TOPIC ..... DATE.....

ASSIGNMENT

EVOLUTION OF AORTIC ARCHES

SUBMITTED BY

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B.Sc. (H) ZOOLOGY

4TH SEMESTER

V. Good.
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12/4/24

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Evolution of Aortic Arches

Basic pattern or embryonic plan

1. Arterial channels carry oxygenated blood and supply to most organs of the body whereas they carry deoxygenated blood to the respiratory organs.

2. In the primitive gnathostome during embryonic development the major arterial channels were

a) **Ventral aorta-**
emerges from heart and passes forward beneath the pharynx

b) **Dorsal aorta-**
paired above the pharynx only and extending towards tail region as caudal artery and towards head region as carotid artery.

c) **Six pairs of aortic arches-**
connecting the ventral aorta with the dorsal aorta.

3. The number of aortic arches varies in living agnathans with the number of branchial branches.

4. The branches of these arterial channels supply all parts of the body.

Teacher's Sign .....

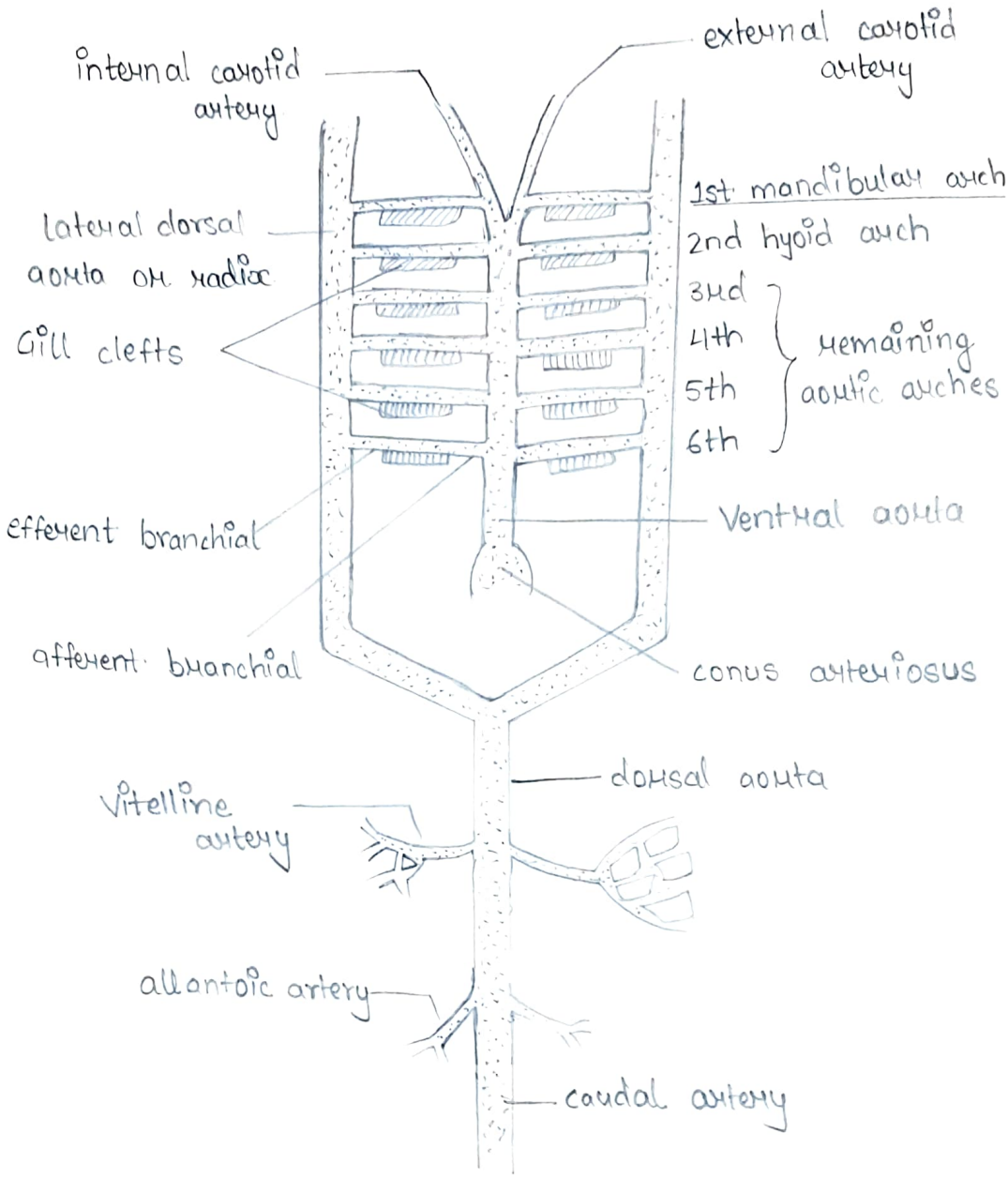

Fig: Basic pattern of chief arterial channels of a typical vertebrate embryo.

