Hôpitaux Universitaires Genève

UNIVERSITÉ DE GENÈVE

Congenital heart disease and pulmonary hypertension

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Pediatric cardiologist
28.05.2024

Epidemiology

CHD ~1/100 live birth

4-28% of CHD will develop pulmonary hypertension

Kaemmerer H 2020, Duffels MGJ 2007

Physiopathology

A cardiac catheterization is essential to measure pressures, flow and estimate resistance

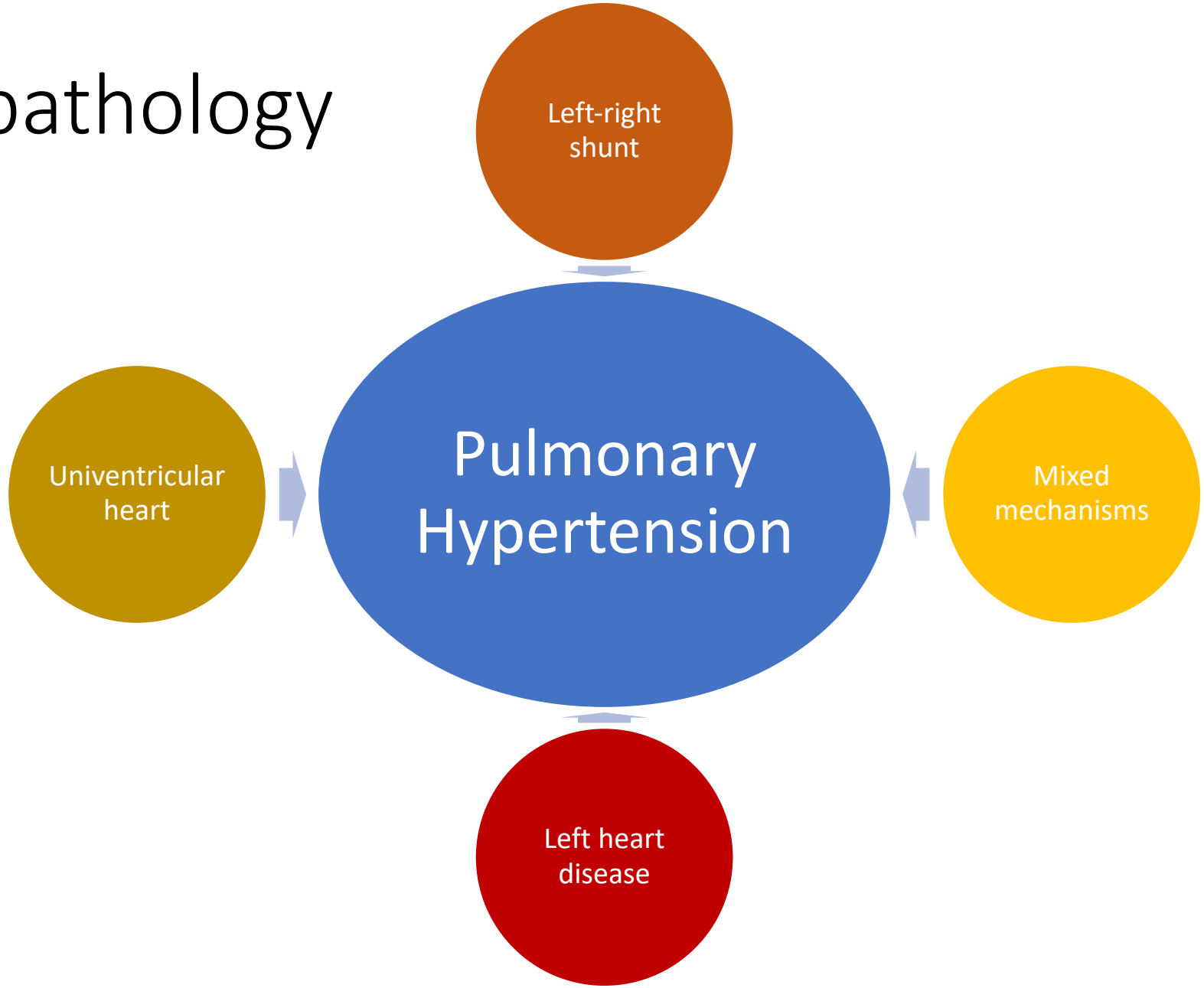
$$Flow = \frac{\Delta\, pressure}{resistance}$$

$$\Delta\, pressure = flow\ x\ resistance$$

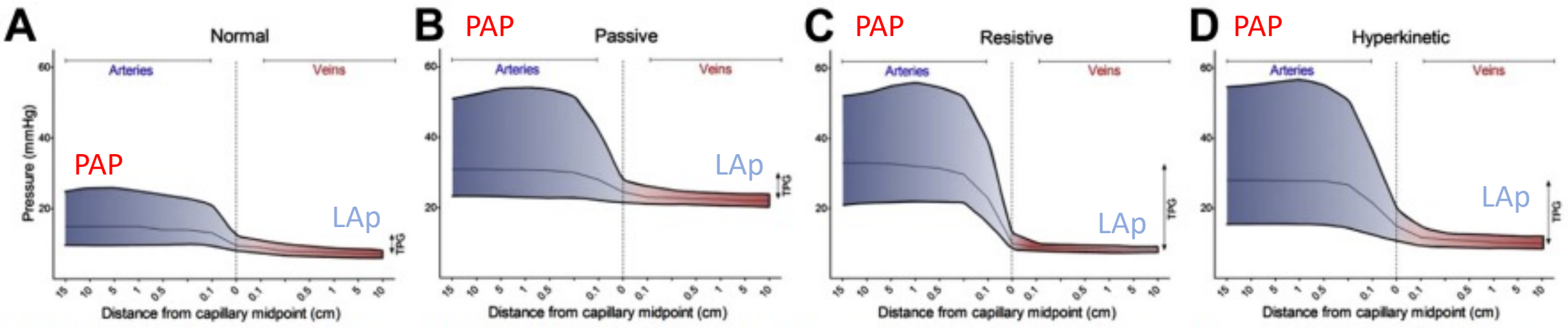
$$mPAP - LAp = \ Pulmonary\ blood\ flow\ x\ Pulmonary\ vascular\ resistance$$

