jaje



jajnik

spermij

- mužjak proizvodi **spermatofore**

Figure

Caption

Fig. 67.14. Schematic illustration of reproductive system of crayfish. A, architecture of ovary; B, spermatozoon with extended radial arms. [A, after Ando & Makioka, 1998; B, after Vogt, 2002.]

This figure was uploaded by Javier Diéguez-Urbeondo

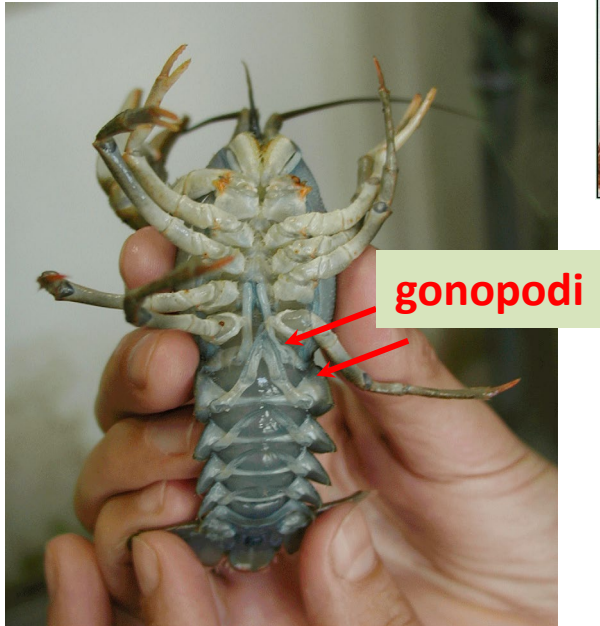
Content may be subject to copyright.



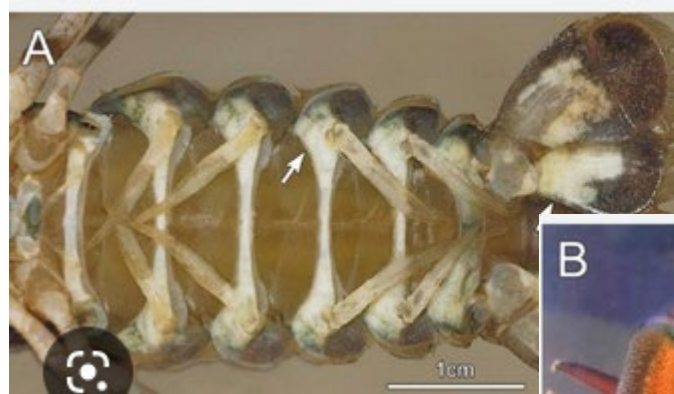
spermatofori na ventralnoj str. ženke riječnog raka

<https://www.google.com/search?client=firefox-b-e&q=crayfish+mating#fpstate=ive&vld=cid:409e5ba2,vid:HBi oiHIF5Q4,st:0>

- mužjaci - 1. dva para začanih nogu (pleopoda) preobražen u **kopulatorne organe (gonopodi)**



Mužjak polaže
spermatofore na
ventralni dio
toraksa



Ženka – cementne
žlijezde – sluz – otapa
spermatofore, lijepi
jaja za pleopode



Spolni dimorfizam

- primarne spolne oznake

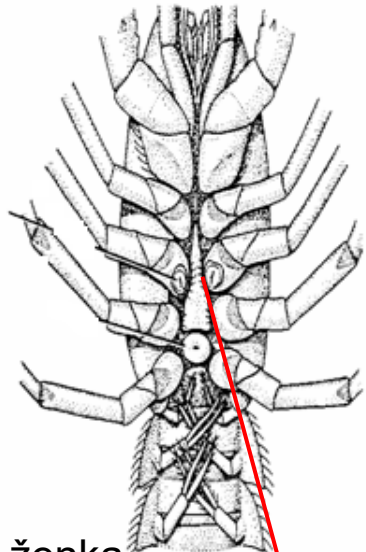
mužjak - 1. dva par začanih nogu preobražen u organe za kopulaciju (gonopodi)

