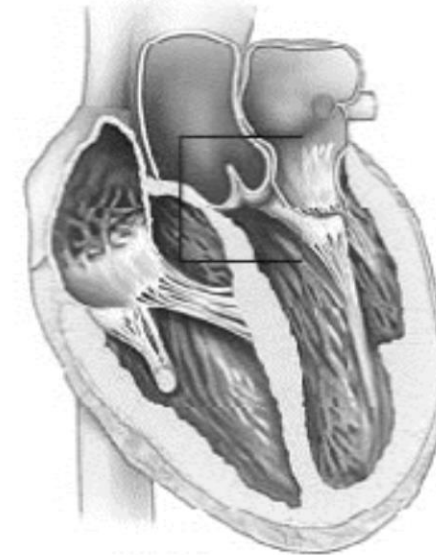
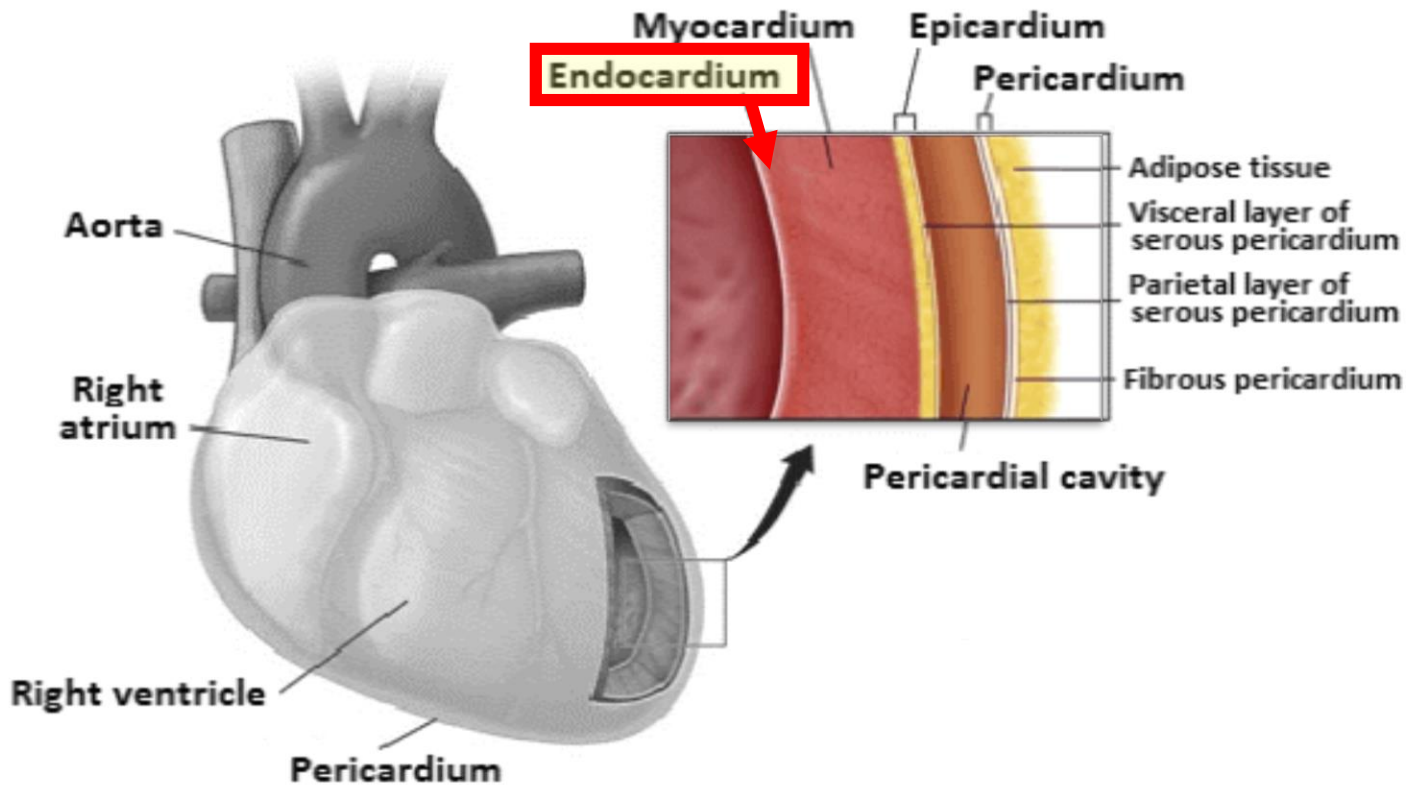


# ***INFECTIVE ENDOCARDITIS***

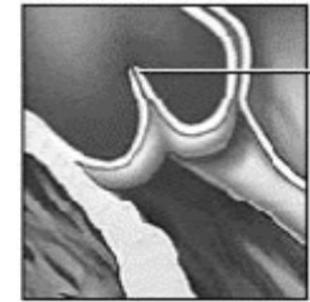
**By**

**Dr. Sheerwan Bahaa Assim  
Interventional Cardiologist**

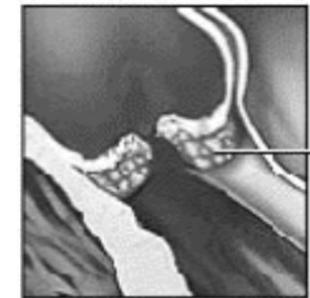
# Endocarditis



Cross section of the heart



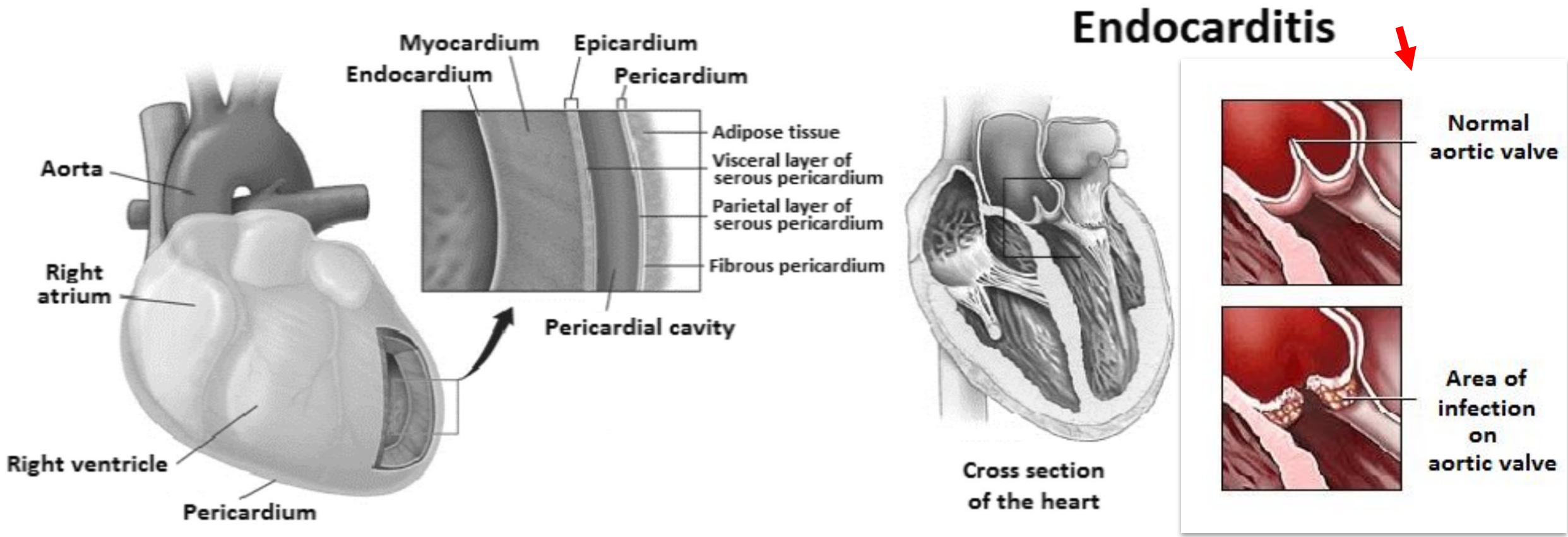
Normal aortic valve



Area of infection on aortic valve

## What is the endocardium?

The heart's endocardium is the innermost layer of tissue that lines the chambers of the heart. It covers the [left atrium](#), the [right atrium](#), the [left ventricle](#), and the [right ventricle](#). In addition, It covers and forms the surface of the four heart valves.