$$mPAP = \ Pulmonary\ blood\ flow\ x\ Pulmonary\ vascular\ resistance + LAp$$

Physiopathology

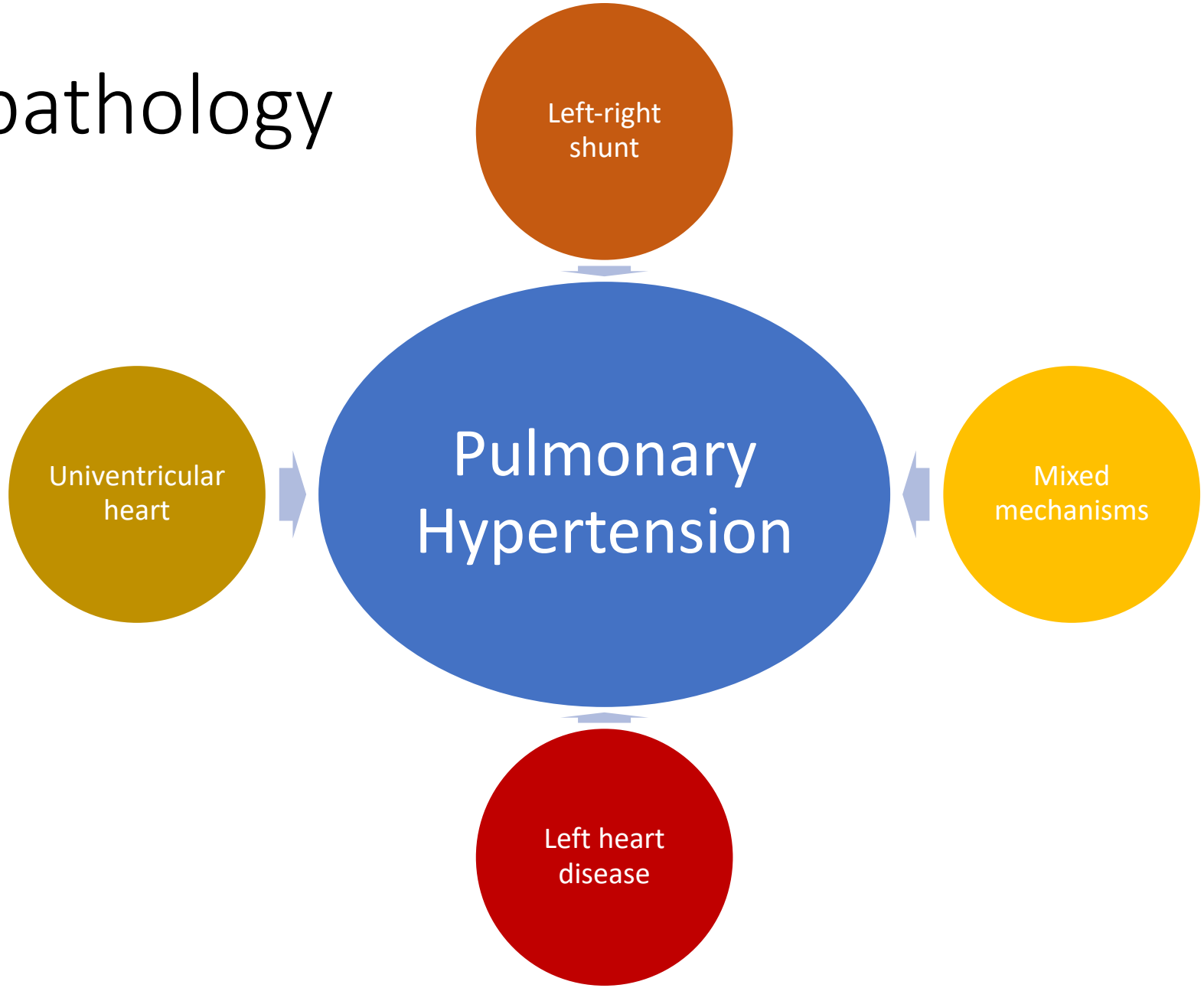


Physiopathology



Opotowsky A 2015

Physiopathology



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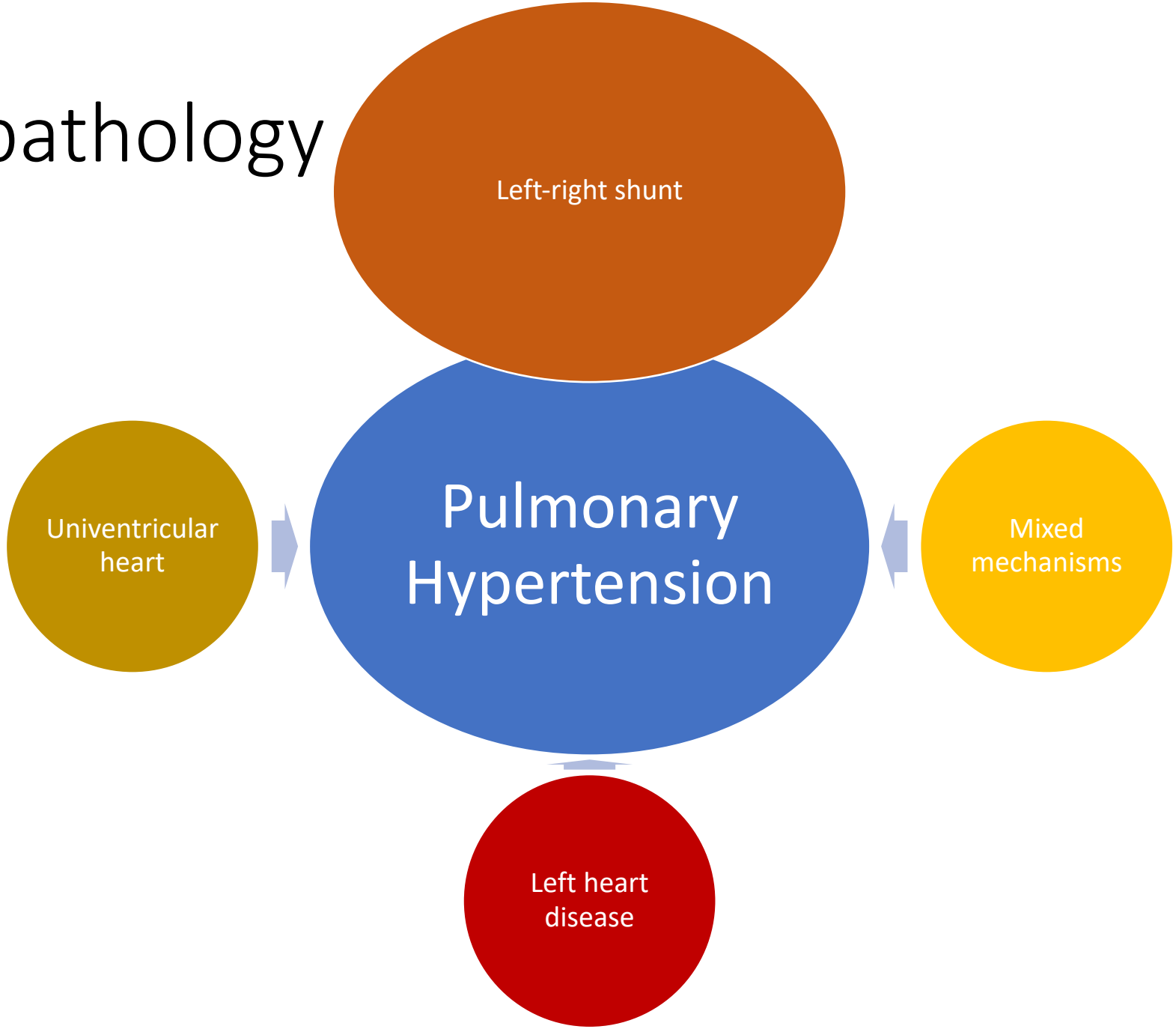

L-R shunts

TABLE 6 Clinical classification of pulmonary hypertension

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  - 1.1.1 Non-responders at vasoreactivity testing
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- 1.5 PAH with features of venous/capillary (PVOD/PCH) involvement
- 1.6 Persistent PH of the newborn

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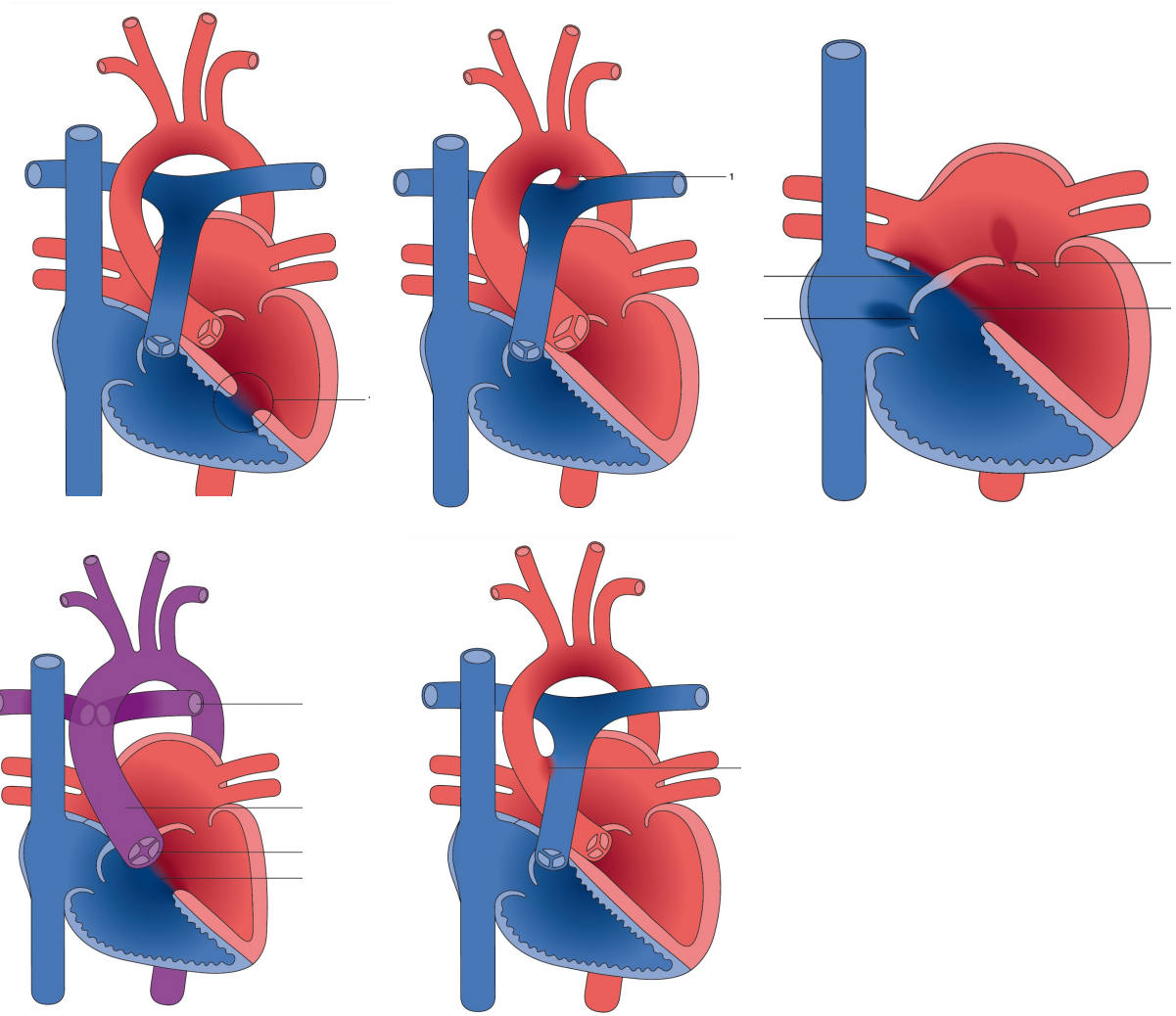
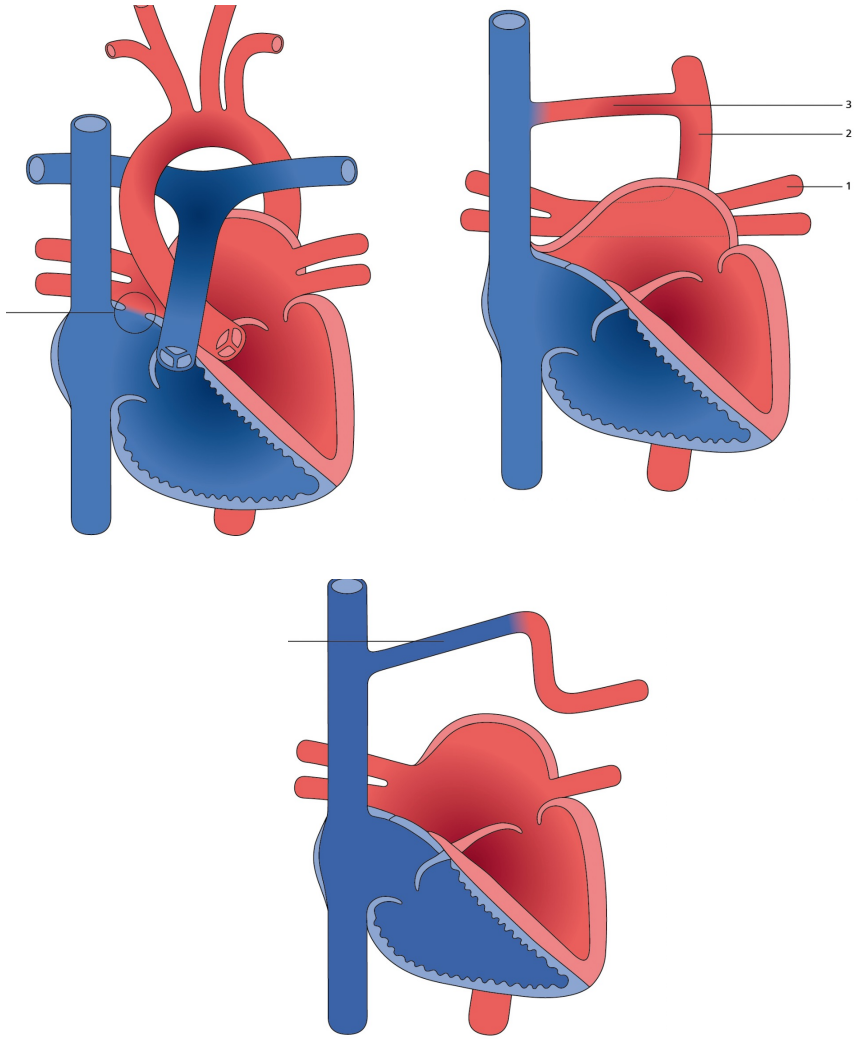
L-R shunts