- spolni otvori u kukovima petog para nogu hodalica

ženka

- 1. par začanih nogu je reduciriran - kvržice

- spolni otvori u kukovima trećeg para nogu hodalica



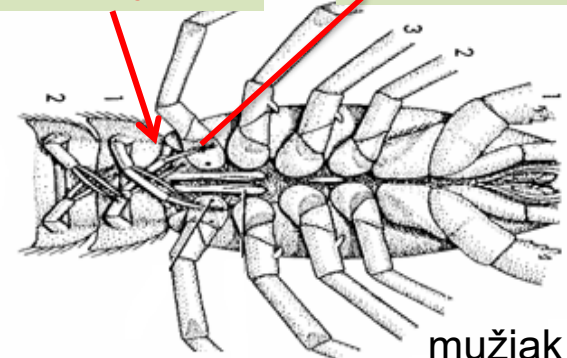
ženka

spolni otvori



organi za
kopulaciju

spolni otvori



mužjak

Spolni dimorfizam

- sekundarne spolne oznake



Veličina kliješta



Širina abdomena

+ ponašanje

EMBRIONALNI RAZVOJ (razvoj organizma od oplodnje do napuštanja jajne ovojnice) i **POSTEMBRIONALNI RAZVOJ** (od napuštanja jajne ovojnice do spolne zrelosti)

s obzirom na mjesto gdje se odvija embrionalni razvoj

oviparne

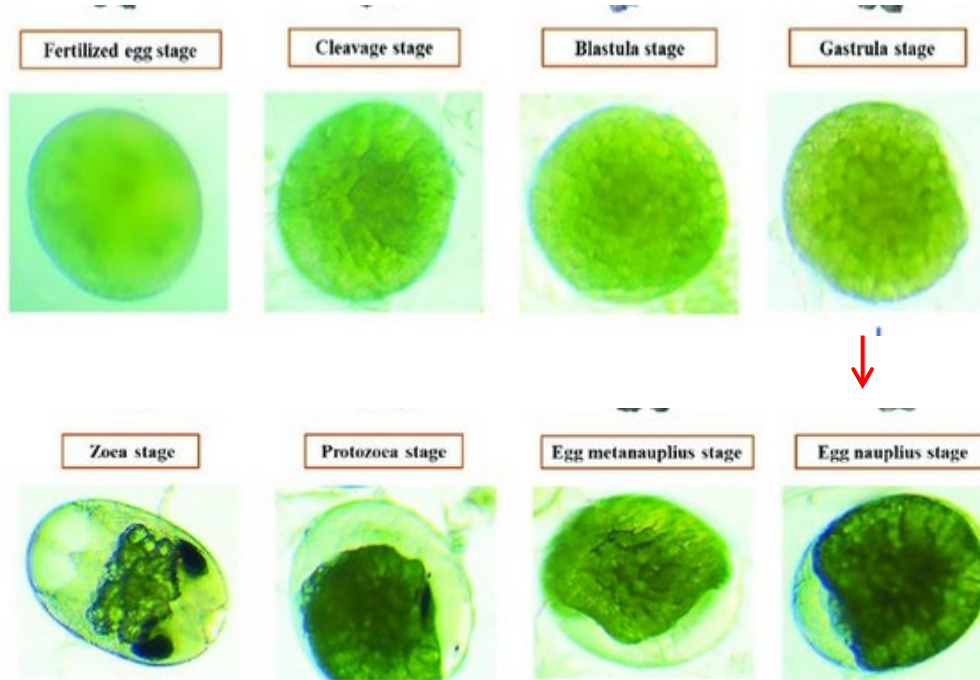
- ženke legu jaja

s obzirom na tip jaja

CENTROLECITALNA JAJA - citoplazma na površini i obavija čitav žumanjak, jezgra obavijena tankim slojem citoplazme smještena u sredini ili pomaknuta prema jednom polu

MEROBLASTIČKO (parcijalno) - ne brazda se čitavo jaje

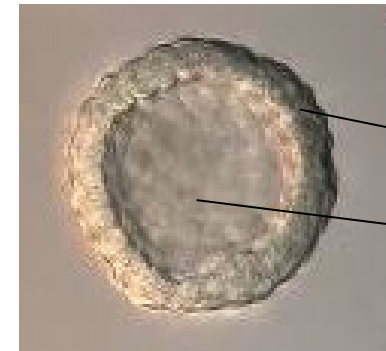
superficialno - brazdaju se samo stanice na površini