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5. In the basic pattern each aortic arch consists of

- a ventral afferent branchial artery carrying venous blood to capillaries in a gill
- a dorsal efferent branchial artery taking arterial blood from the gills.

All the efferent branchial arteries join a lateral dorsal aorta on each side that extends towards head region as internal carotid artery and a single median dorsal aorta that extends towards tail region as caudal artery.

6. Modifications occur in this inherited basic pattern during embryonic development which involve mainly the aortic arches. Thus evolution of aortic arches occurs mainly as an adaptation from aquatic to terrestrial with a shift from gills to lungs and an establishment of pulmonary circulation.

II Fishes :

1. Developmental changes due to adaptive modifications of the six embryonic aortic arches for adult respiration by gills convert the embryonic aortic arches into afferent and efferent branchial arteries.

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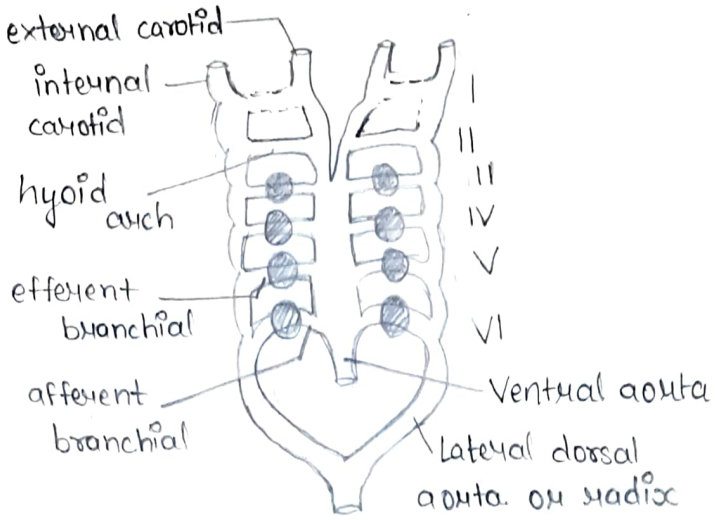
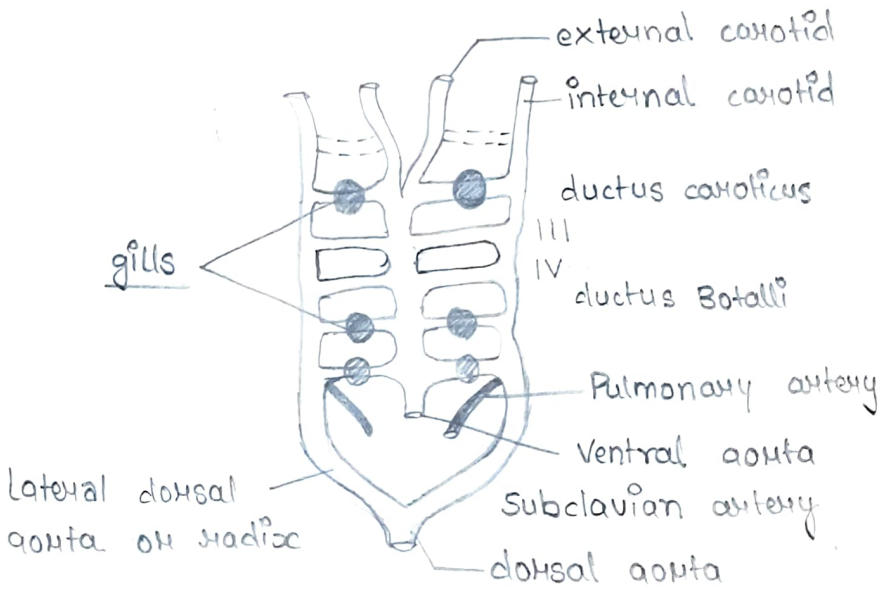


Teleost Fish



Dipnoan Fish

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2. The specific number of aortic arches that are converted depend upon the number of functional gills.