## What is the endocardium?

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## Infective endocarditis

Microbial infection of endocardium of any of the following:

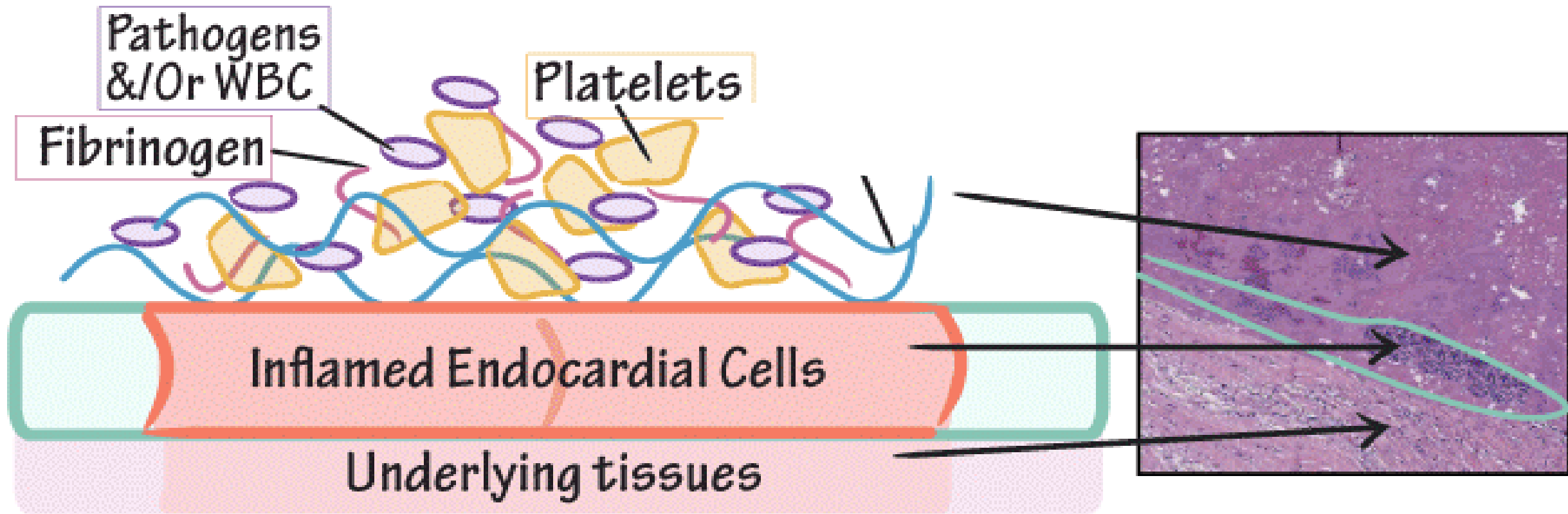
- a heart valve ( both native and prosthetic valves)
- the lining of a cardiac chamber
- congenital heart defects

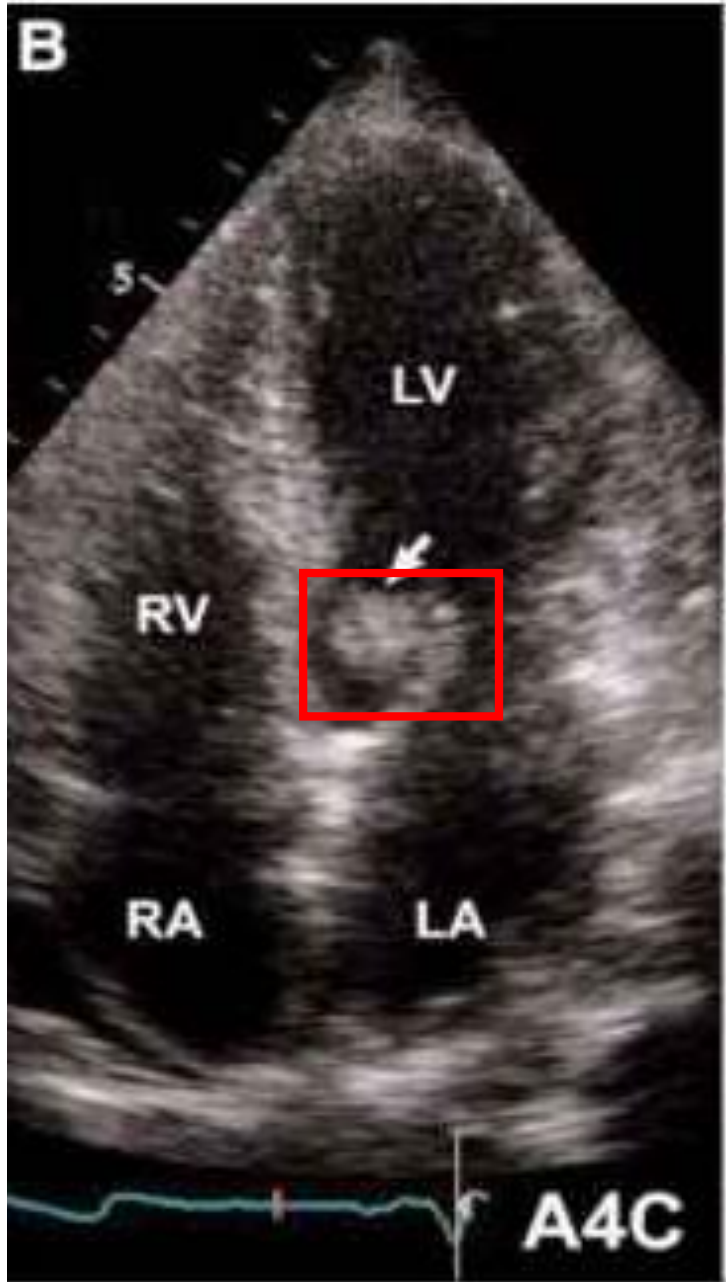
## Pathophysiology

Abnormal heart :Infective endocarditis typically occurs at sites of pre-existing endocardial damage

Normal heart : infection with particularly virulent or aggressive organisms such as *Staphylococcus aureus* can cause endocarditis in a previously normal heart.

# Vegetations





LV : left ventricle

LA : left atrium

RV : right ventricle

RA : right atrium

vegetations ( microorganisms, fibrin and platelets)

→ grow and may become large

→ obstruction

→ embolism:e.g. to brain ( CVA) , to kidney ( renal failure) , limbs ( limb ischemia)

→ Adjacent tissues are destroyed → abscess formation

→ valve damage → heart failure



## Microbiology

Over three-quarters of cases are caused by streptococci or staphylococci.

1- Staph. aureus

Origin : skin infections, abscesses or vascular access sites or from intravenous drug use.

2- **Viridans streptococci (such as Strep. mitis and Strep. sanguis )**

**Origin: chewing or tooth-brushing, or at the time of dental treatment, and are common causes of subacute endocarditis**

**3- HACEK group (Haemophilus aphrophilus , Aggregatibacter actinomycetemcomitans; Cardiobacterium hominis; Eikenella corrodens; and Kingella kingae)**

**Origin : poor dental hygiene and recent dental procedures**

4- Coagulase-negative staphylococci such as Staph. Epidermidis

Origin : part of the normal skin flora.

Post-operative endocarditis after cardiac surgery.

5- Enterococcus faecalis, E. faecium and Strep. gallolyticus (previously known as Strep. bovis)

Origin: bowel or urinary tract.

6- *Brucella endocarditis*

*Origin: contact with goats or cattle.*

7- Yeasts and fungi

*Origin: immunocompromised patients or those with in-dwelling intravenous catheters.*

## i

## 16.94 Microbiology of infective endocarditis

Pathogen	Of native valve (n = 280)	In injection drug users (n = 87)	Of prosthetic valve	
			Early (n = 15)	Late (n = 72)
<b>Staphylococci</b>	124 (44%)	60 (69%)	10 (67%)	33 (46%)
<i>Staph. aureus</i>	106 (38%)	60 (69%)	3 (20%)	15 (21%)
Coagulase-negative	18 (6%)	0	7 (47%)	18 (25%)
<b>Streptococci</b>	86 (31%)	7 (8%)	0	25 (35%)
Oral	59 (21%)	3 (3%)	0	19 (26%)
Others (non-enterococcal)	27 (10%)	4 (5%)	0	6 (8%)
<b><i>Enterococcus</i> spp.</b>	21 (8%)	2 (2%)	1 (7%)	5 (7%)
<b>HACEK</b>	12 (4%)	0	0	1 (1%)
<b>Polymicrobial</b>	6 (2%)	8 (9%)	0	1 (1%)
<b>Other bacteria</b>	12 (4%)	4 (5%)	0	2 (3%)
<b>Fungi</b>	3 (1%)	2 (2%)	0	0
<b>Negative blood culture</b>	16 (6%)	4 (5%)	4 (27%)	5 (7%)