Juvenilni rakovi



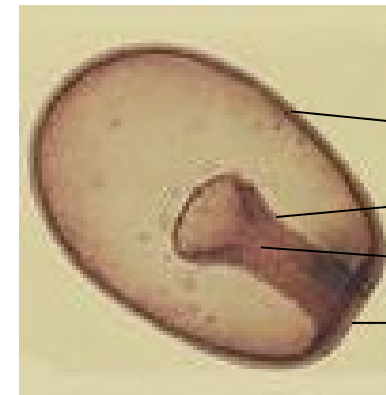
MORULA



BLASTULA

blastoderm

blastocel



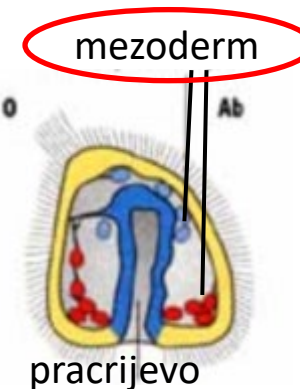
GASTRULA

ektoderm

endoderm

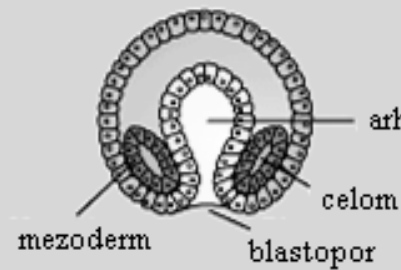
pracrjevo

blastopor

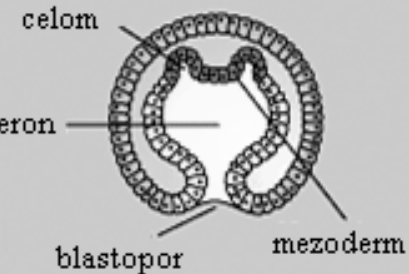


Razvoj mezoderma i celoma

stvaranje mezoderma
i celoma

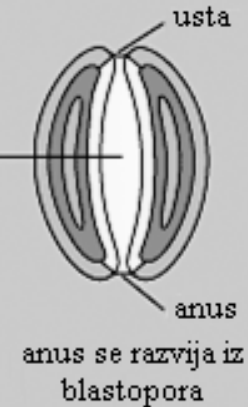
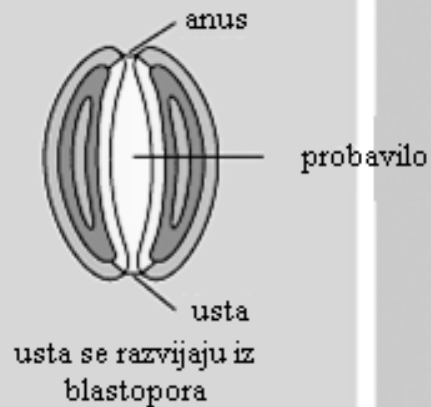