3. After branching from the ventral aorta the aortic arches divide into capillary beds within the gills in both the cartilaginous and bony fishes. The afferent artery delivers blood to the gills artery whereas the efferent artery carries blood away from the gills.

4. In most teleosts only 4 pairs of aortic arches (III, IV, V & VI) remain functional and the I and II aortic arches disappear.

AMPHIBIANS-

In amphibians the anatomical arrangement of the aortic arches imply some mixing of oxygenated blood and deoxygenated blood. The first two aortic arches (I, II) disappear early in the developmental process. The pattern of remaining arches differ between larvae and adults.

a) URODELES

i) There is a partial shift from the aortic arches present in fishes as the urodeles live in water and retain the external gills in addition to the lungs.

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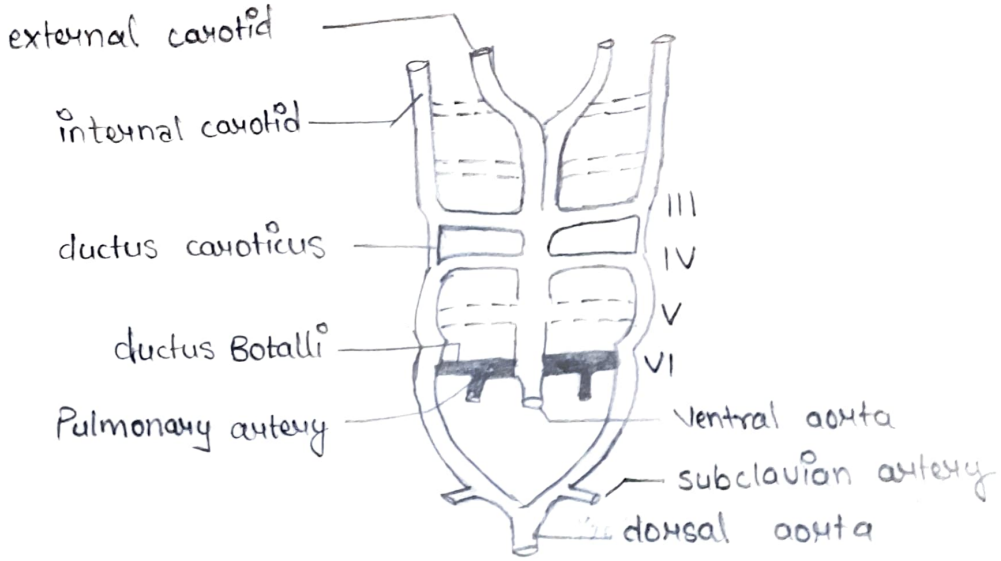
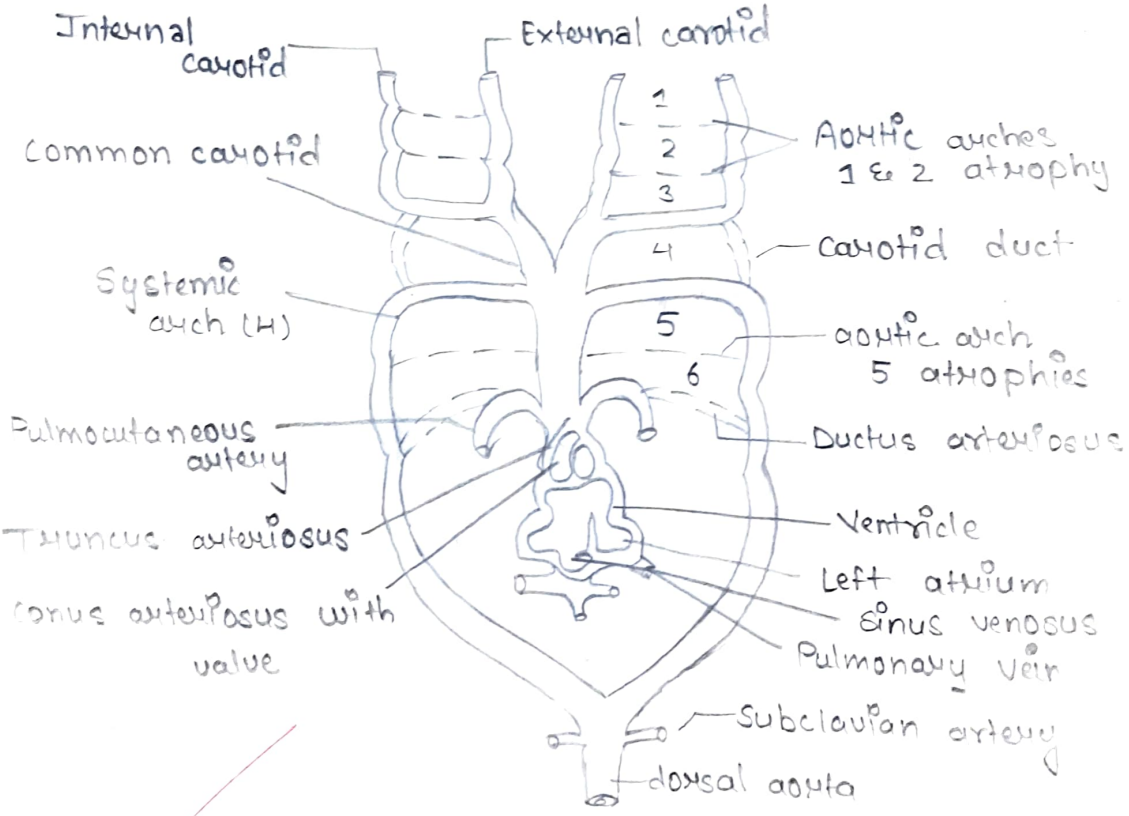