https://www.congenital-heart-disease.ch

L-R shunts

- Volume +/- pressure overload

→ Endothelial dysfunction

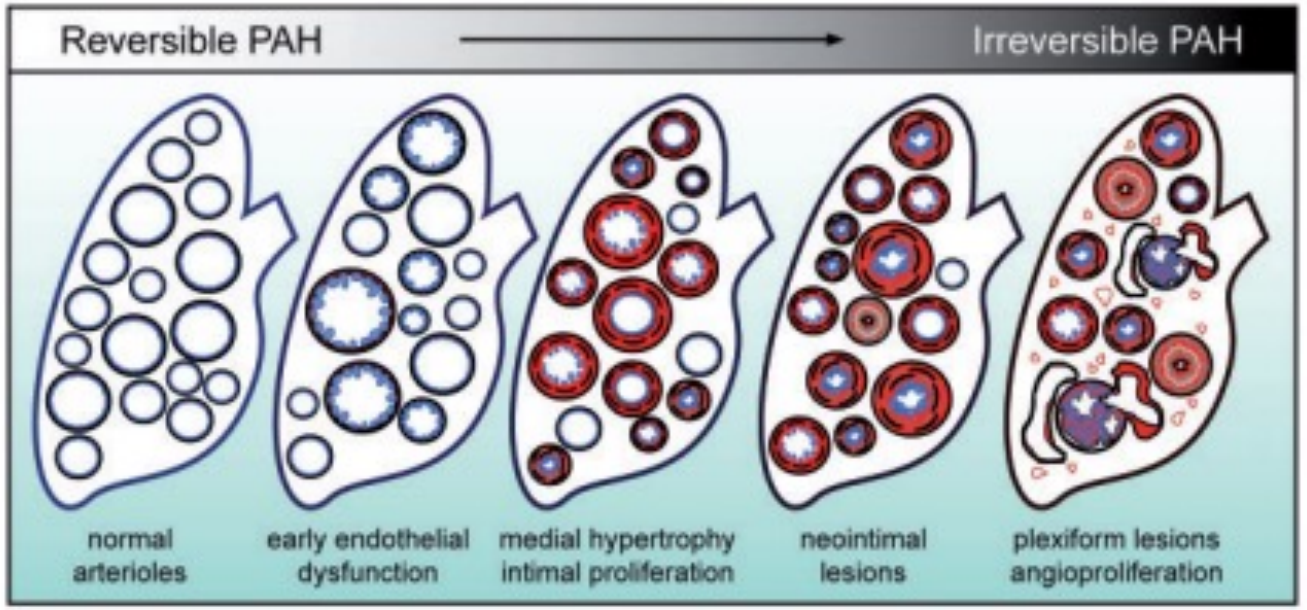
→ Vasoconstriction

→ Thrombosis

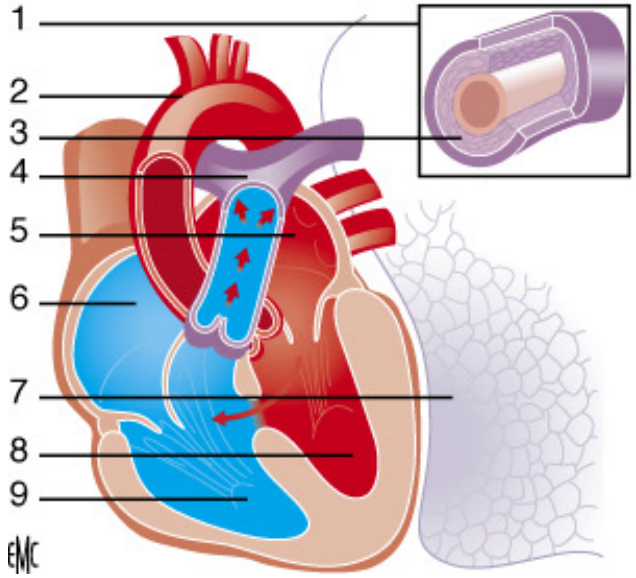
→ Inflammation

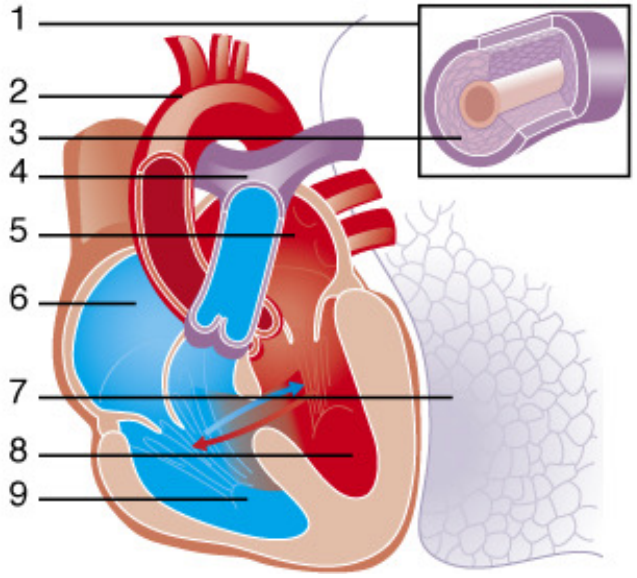
→ Apoptosis dysregulation

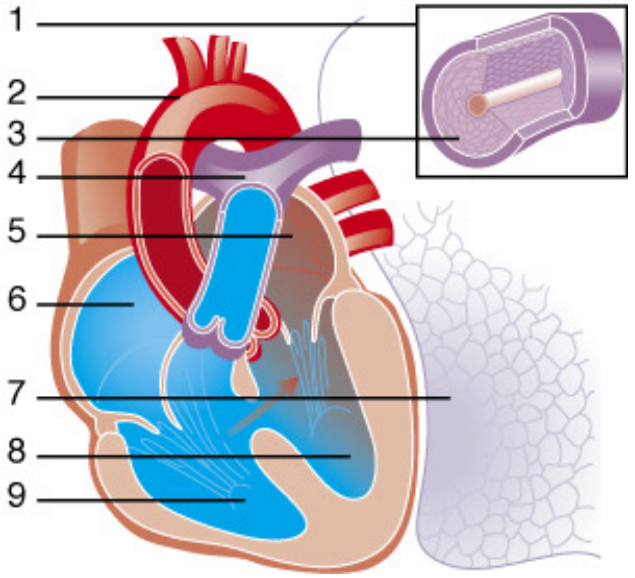
⇒ Pulmonary vascular disease



L-R shunts

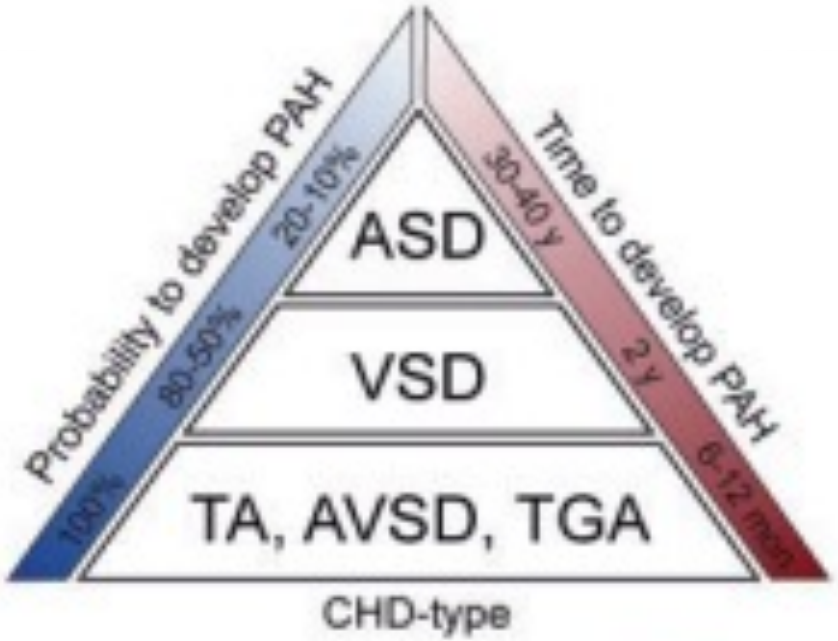






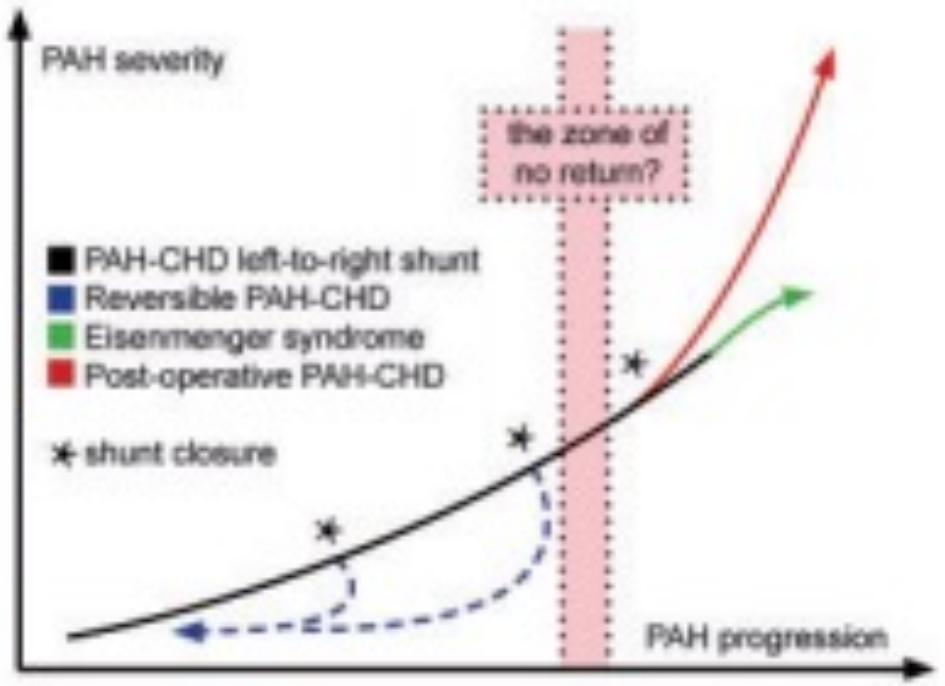
Wacker J EMC 2018

L-R shunts



Van der Feen Eur Heart J 2017

L-R shunts



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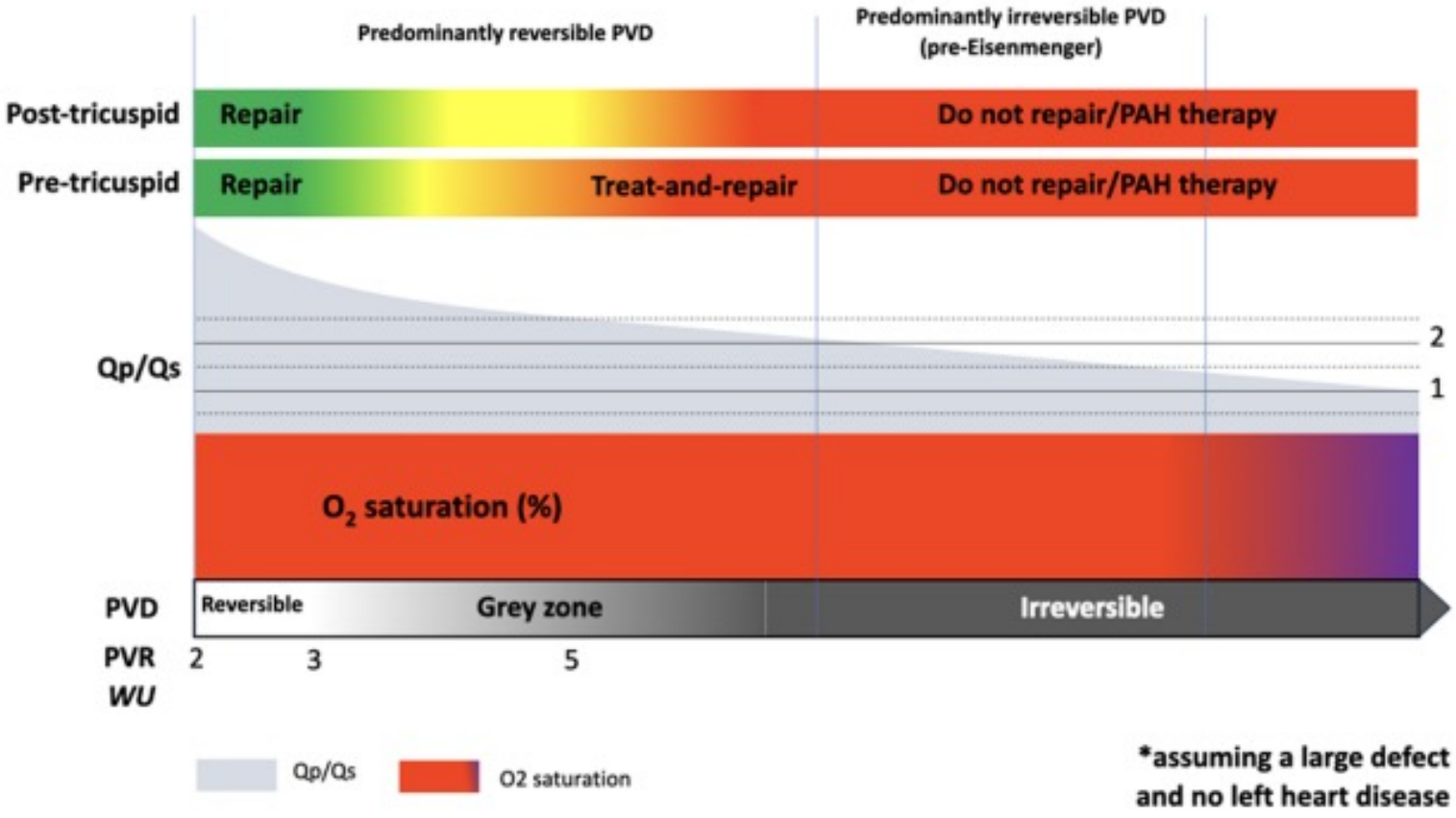


Ferrero P 2024

L-R shunts

TABLE 21 Clinical classification of pulmonary arterial hypertension associated with congenital heart disease

1) Eisenmenger syndrome

Includes all large intra- and extracardiac defects that begin as systemic-to-pulmonary shunts and progress to severely elevated PVR and to reverse (pulmonary-to-systemic) or bidirectional shunting. Cyanosis, secondary erythrocytosis, and multiple organ involvement are usually present. Closing the defects is contraindicated.

2) PAH associated with prevalent systemic-to-pulmonary shunts

- Correctable[a]
- Non-correctable

Include moderate-to-large defects. PVR is mildly to moderately increased and systemic-to-pulmonary shunting is still prevalent, whereas cyanosis at rest is not a feature.

3) PAH with small/coincidental[b] defects

Markedly elevated PVR in the presence of cardiac defects considered haemodynamically non-significant (usually ventricular septal defects <1 cm and atrial septal defects <2 cm of effective diameter assessed by echocardiography), which themselves do not account for the development of elevated PVR. The clinical picture is very similar to IPAH. Closing the defects is contraindicated.

4) PAH after defect correction

Congenital heart disease is repaired, but PAH either persists immediately after correction or recurs/develops months or years after correction in the absence of significant, post-operative, haemodynamic lesions.