schizocelan postanak
celoma



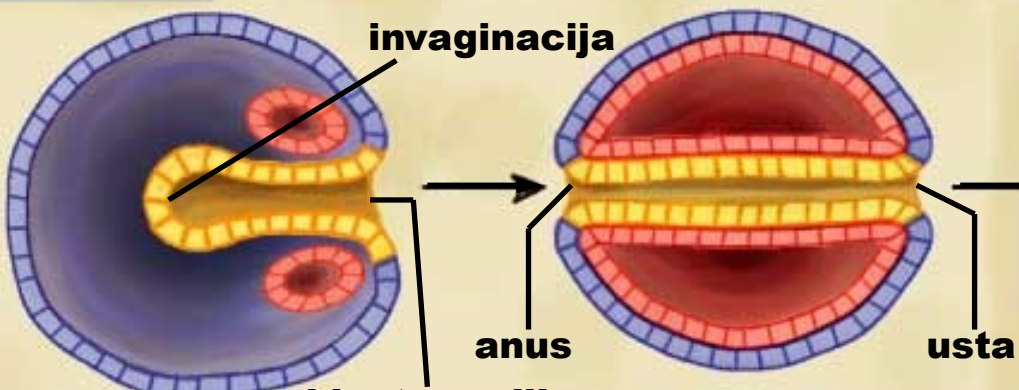
enterocelan postanak
celoma

način zatvaranja
blastopora



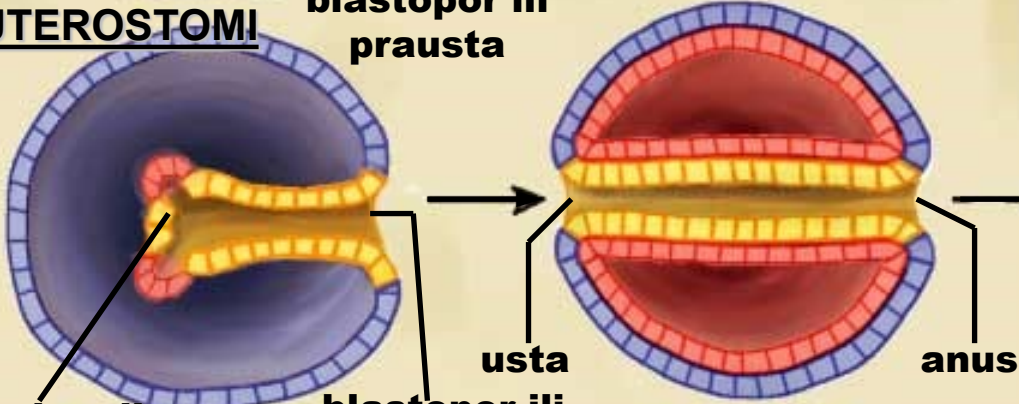
PROTOSTOMI

razvitak embrija

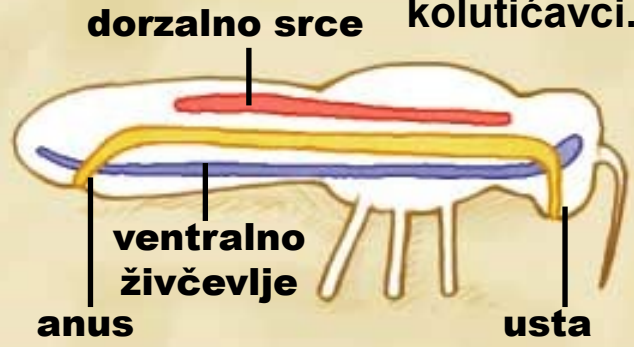


DEUTEROSTOMI

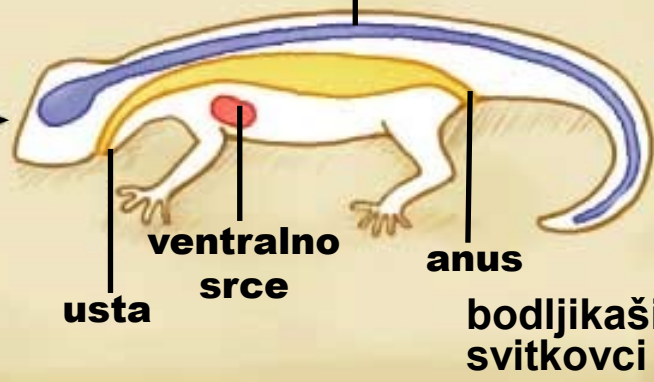
blastopor ili prausta



odrasli člankonošci, mekušci, kolutičavci...



dorzalno živčevlje



bodljikaši, svitkovci

bez diferenciranih tkiva:
parazoa
Porifera

diferencirana tkiva:
eumetazoa

diploblastični
radijalna sim
Cnidaria
Ctenophora

triploblastični
bilateralna sim

Acelomata
Platyhelminthes
Nemertina

Pseudocelomata
protostomi
Bivši Aschelminthes

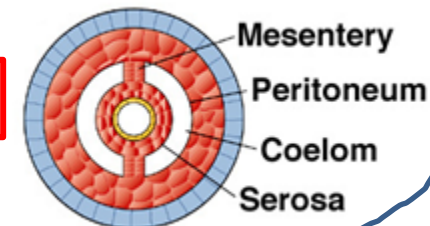
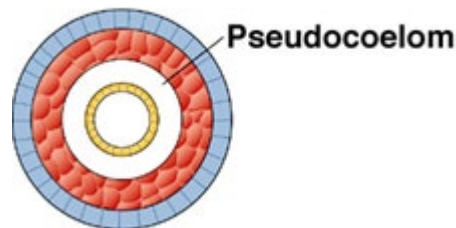
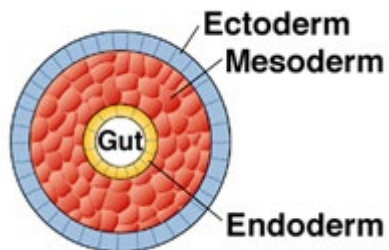
Celomata