Urodele Amphibian



Anuran (Adult frog)

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ii) There are usually 4 pairs of arches (III to IV) but in some the IV arch is reduced or absent.

iii) III arch — forms the carotid arches.
IV arch — forms the systemic arches
VI arch — forms the Pulmocutaneous arch.

iv) The lateral aorta between III and IV arches have a connection between them called ductus caroticus.

v) The pulmocutaneous arch retains connection with the lateral aorta called ductus botalli or ductus arteriosus.

vi) Shortly before joining the dorsal aorta the VI arch gives off the pulmonary artery which divides further into smaller branches supplying the mouth, pharynx, and oesophagus before entering the lungs.

b) **ANURANS**

i) In anurans the larva has internal gills which are lost during metamorphosis thus the aortic arches that persists are III, IV and VI which supply blood to the head, body and pulmonary circuits respectively.

ii) III arch and associated section of dorsal aorta ⟶ form the internal carotid.

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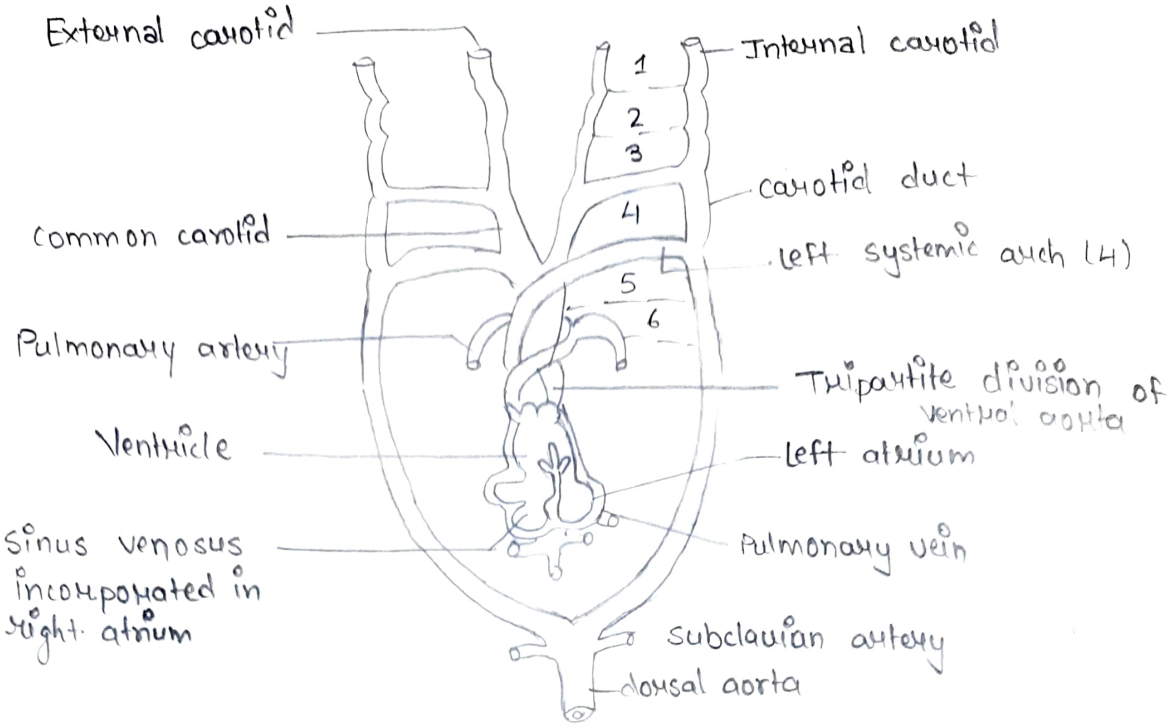