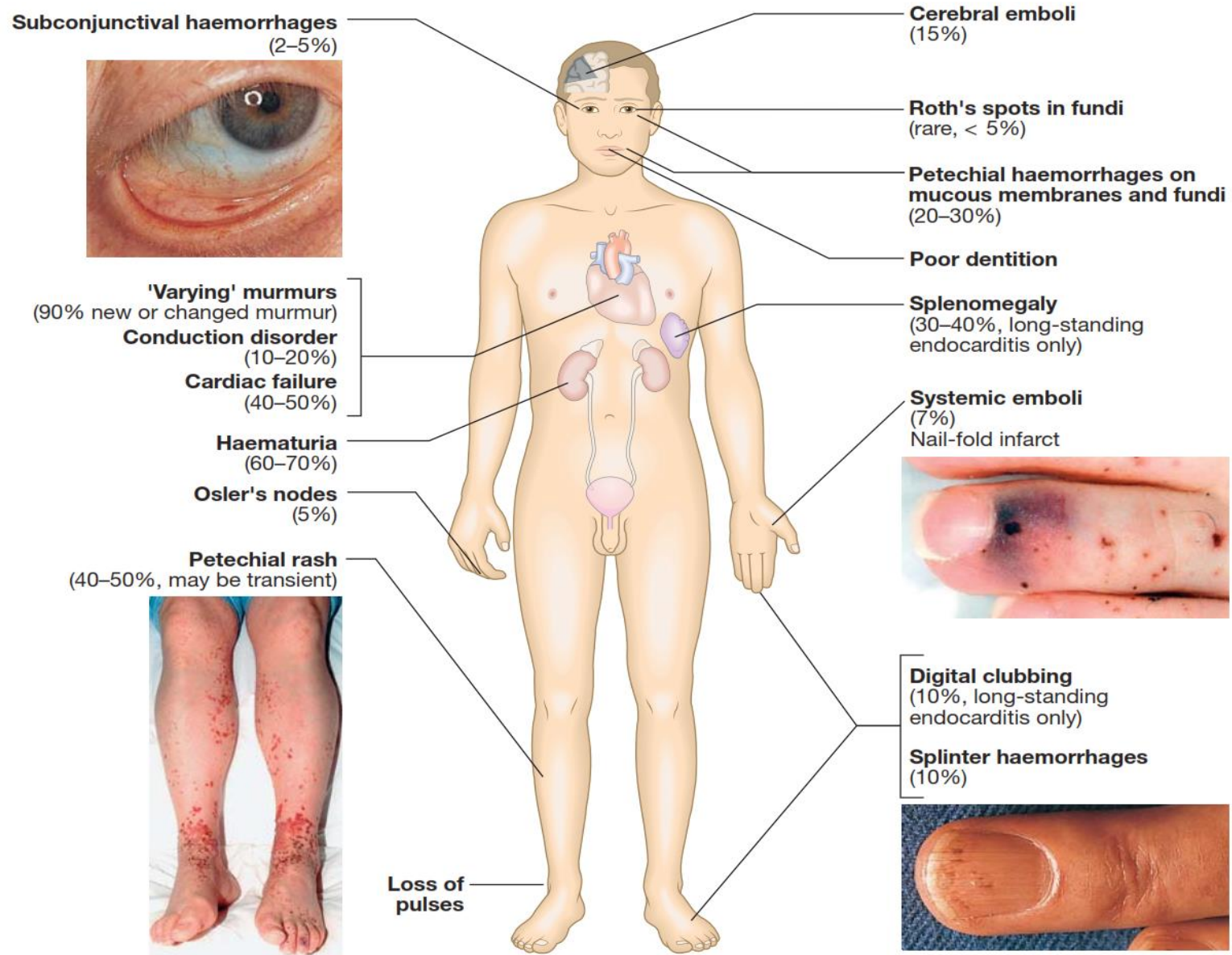
(HACEK = *Haemophilus aphrophilus* – now known as *Aggregatibacter aphrophilus*–*Aggregatibacter actinomycetemcomitans*; *Cardiobacterium hominis*; *Eikenella corrodens*; and *Kingella kingae*)

Adapted from Moreillon P, Que YA. Infective endocarditis. *Lancet* 2004; 363:139–149.

## Clinical features

This should be suspected when a patient with congenital or valvular heart disease develops a persistent fever, unusual tiredness, night sweats or weight loss, or develops new signs of valve dysfunction or heart failure.

Less often, it presents with:



**Fig. 16.89** Clinical features that may be present in endocarditis. Insets (Petechial rash, nail-fold infarct). From Newby D, Grubb N. *Cardiology: an*

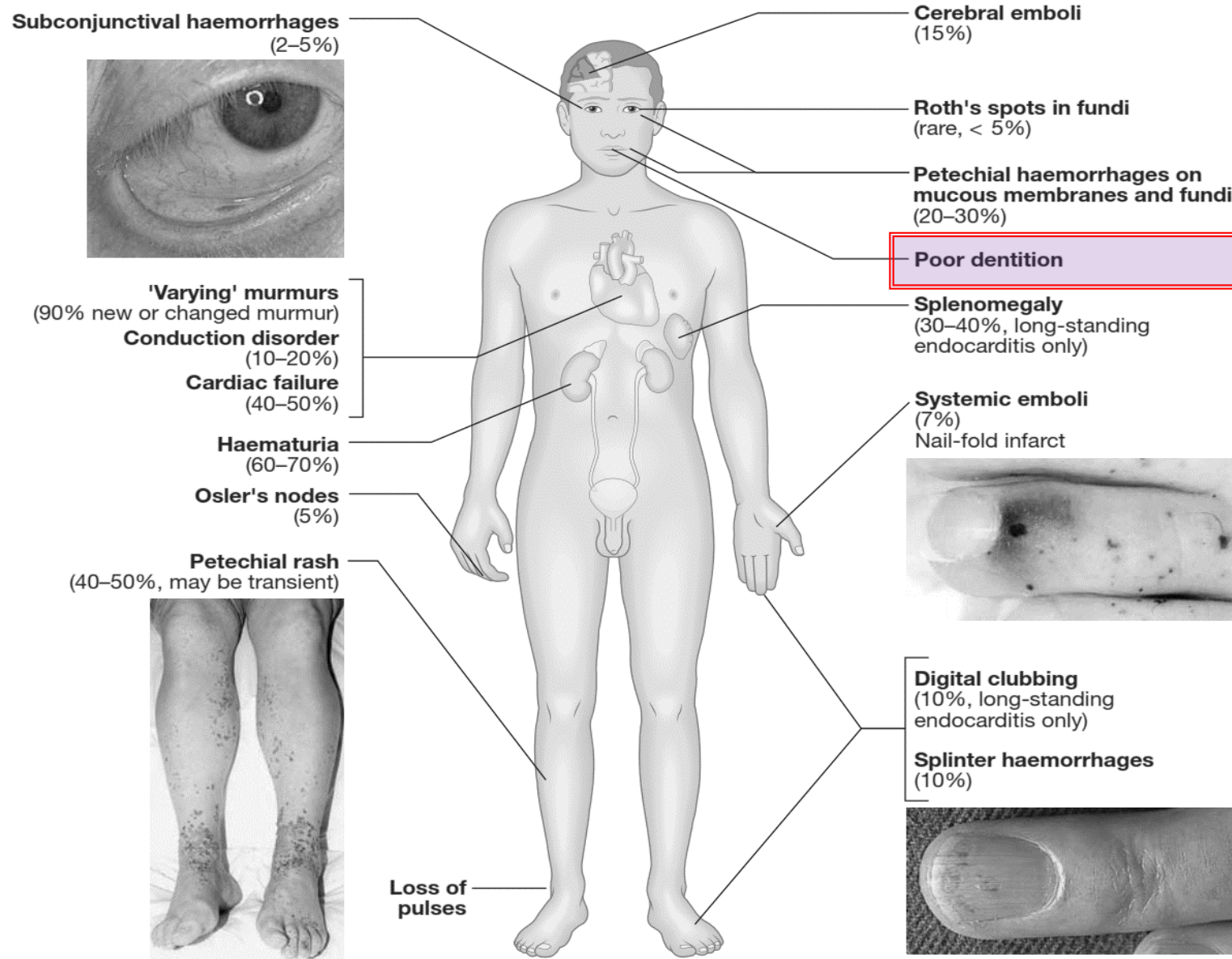


Fig. 16.89 Clinical features that may be present in endocarditis. Insets (Petechial rash, nail-fold infarct) From Newby D, Grubb N. *Cardiology: an*