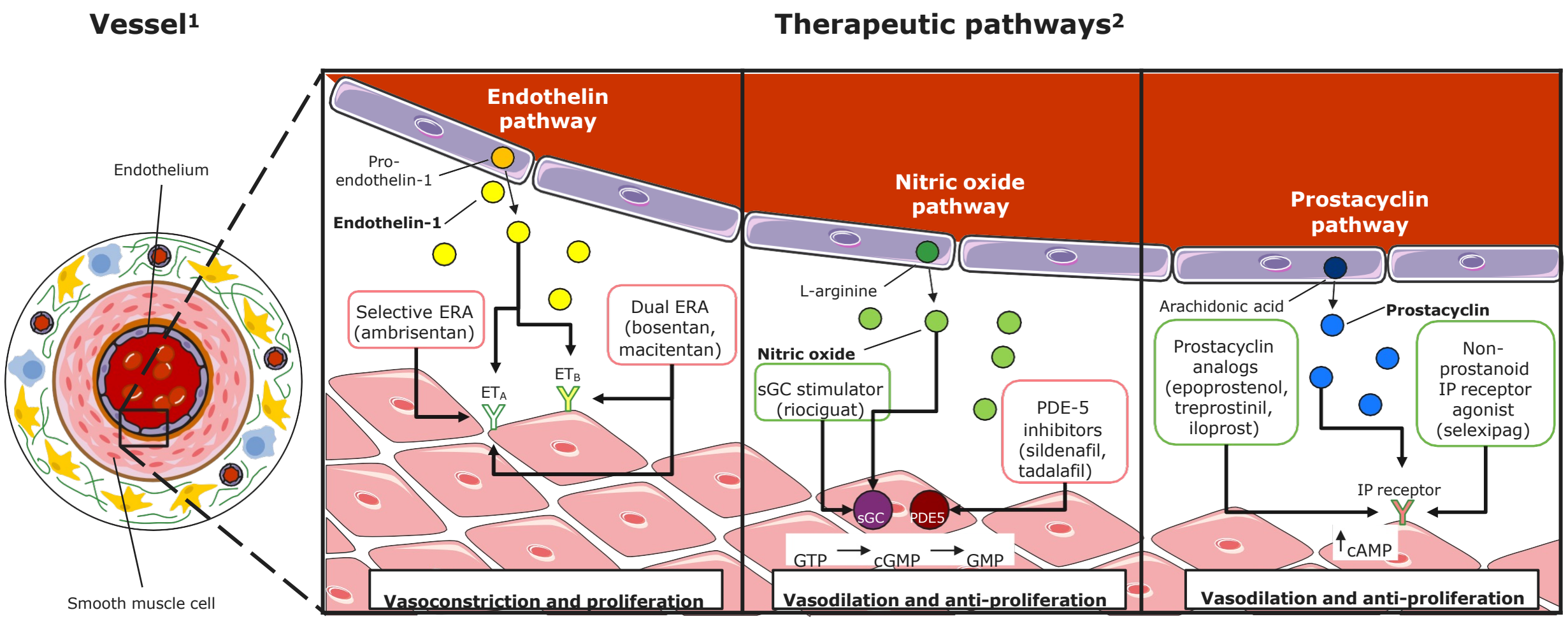
Medical treatment

Repair
Treat and repair
Repair and treat
Treat

Similar to iPAH
Medical treatment

Similar to iPAH
Medical treatment

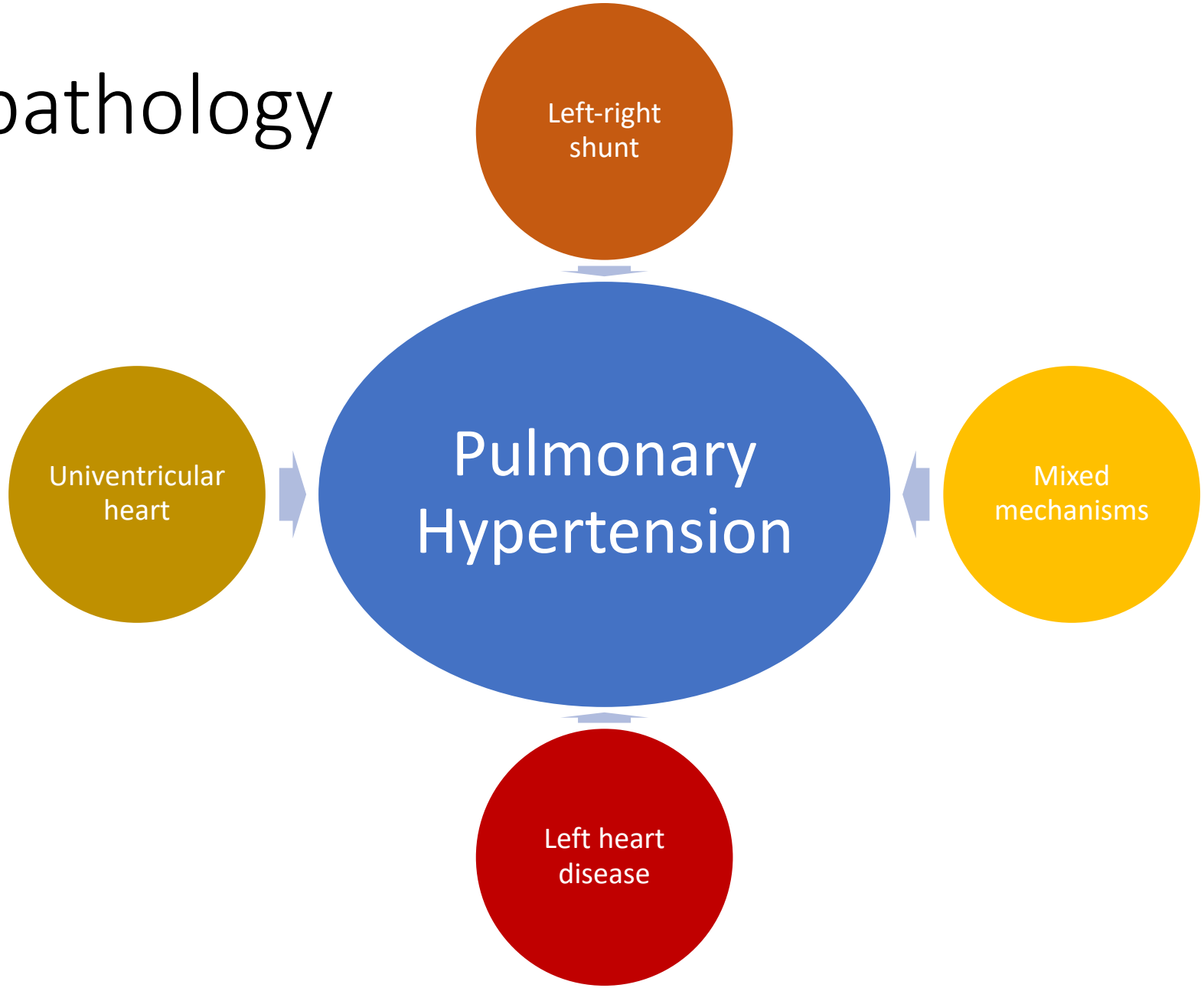
Treatments target 3 distinct pathways: Prostacyclin, endothelin and nitric oxide



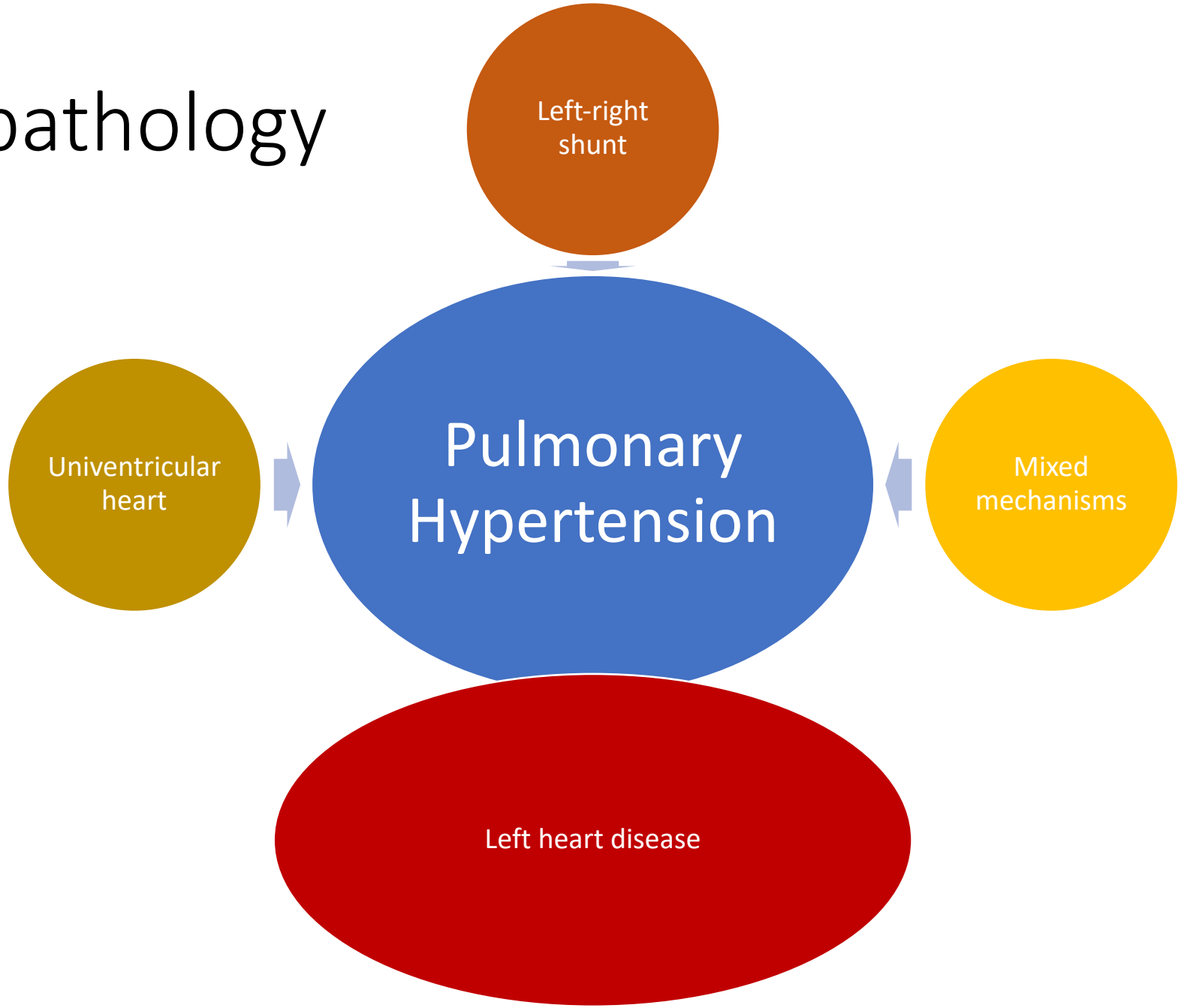
cAMP: cyclic adenosine monophosphate; cGMP: cyclic guanidine monophosphate; GTP; guanidine triphosphate.