Reptile : Aortic arches & heart

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iii) Anterior extension of ventral aorta → forms the external carotid.

iv) The section of ventral aorta between the III & IV arches → form common carotid.

v) IV arch joins the dorsal aorta and is → major systemic artery supplying the body.

vi) VI arch loses its connection to the dorsal aorta because the ductus arteriosus closes and becomes the pulmocutaneous artery.

* Pulmocutaneous artery - One branch is well-developed pulmonary artery that enters the lungs.
→ Other branch is the cutaneous artery that delivers blood to the skin.

IV REPTILES

i) Since the reptiles are fully terrestrial, the gills are replaced by the lungs and only 3 functional aortic arches are present. (III, IV & VI)

ii) The symmetric aortic arches of the embryo tend to become assymetrical in the adult form.

iii) Mostly the modifications occur in the IV arch.

iv) Ventral aorta subdivides into three separate channels.

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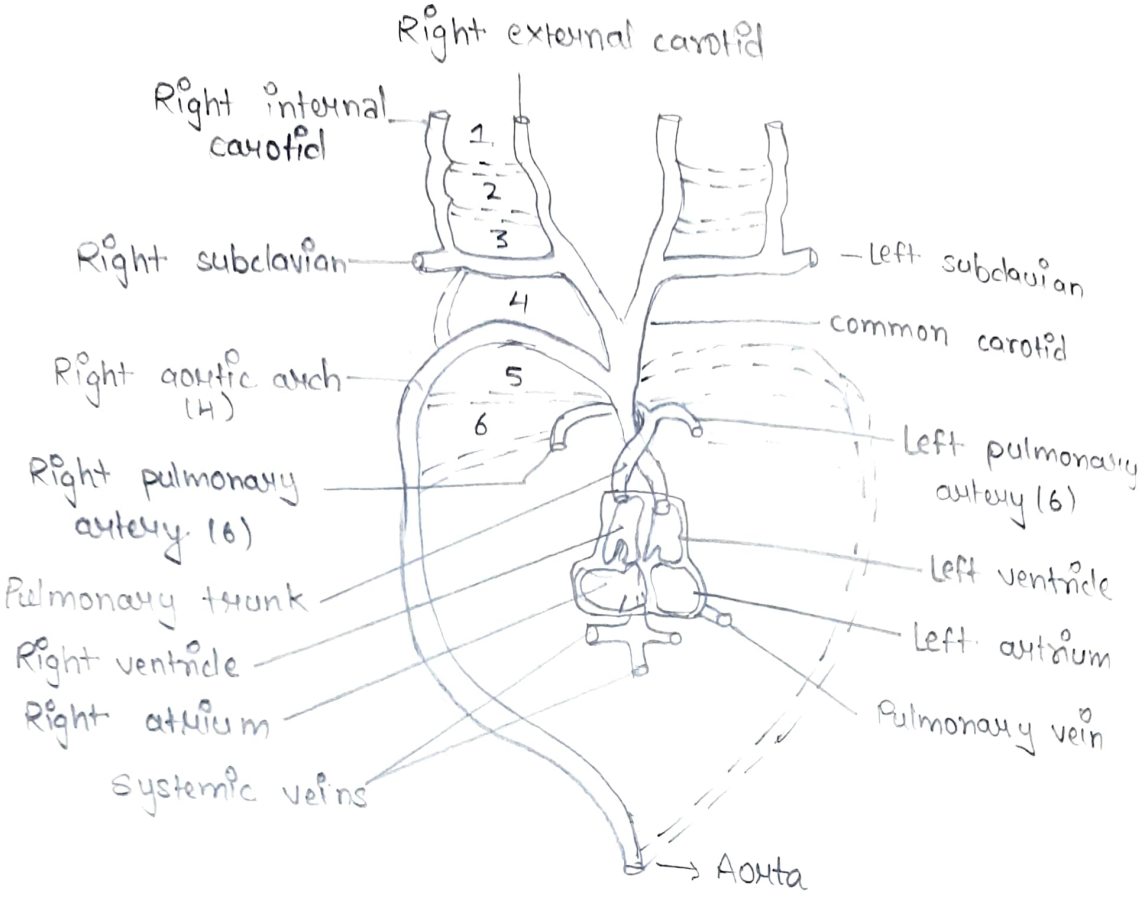