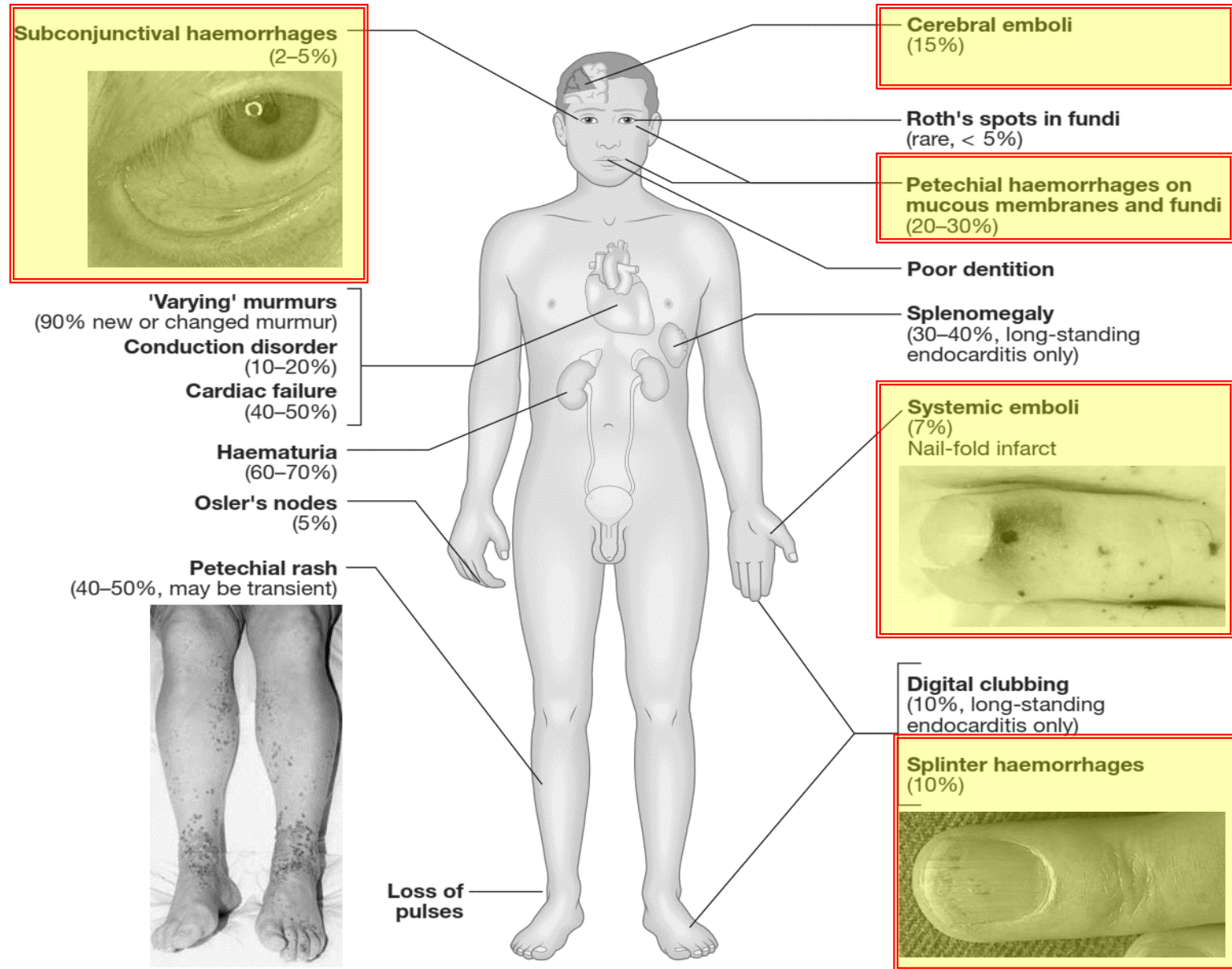


Fig. 16.89 Clinical features that may be present in endocarditis. Insets (Petechial rash, nail-fold infarct) From Newby D, Grubb N. *Cardiology: an*

**Emboic phenomenon**



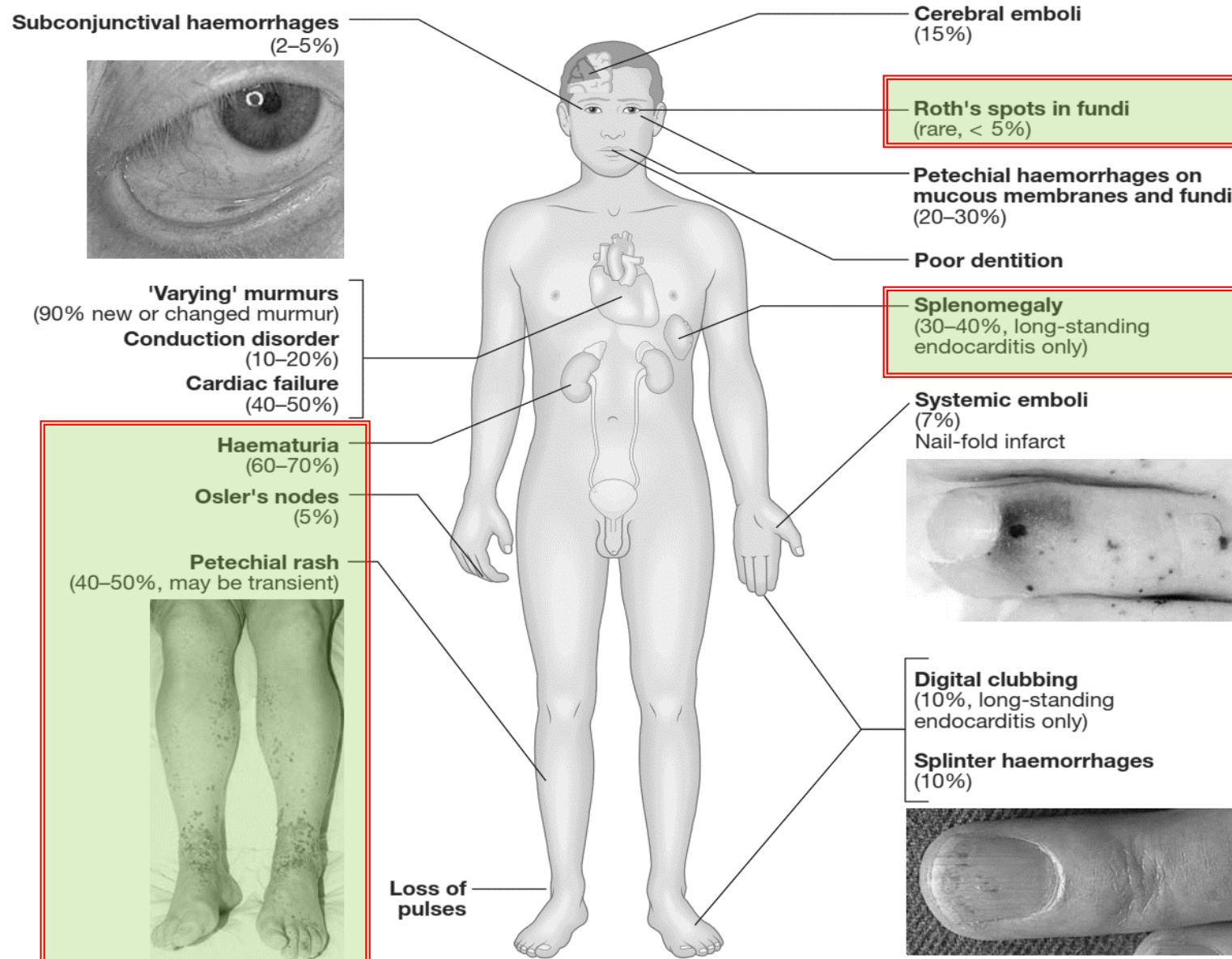


Fig. 16.89 Clinical features that may be present in endocarditis. Insets (Petechial rash, nail-fold infarct) From Newby D, Grubb N. *Cardiology: an*

**Vasculitic (immune phenomenon)**



## 16.95 Diagnosis of infective endocarditis\*

### Major criteria

#### Positive blood culture

- Typical organism from two cultures

- P

- T

#### Endo

- P

- N

#### Minor

- P

- Intravenous drug misuse

- Pyrexia  $\geq 38^{\circ}\text{C}$

- Embolic phenomenon

- Vasculitic phenomenon

- Blood cultures suggestive: organism grown but not achieving major criteria

- Suggestive echocardiographic findings

\*Modified Duke criteria. Patients with two major, or one major and three minor, or five minor have definite endocarditis. Patients with one major and one minor, or three minor have possible endocarditis.