1. Adapted from Pugliese S, *et al. Am J Physiol Lung Cell Mol Physiol* 2015; 308:L229–52; 2. Lau EMT, *et al. Nat Rev Cardiol.* 2017;14:603-14.

Physiopathology



Physiopathology



Left sided heart disease

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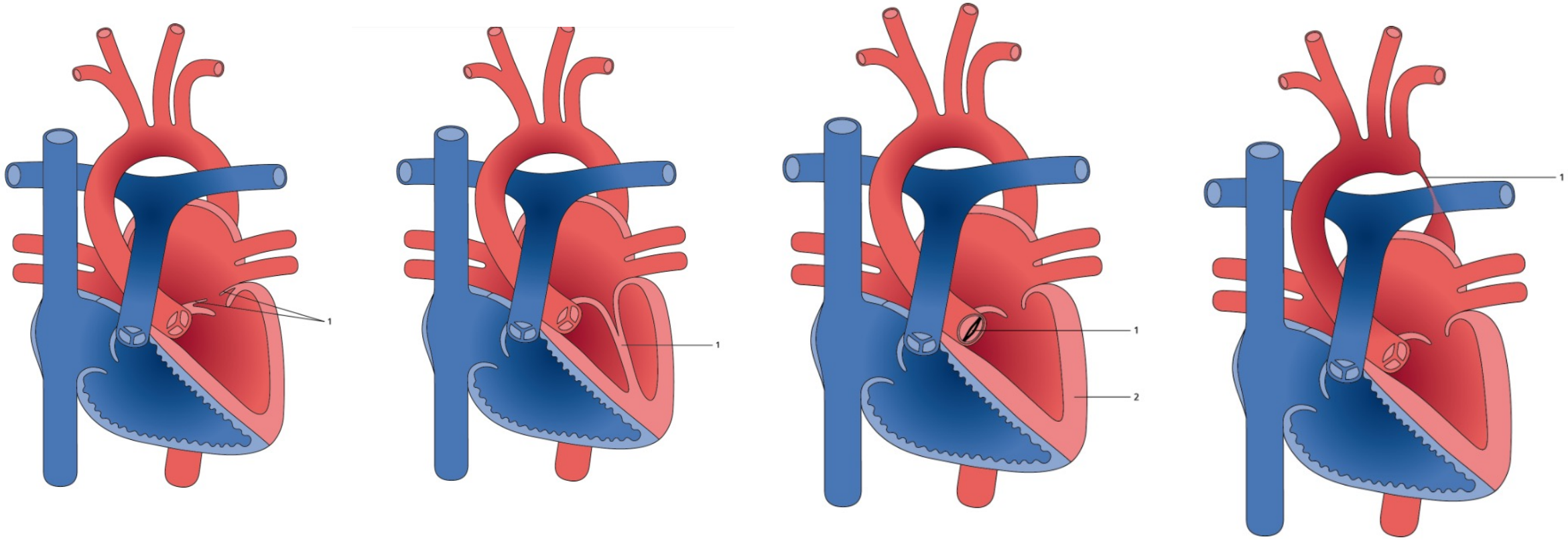
Humbert Eur Resp J 2022

Left sided heart disease



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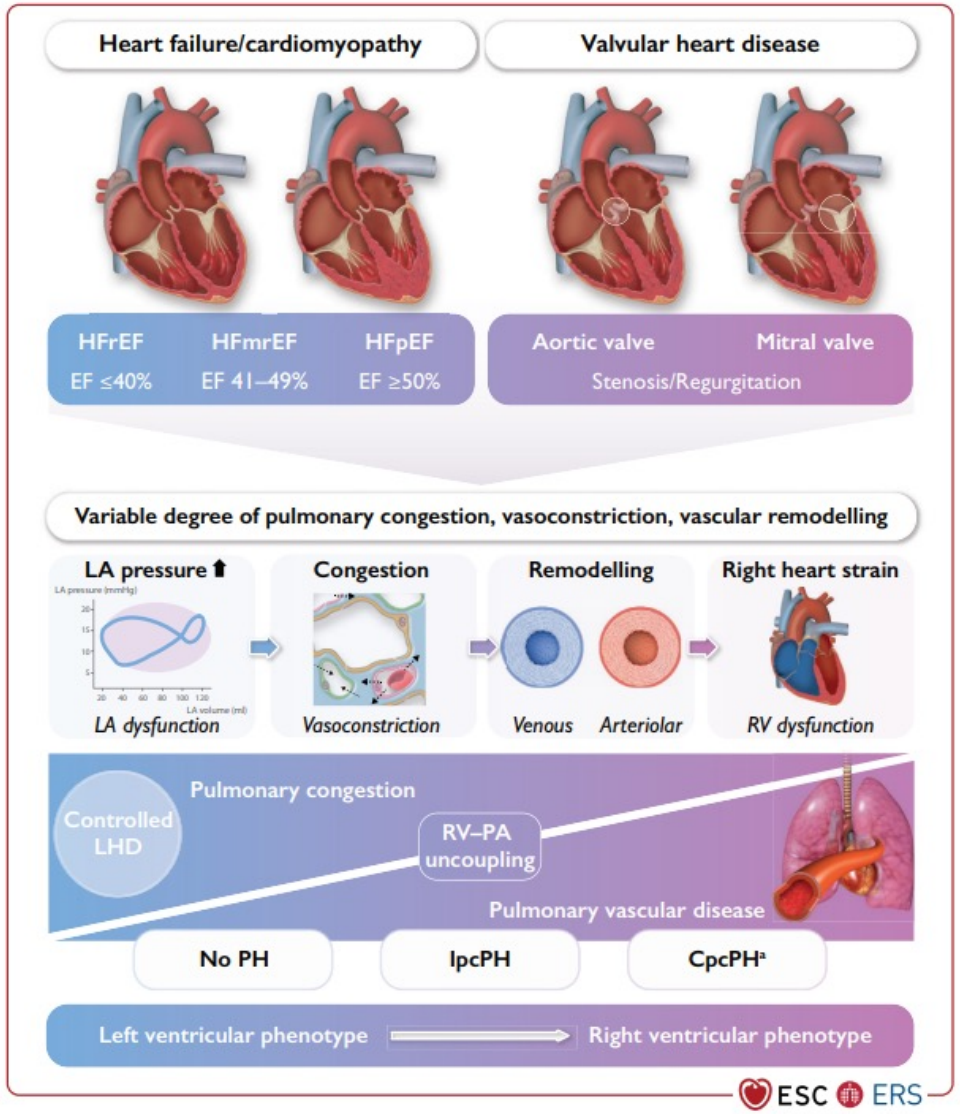
Left sided heart disease

Pulmonary vasodilators contra-indicated in patients with isolated post-capillary pulmonary hypertension

Studies in CpcPH are awaited



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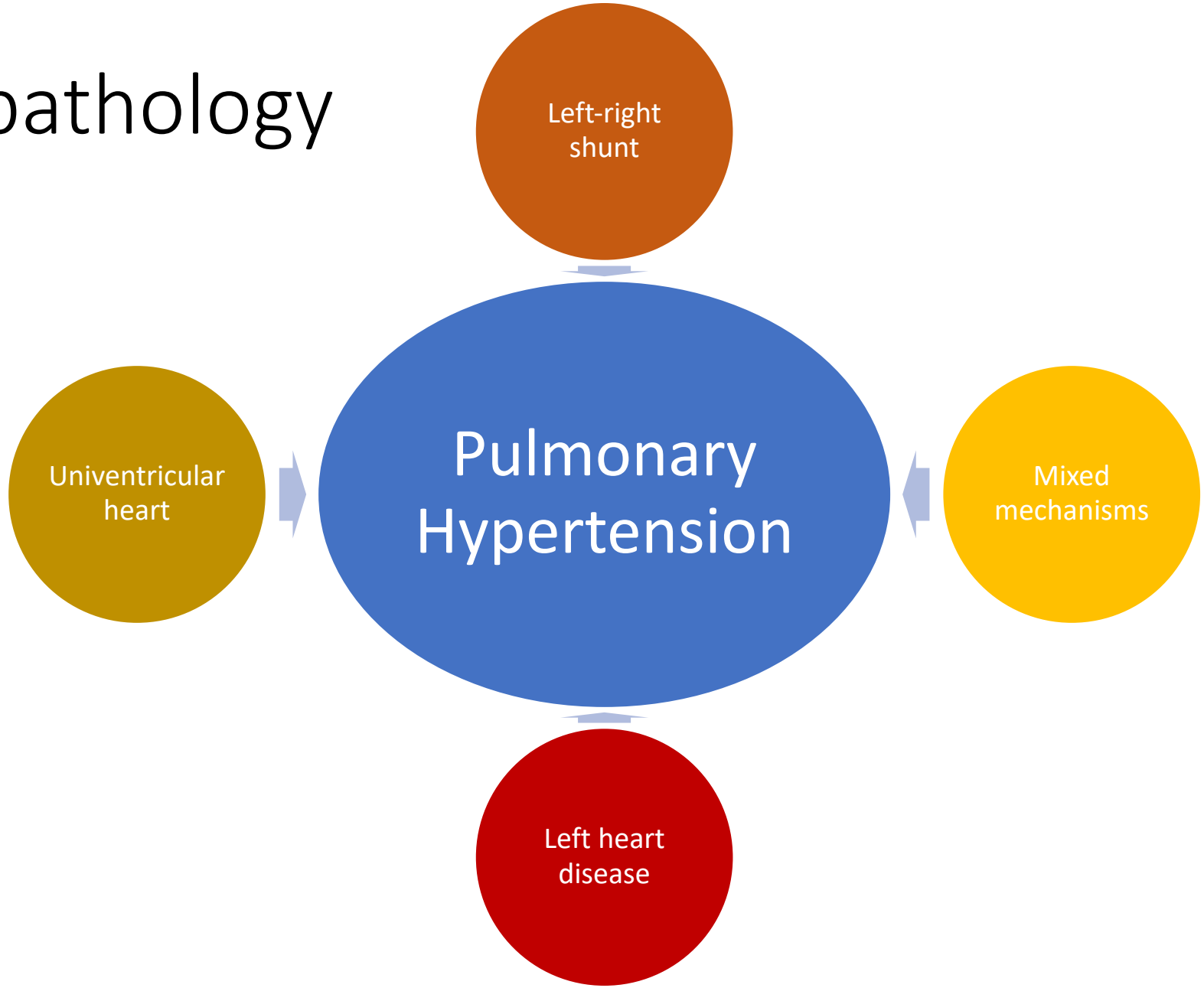