Aves : Aortic arches & heart

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Ventral aorta

Two Aortic Trunks

3) Pulmonary Trunk.

1) Left systemic Arch

2) Right systemic Arch.

v) The left systemic arch is formed of the base of the left aortic arch, the left aortic arch itself & curved section of the left dorsal aorta.

vi) The right systemic arch is formed of the base of the right aortic arch, the right aortic arch itself & the curved section of the right dorsal aorta.

vii) The 2 systemic arches unite behind the heart to form the common dorsal aorta and supply oxygenated blood to all parts of the body.

viii) The pulmonary trunk includes the bases of the paired VI arch & their branches (right & Left pulmonary arch). The pulmonary trunk emerges from the right ventricle & carries deoxygenated blood to the lungs for purification.

ix) Thus in reptiles aortic arches are modified to form one pulmonary circuit & 2 systemic circuits.

V BIRDS-

i) There is no mixing of oxygenated & deoxygenated blood due to complete septum present in the atria & ventricles. Only 3

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arches persist in adult is III, IV & VI arch.

(ii) III aortic arch → represents the carotid arteries.

(iii) IV aortic arch → Only the right systemic arch forms during embryonic development. It emerges from the left ventricle & carries oxygenated blood. The left systemic arch fails to develop & is thus absent.

(iv) VI aortic arch → forms a single pulmonary trunk that carries deoxygenated blood from right ventricle to the lungs for purification.

VI MAMMALS -

(i) No mixing of oxygenated & deoxygenated blood due to complete septum present in the atria & ventricles. Only 3 aortic arches persist in adult. i.e. III, IV & VI arch.

(ii) III aortic arch - separates the carotid arteries.

(iii) IV aortic arch - Only the left systemic arch forms during embryonic development. It emerges from the left ventricles & carries the oxygenated blood. The right systemic arch fails to develop.

(iv) VI aortic arch - forms a single pulmonary trunk that carries deoxygenated blood from right ventricle to the lungs for purification

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Note - The main difference in the aortic arches of birds & mammals is that in birds only right systemic arch is present & in mammals only left systemic arch is present.

Note - The vessels that carries blood from the heart to the early aortic arches in amniotes are called truncus arteriosus and bulbus cordis.

CONCLUSION :-

i) The basic six arch pattern that emerges in the embryonic development of living gnathostomes suggests that this is the ancestral pattern.

ii) In fishes (mostly) the aortic arches supply deoxygenated blood to the respiratory surface of the gills & then distributes oxygenated blood to rest of the body.

iii) In tetrapods the aortic arches form the pulmonary arch (arterial circuit to the lungs) and the systemic arch (arterial circuit to the body).

iv) In tetrapods III aortic arch generally forms the carotid arteries supplying blood to the head.

v) The IV aortic arch which are double systemic arches (left & right) in the amphibians & reptiles reduce to a single systemic arch (right in birds and left in mammals). These supply blood to the rest of the body.

Teacher's Sign. .....

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