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**i****16.95 Diagnosis of infective endocarditis\*****Major criteria****Positive blood culture**

- Typical organism from two cultures
- Persistent positive blood cultures taken >12 hrs apart
- Three or more positive cultures taken over >1 hr


**Endocardial involvement**

- Positive echocardiographic findings of vegetations
- New valvular regurgitation

**Minor criteria**

- Predisposing valvular or cardiac abnormality
- Intravenous drug misuse
- Pyrexia  $\geq 38^{\circ}\text{C}$
- Embolic phenomenon
- Vasculitic phenomenon
- Blood cultures suggestive: organism grown but not achieving major criteria
- Suggestive echocardiographic findings

\*Modified Duke criteria. Patients with two major, or one major and three minor, or five minor have definite endocarditis. Patients with one major and one minor, or three minor have possible endocarditis.

- 
- **Viridans streptococci**
  - Streptococcus bovis
  - **HACEK group**
  - Staphylococcus aureus
  - Enterococci, in the absence of a primary focus

## Empirical treatment

### Subacute presentation :

antibiotic treatment should ideally be withheld until the results of blood cultures are available.

### Acute presentation :

**Initially**, empirical therapy should be started, after blood samples for blood culture are drawn, with:

- Native valve endocarditis : vancomycin IV and gentamicin IV
- Prosthetic valve endocarditis : vancomycin IV and gentamicin IV plus rifampicin orally.

**Then**, Specific treatment : Results of blood culture and sensitivity ( MIC = minimum inhibitory concentration of drugs) help to guide antibiotic therapy



Antimicrobial susceptibility	Antimicrobial	Dose	Duration	
			Native valve	Prosthetic valve
<b>Streptococci</b>				
Penicillin MIC $\leq 0.125$ mg/L	Benzylpenicillin IV	1.2 g 6 times daily	4 weeks <sup>1</sup>	6 weeks
Penicillin MIC $> 0.125$ , $\leq 0.5$ mg/L	Benzylpenicillin IV and gentamicin IV	2.4 g 6 times daily 1 mg/kg twice daily <sup>2</sup>	4 weeks 2 weeks	6 weeks 2 weeks
Penicillin MIC $> 0.5$ mg/L	Vancomycin IV and gentamicin IV	1 g twice daily <sup>3</sup> 1 mg/kg twice daily <sup>2</sup>	4 weeks 4 weeks	6 weeks 6 weeks
<b>Enterococci</b>				
Amoxicillin MIC $\leq 4$ mg/L and gentamicin MIC $\leq 128$ mg/L	Amoxicillin IV and gentamicin IV <sup>2</sup>	2 g 6 times daily 1 mg/kg twice daily <sup>2</sup>	4 weeks 4 weeks	6 weeks 6 weeks
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<b>Staphylococci – native valve</b>				
Meticillin-sensitive	Flucloxacillin IV	2 g 4–6 times daily <sup>4</sup>	4 weeks	–
Meticillin-resistant, vancomycin MIC $\leq 2$ mg/L, rifampicin-sensitive	Vancomycin IV Rifampicin orally	1 g twice daily <sup>3</sup> 300–600 mg twice daily	4 weeks 4 weeks	– –
<b>Staphylococci – prosthetic valve</b>				
Meticillin-sensitive	Flucloxacillin IV and gentamicin IV and rifampicin orally	2 g 4–6 times daily 1 mg/kg twice daily <sup>2</sup> 300–600 mg twice daily	– – –	6 weeks 6 weeks 6 weeks
Meticillin-resistant, vancomycin MIC $\leq 2$ mg/L, rifampicin-sensitive	Vancomycin IV and rifampicin orally	1 g twice daily <sup>3</sup> 300–600 mg twice daily	– –	6 weeks 6 weeks

<sup>1</sup>When conditions in Box 16.97 are met, 2 weeks of benzylpenicillin and gentamicin (1 mg/kg twice daily) may be sufficient. Ceftriaxone 2 g once daily IV/IM can be used instead of benzylpenicillin for those with non-severe penicillin allergy. <sup>2</sup>Pre-dose gentamicin level should be  $\leq 1$  mg/L, post-dose 3–5 mg/L. Adjust dose according to levels and renal function. <sup>3</sup>Pre-dose vancomycin level should be 15–20 mg/L. Adjust dose according to levels and renal function. <sup>4</sup>Use 6 times daily if weight  $> 85$  kg. (IV = intravenous; MIC = minimum inhibitory concentration)

Adapted from Gould FK, Denning DW, Elliott TS, et al. Guidelines for the diagnosis and antibiotic treatment of endocarditis in adults: a report of the working party of the British Society for Antimicrobial Chemotherapy. *J Antimicrob Chemother* 2012; 67:269–289.

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**i**

## 16.98 Indications for cardiac surgery in infective endocarditis\*

- Heart failure due to valve damage
- Failure of antibiotic therapy (persistent/uncontrolled infection)
- Large vegetations on left-sided heart valves with echo appearance suggesting high risk of emboli
- Previous evidence of systemic emboli
- Abscess formation

\*Patients with prosthetic valve endocarditis or fungal endocarditis often require cardiac surgery.

## **IE prophylaxis:**

- ***Antibiotic prophylaxis***
- ***Non specific preventive measures***



*A/Antibiotic prophylaxis:*

Cardiac conditions  
high risk for infective  
endocarditis

+

Procedures  
high risk for infective  
endocarditis

## **High risk cardiac conditions :**

**Antibiotic prophylaxis should only be considered for:**

- (1) Prosthetic valve
- (2) Previous episode of IE.
- (3) CHD ( congenital heart disease)
  - (a) Cyanotic CHD.
  - (b) CHD repaired with a prosthetic material  
( up to 6 months if complete repair / lifelong if residual shunt remains.)

## **High risk procedures :**

**Antibiotic prophylaxis should only be considered for:**

**Dental procedures requiring :**

- **manipulation of the gingival or periapical region of the teeth**
- **or perforation of the oral mucosa**

***While Antibiotic prophylaxis is NOT recommended for***

***1. Other dental procedures :***

***local anaesthetic injections in non-infected tissues, treatment of superficial caries, removal of sutures, dental X-rays, placement or adjustment of removable prosthodontic or orthodontic appliances or braces or following the shedding of deciduous teeth or trauma to the lips and oral mucosa***

1. Respiratory tract procedures
2. Gastrointestinal or urogenital procedures
3. Skin and soft tissue procedures

## Recommended prophylaxis for high-risk dental procedures in high-risk patients

Situation	Antibiotic	Single-dose 30–60 minutes before procedure	
		Adults	Children
No allergy to penicillin or ampicillin	Amoxicillin or ampicillin <sup>a</sup>	2 g orally or i.v.	50 mg/kg orally or i.v.
Allergy to penicillin or ampicillin	Clindamycin	600 mg orally or i.v.	20 mg/kg orally or i.v.

<sup>a</sup>Alternatively, cephalexin 2 g i.v. for adults or 50 mg/kg i.v. for children, cefazolin or ceftriaxone 1 g i.v. for adults or 50 mg/kg i.v. for children.

Cephalosporins should not be used in patients with anaphylaxis, angio-oedema, or urticaria after intake of penicillin or ampicillin due to cross-sensitivity.

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Cephalosporins should not be used in patients with anaphylaxis, angio-oedema, or urticaria after intake of penicillin or ampicillin due to cross-sensitivity.

## **B/Non-specific prevention measures**

These measures should ideally be applied to the general population and particularly reinforced in high-risk patients:

- **Strict dental and cutaneous hygiene. Dental follow-up should be performed twice a year in high-risk patients and yearly in the others (a standard cardiac centre should include a dental clinic )**
- Disinfection of wounds.
- Curative antibiotics for any focus of bacterial infection.
- Strict infection control measures for any at-risk procedure.
  - No self-medication with antibiotics.
- Discourage piercing and tattooing.