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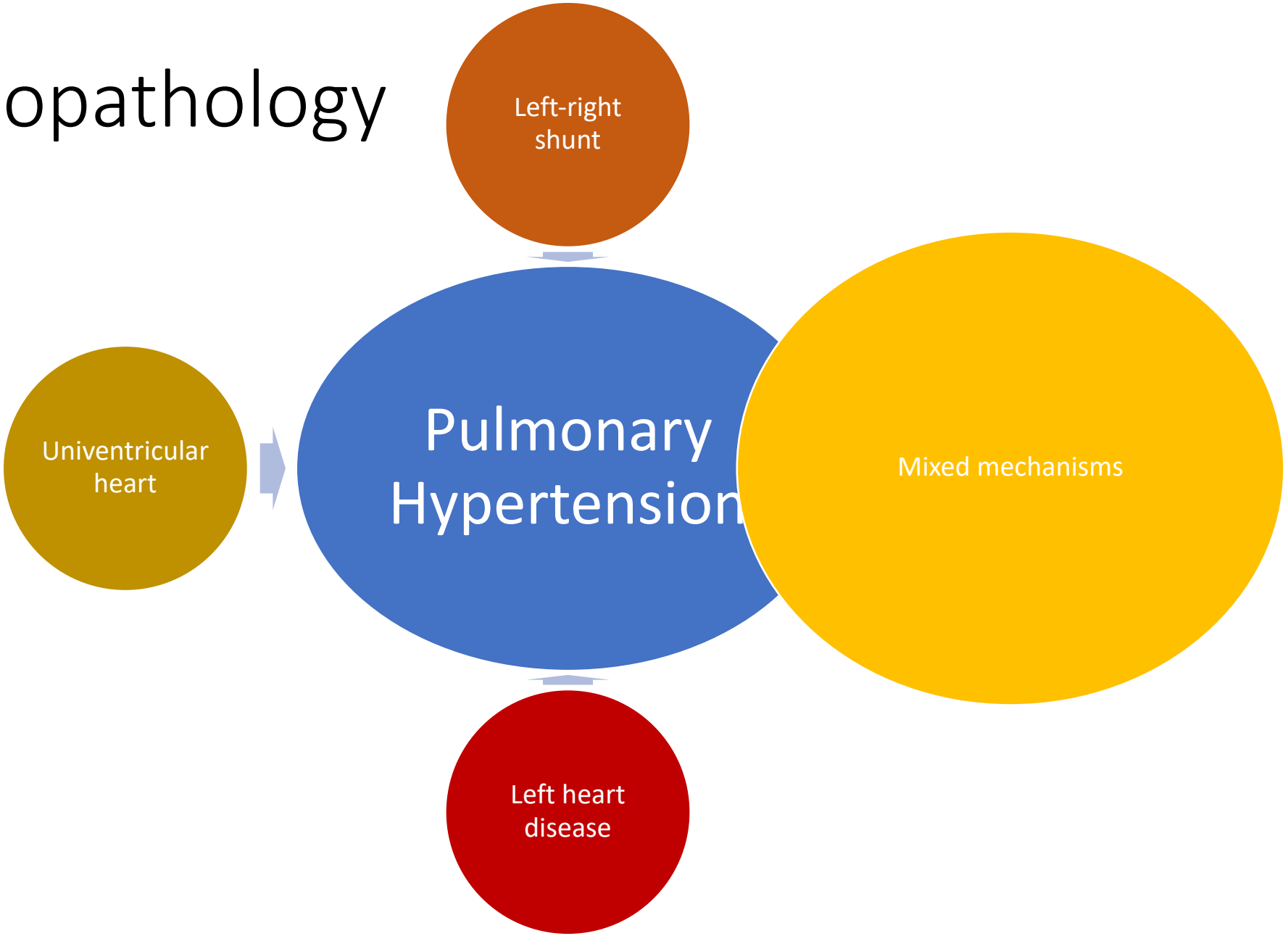

Unclear/mixed mechanisms

TABLE 5 Complex congenital heart disease (group 5.4)

Segmental pulmonary hypertension
- Isolated pulmonary artery of ductal origin
- Absent pulmonary artery
- Pulmonary atresia with ventricular septal defect and major aorto-pulmonary collateral arteries
- Hemitruncus
- Other

Single ventricle
- Unoperated
- Operated

Scimitar syndrome

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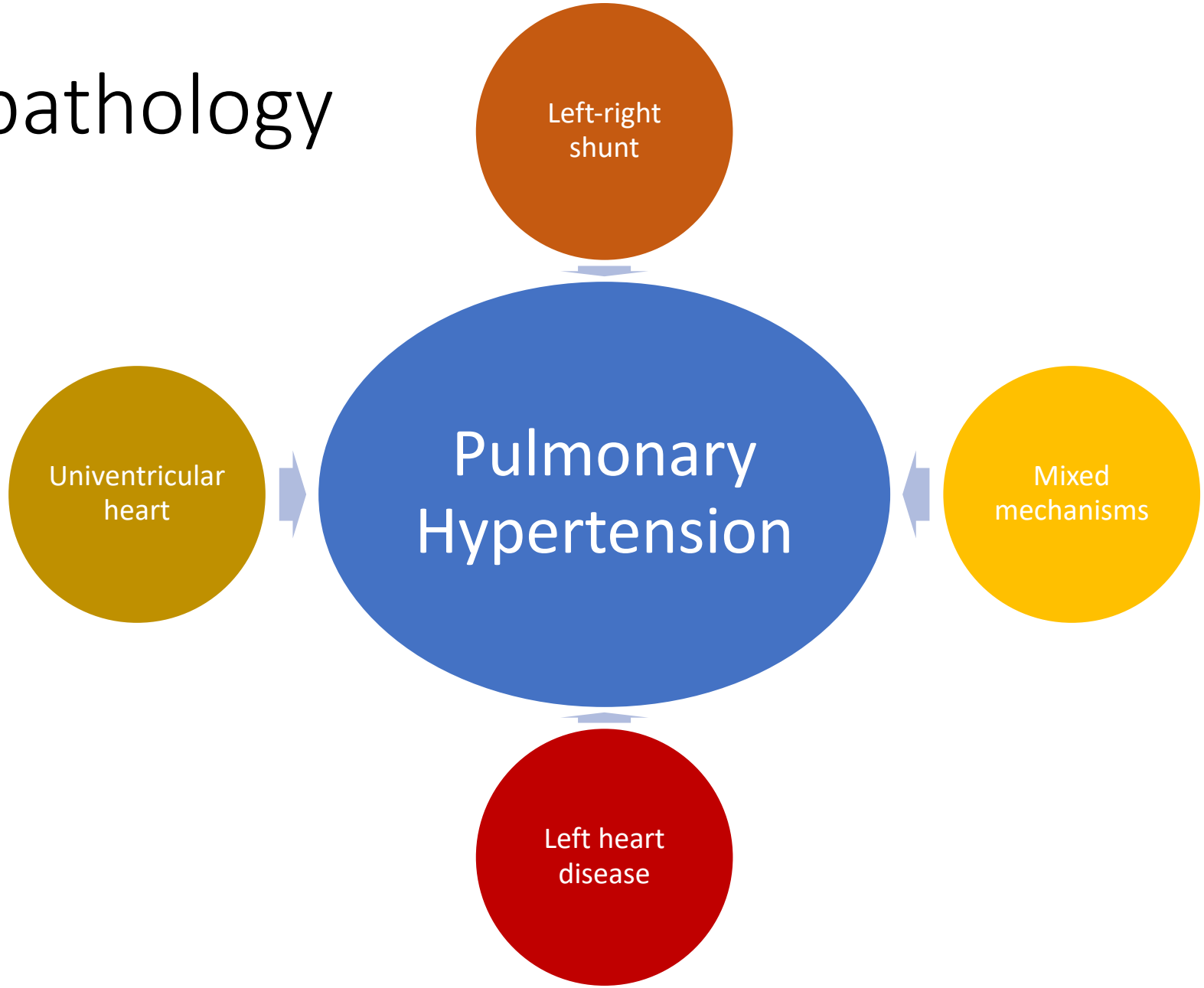
Rosenzweig E 2019