protostomi

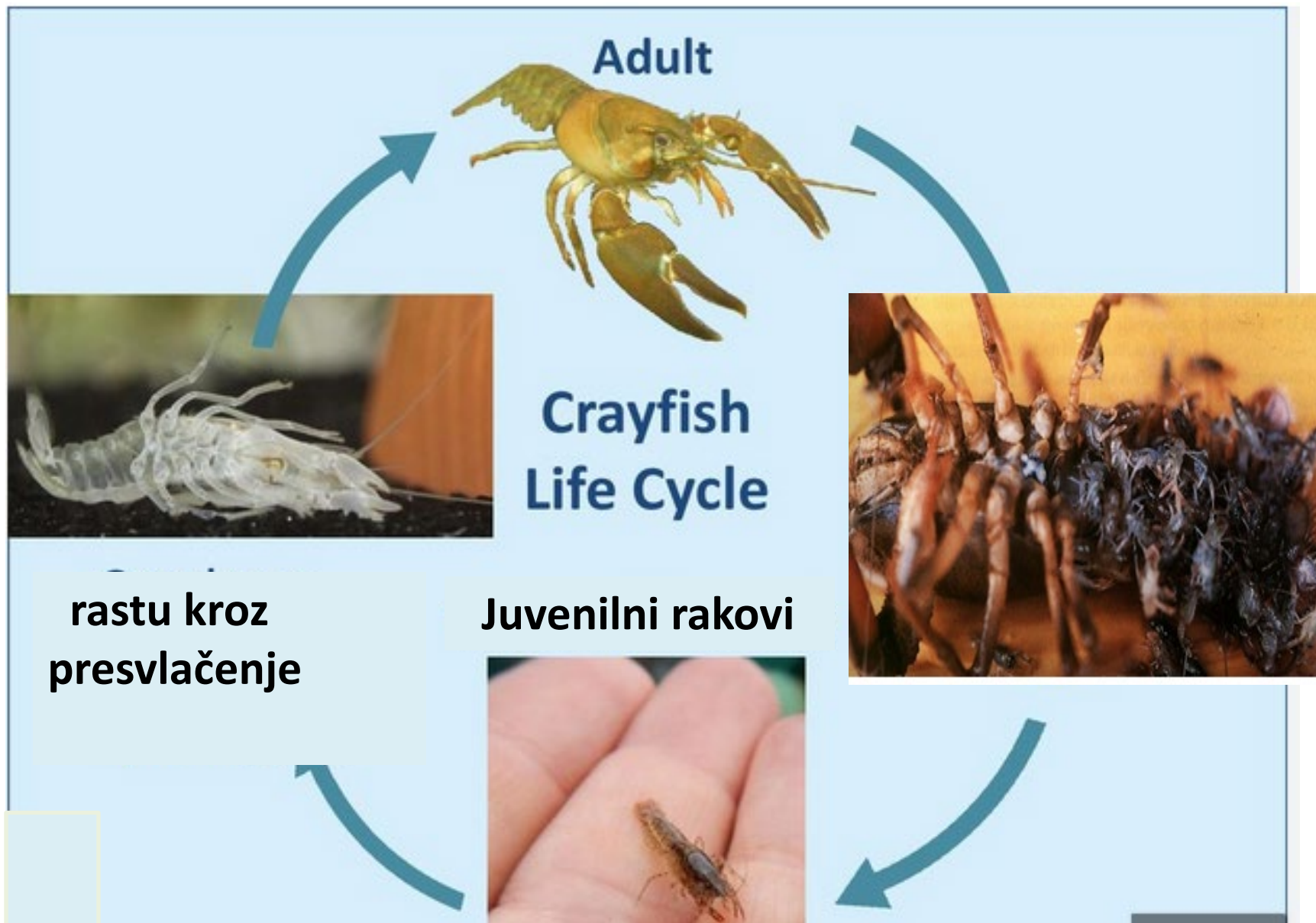
Mollusca
Arthropoda
Annelida
i drugi..

deuterostomi

Echinodermata
Chordata
i drugi....



Juvenilni rakovi – presvlačenje do postizanja spolne zrelosti



Hormonalni sustav

rakovi - 3 vrste struktura vezane s hormonalnom djelatnošću:

Y-organ - na antenalnom ili 2. maksilarnom kolutiću glave, hormon **ekdison** koji potiče presvlačenje

X-organ - unutar očnog drška, hormoni koji sprečavaju presvlačenje i djeluju inhibirajuće na razvoj jajnika

sinusna žlijezda - u očnom dršku (nije žlijezda)

- **sprema i oslobađa hormone iz X-organa**, koji djeluju inhibirajuće na Y-organ (prestane lučiti kad su posebni vanjski uvjeti: temperatura, fotoperiod, prehrambeni status..)