# **HEART FAILURE**

**By**

**Dr. Sheerwan Bahaa Assim  
Interventional Cardiologist**

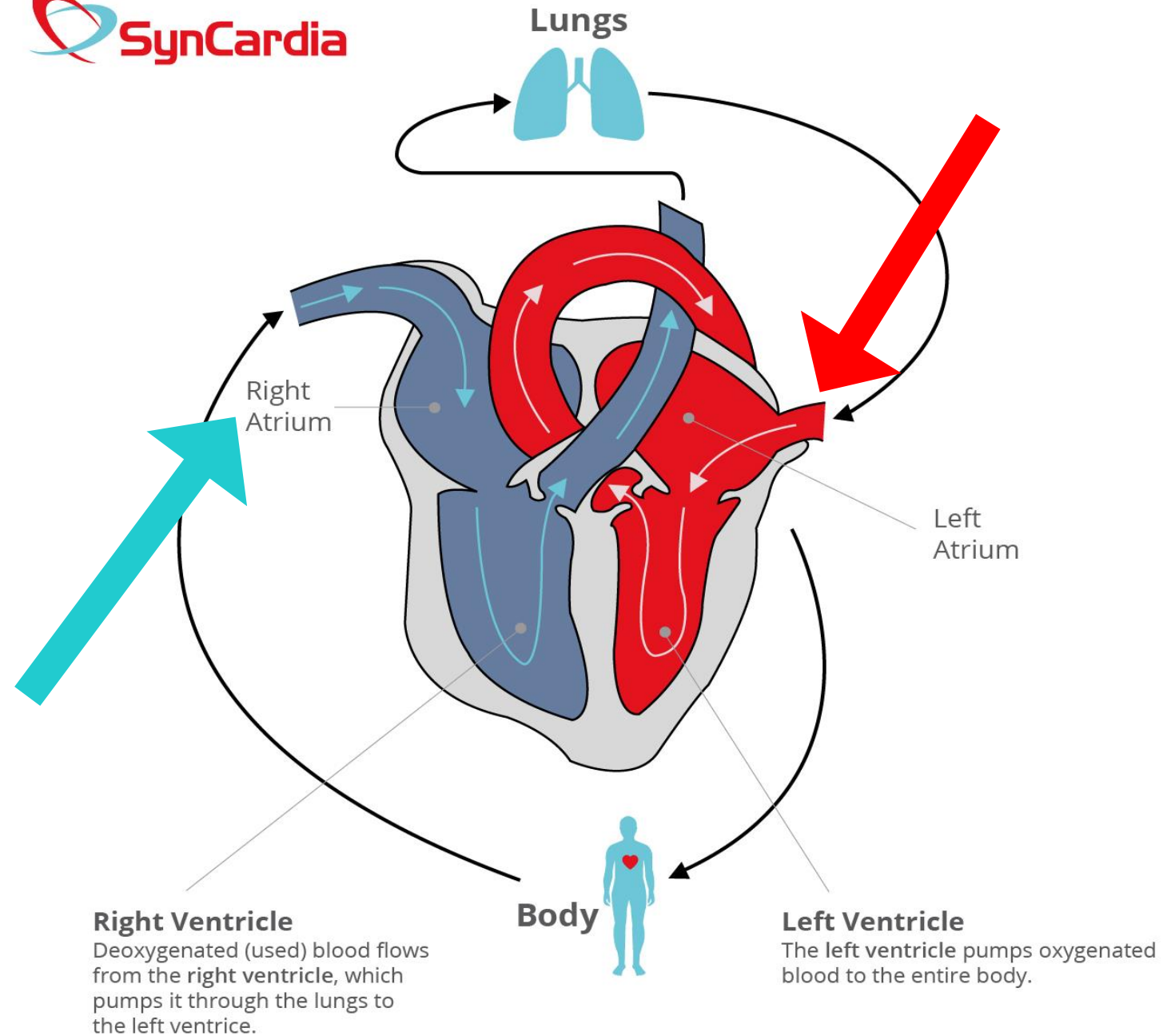


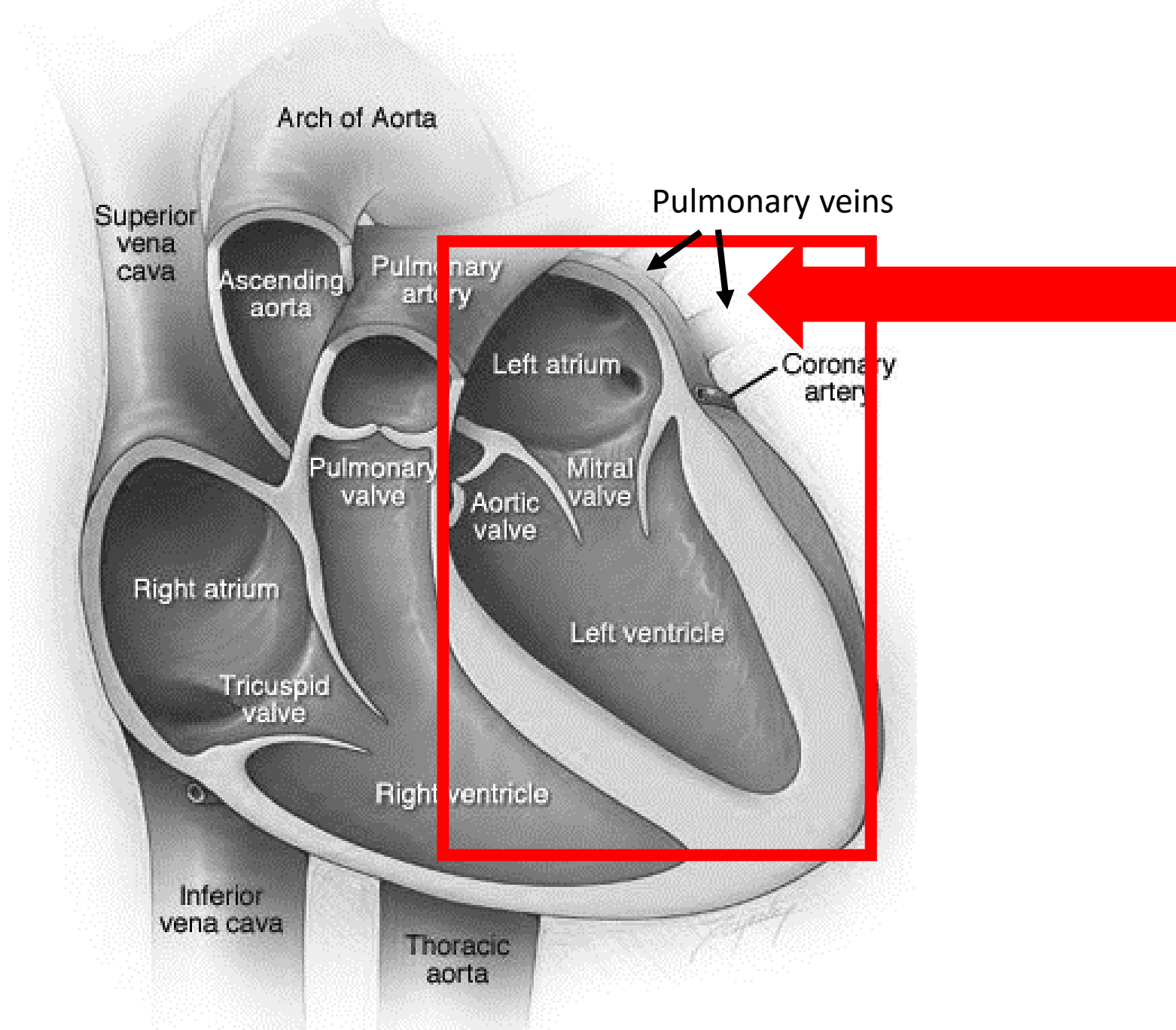


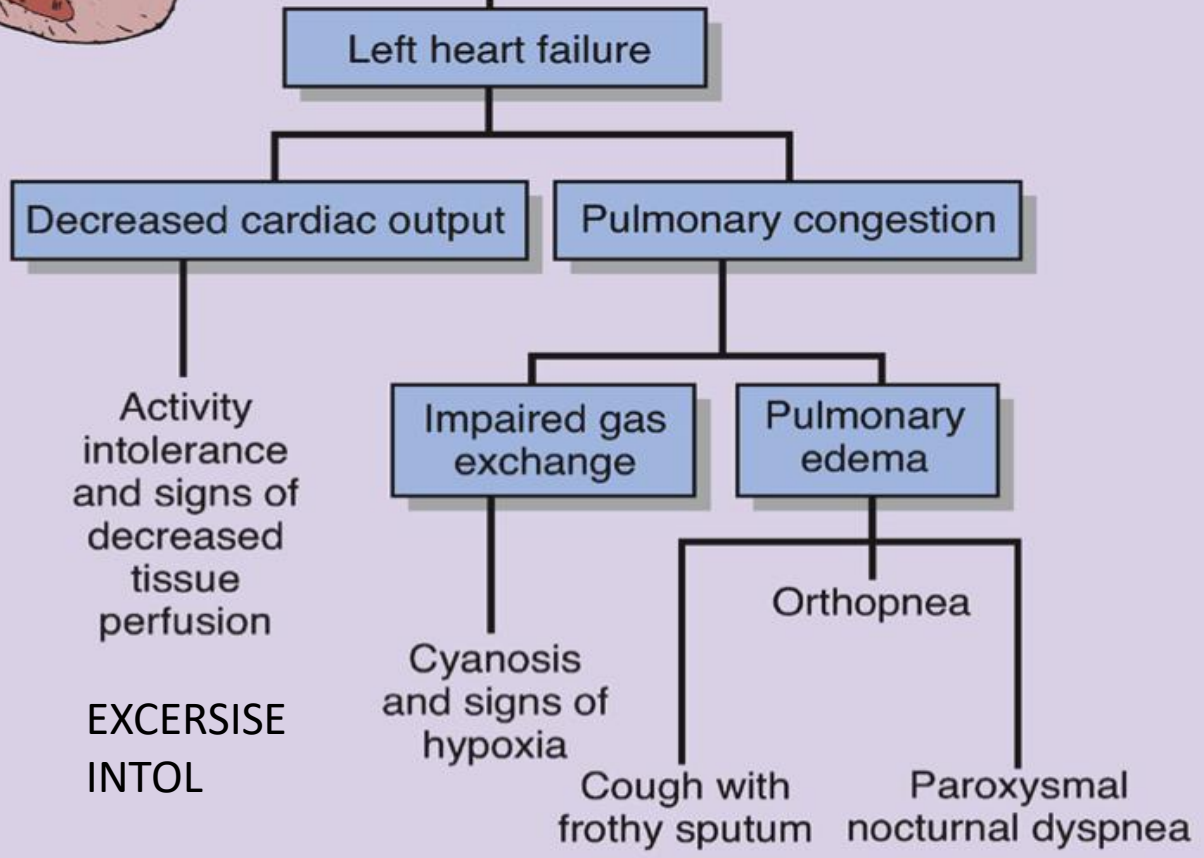
## **HEART FAILURE**

The heart cannot maintain adequate cardiac output

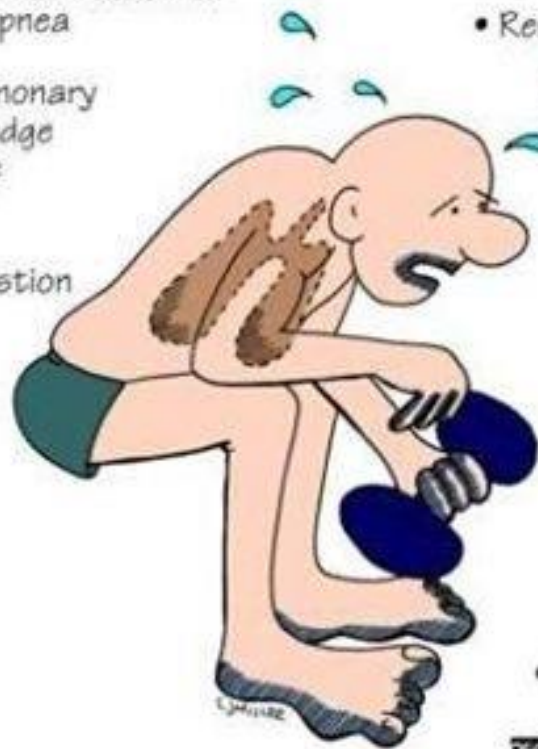






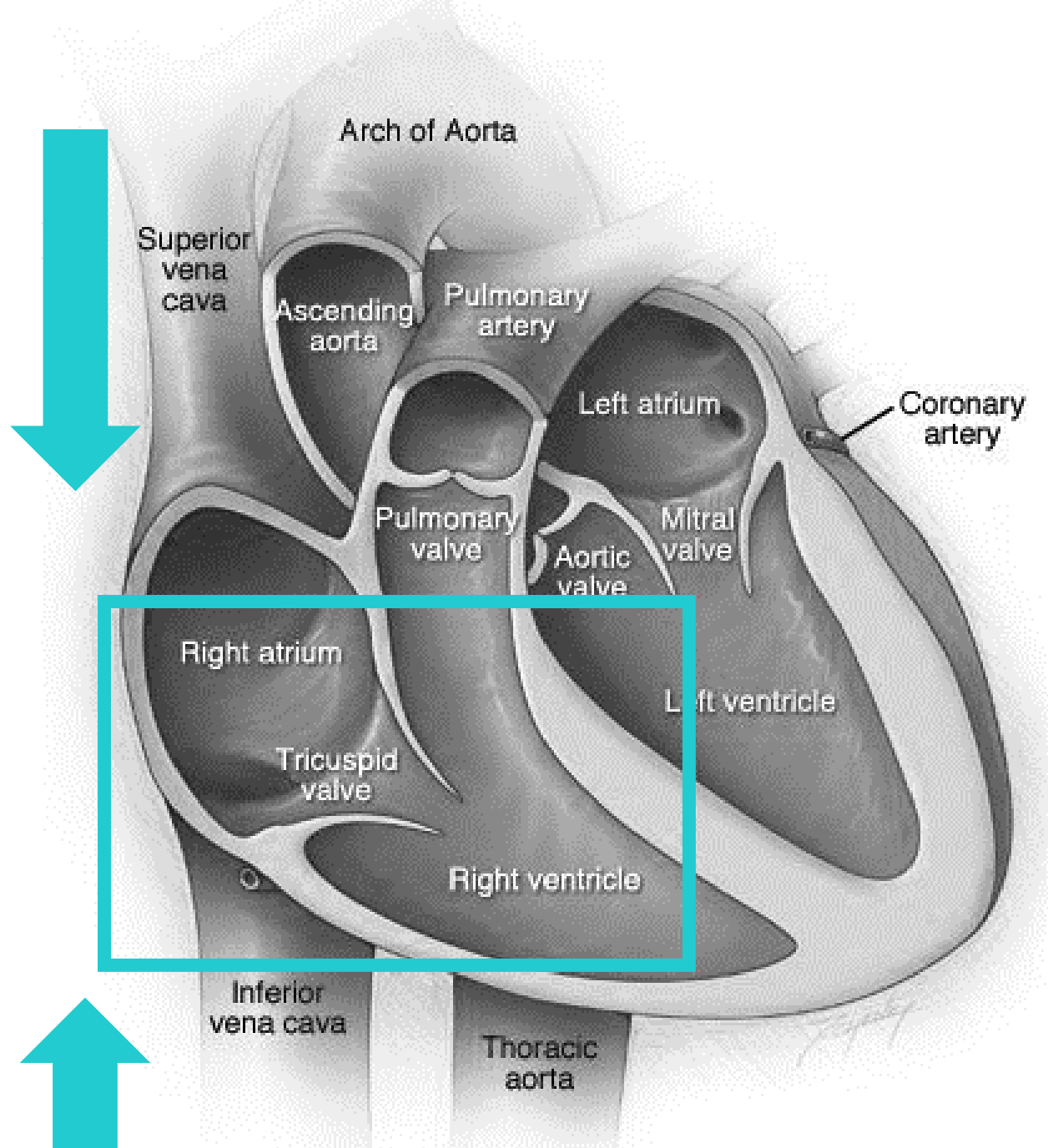


# LEFT SIDED ❤️ FAILURE

- Paroxysmal Nocturnal Dyspnea
  - Elevated Pulmonary Capillary Wedge Pressure
  - Pulmonary Congestion
    - Cough
    - Crackles
    - Wheezes
    - Blood-Tinged Sputum
    - Tachypnea
  - Restlessness
  - Confusion
  - Orthopnea
  - Tachycardia
  - Exertional Dyspnea
  - Fatigue
  - Cyanosis
- 

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Right heart failure

Congestion of peripheral tissues

Dependent edema and ascites

Liver congestion

GI tract congestion

Signs related to impaired liver function

Anorexia, GI distress, weight loss



# RIGHT SIDED ♥ FAILURE

(Cor Pulmonale)

- 
- Fatigue
  - ↑ Peripheral Venous Pressure
  - Ascites
  - Enlarged Liver & Spleen
  - May be secondary to chronic pulmonary problems
  - Distended Jugular Veins
  - Anorexia & Complaints of GI Distress
  - Weight Gain
  - Dependent Edema

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## **BIVENTRICULAR HEART FAILURE**

This may occur because the disease process, such as dilated cardiomyopathy or ischaemic heart disease, affects both ventricles

or because disease of the left heart leads to chronic elevation of the left atrial pressure, pulmonary hypertension and right heart failure.