Physiopathology



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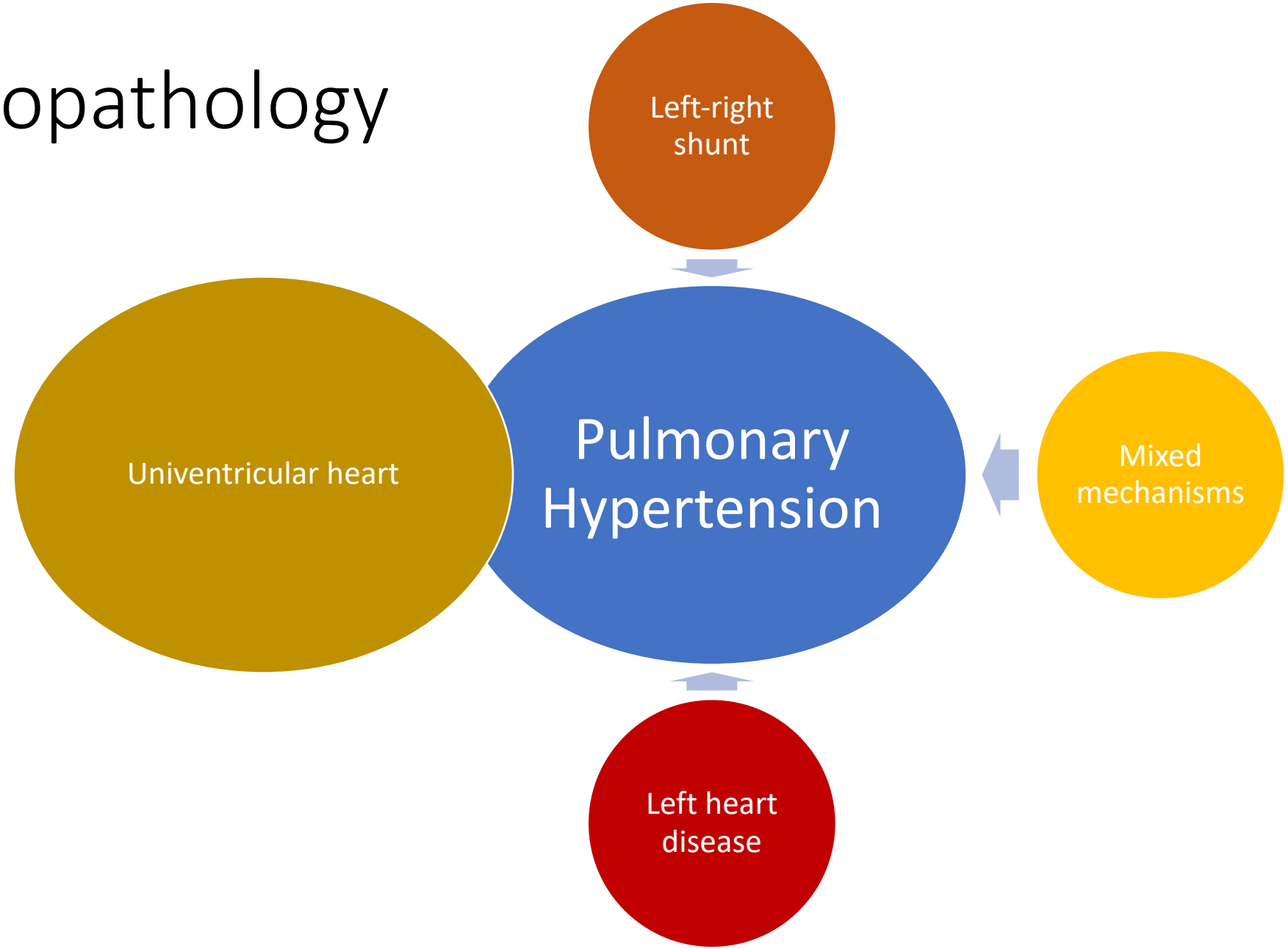
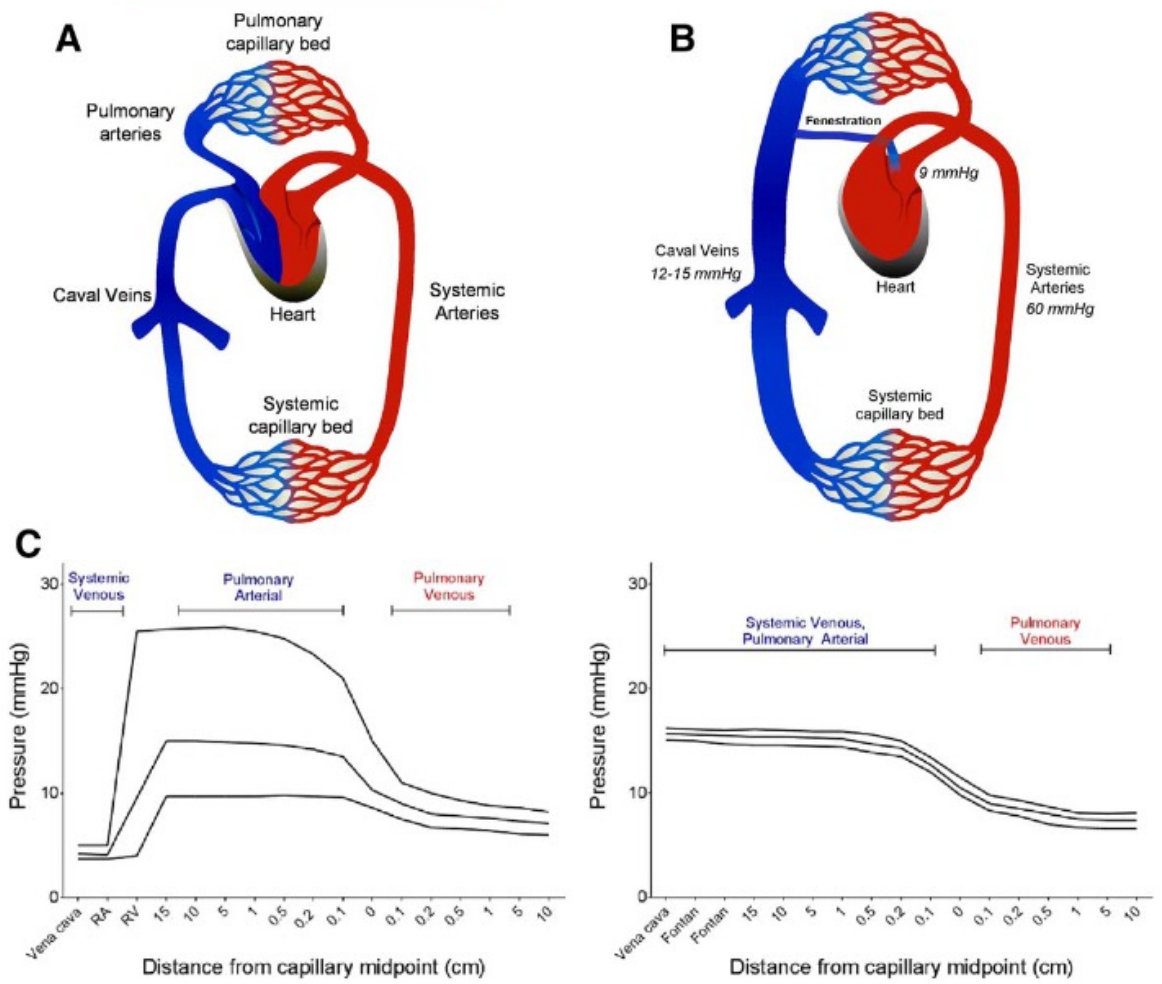
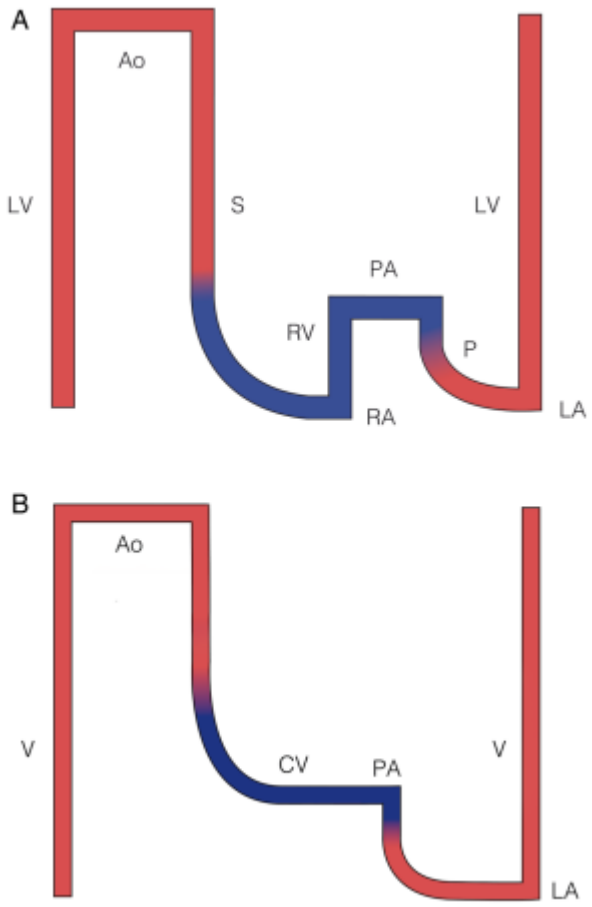


Univentricular heart



Veldtman G 2017

Univentricular heart



In Fontan with increased PVR, pulmonary vasodilators may be of interest

Gewillig M 2016

Future directions

- Pulmonary vasodilators use in Fontan patients
- Pulmonary vasodilators use in CpcPH
- Operability criteria in PAH-CHD

Thank you for your attention