## Etiologies:

- Myocardial disease: Cardiomyopathy, Myocardial infarction
- Pericardial disease : Constrictive pericarditis, Cardiac tamponade
- Valvular disease: stenosis or regurgitation
- Congenital or acquired heart defect : ASD , VSD , PDA
- Increase metabolic demand: high output severe anaemia or thyrotoxicosis



# **Acute heart failure**

sudden onset of dyspnoea at rest that rapidly progresses to acute respiratory distress and prostration.



**i**

## 16.13 Factors that may precipitate or aggravate heart failure in pre-existing heart disease

- Myocardial ischaemia or infarction
- Intercurrent illness
- Arrhythmia
- Inappropriate reduction of therapy
- Administration of a drug with negative inotropic ( $\beta$ -blocker) or fluid-retaining properties (non-steroidal anti-inflammatory drugs, glucocorticoids)
- Pulmonary embolism
- Conditions associated with increased metabolic demand (pregnancy, thyrotoxicosis, anaemia)
- Intravenous fluid overload



- F** Intravenous **F**luid overload
- A** **A**rrhythmias
- I** Myocardial **i**schaemia or **i**nfarction / Intercurrent **i**llness
- L** **L**ow compliance with treatment and diet
- E** Pulmonary **E**mbolism
- D** wrong **D**rug



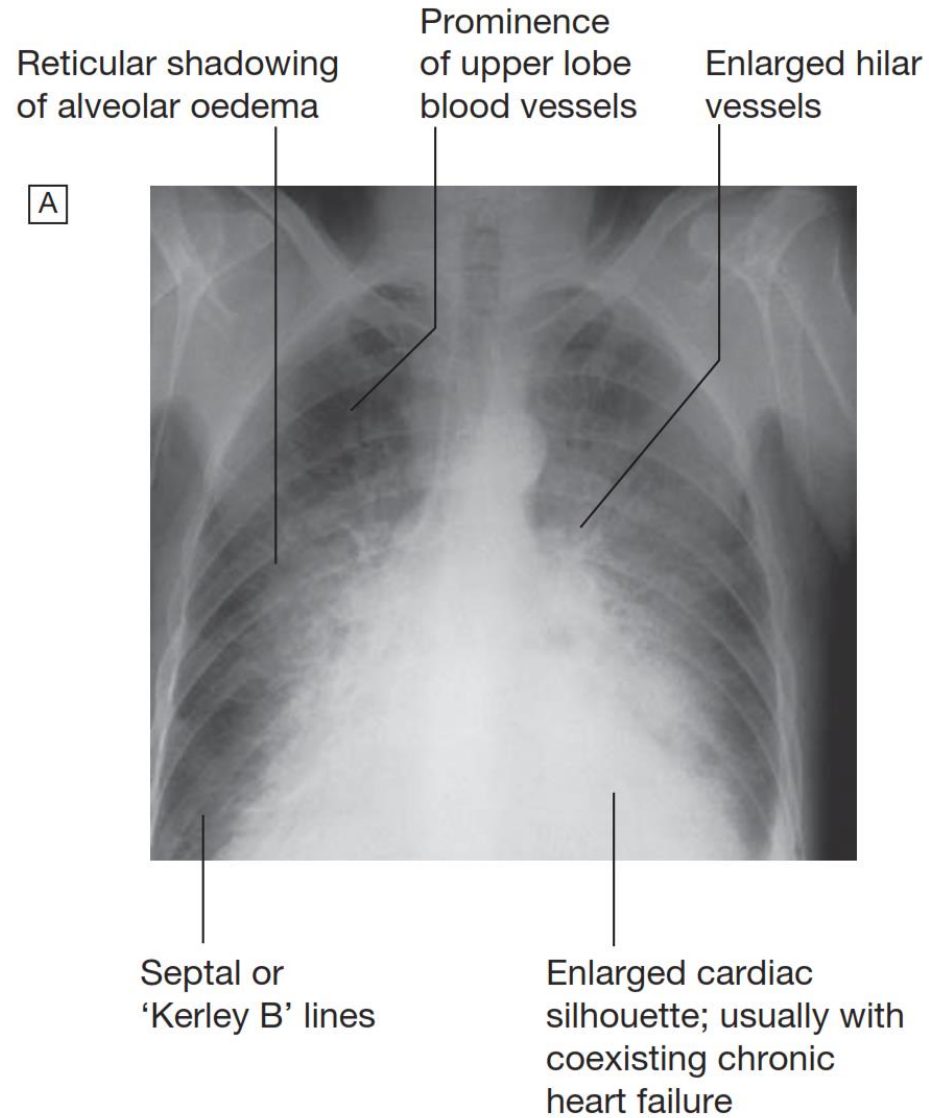
# Investigations





# Investigations

## 1- chest X-ray



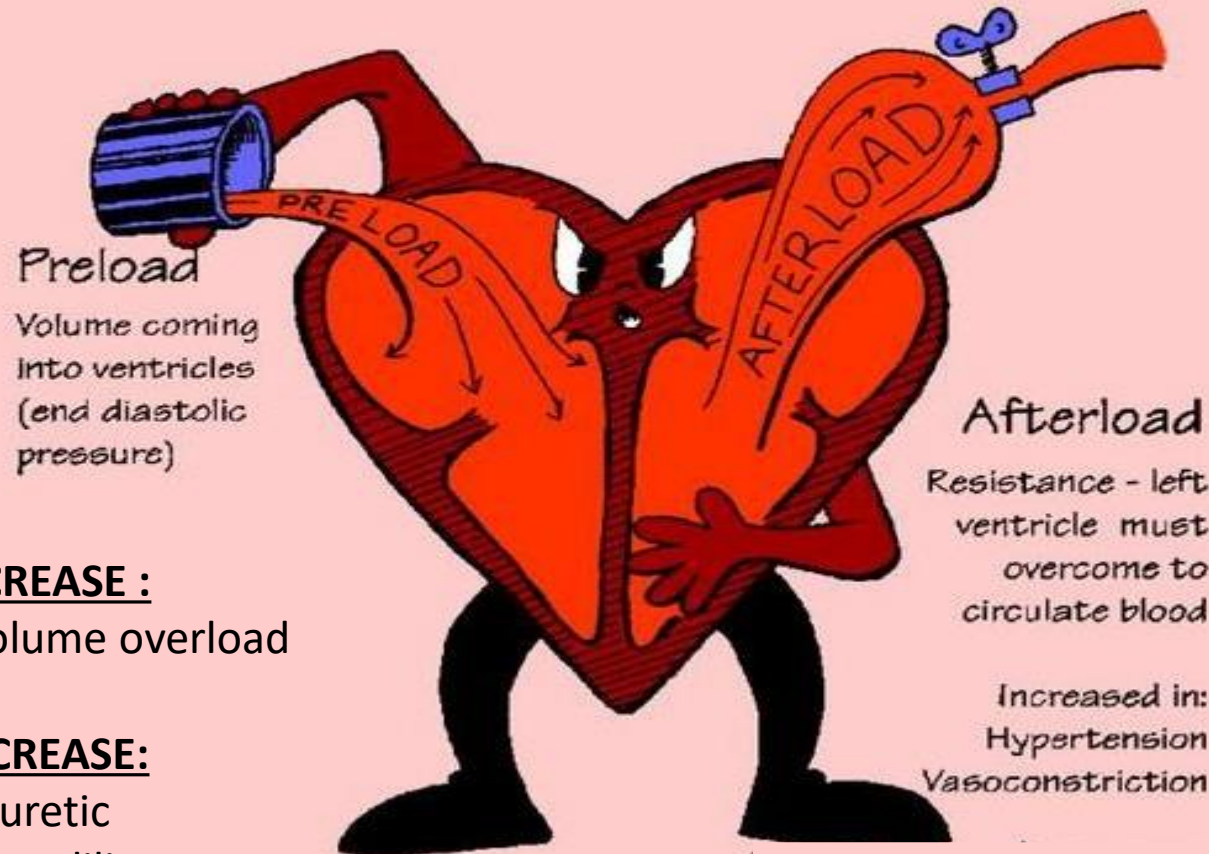
- Echocardiography
- BNP
- Serum urea, creatinine and electrolytes
- haemoglobin
- thyroid function



# TREATMENT OF ACUTE HEART FAILURE



# PRELOAD AND AFTERLOAD



## Preload

Volume coming into ventricles (end diastolic pressure)

### INCREASE :

- Volume overload

### DECREASE:

- Diuretic
- Venodilator

## Afterload

Resistance - left ventricle must overcome to circulate blood

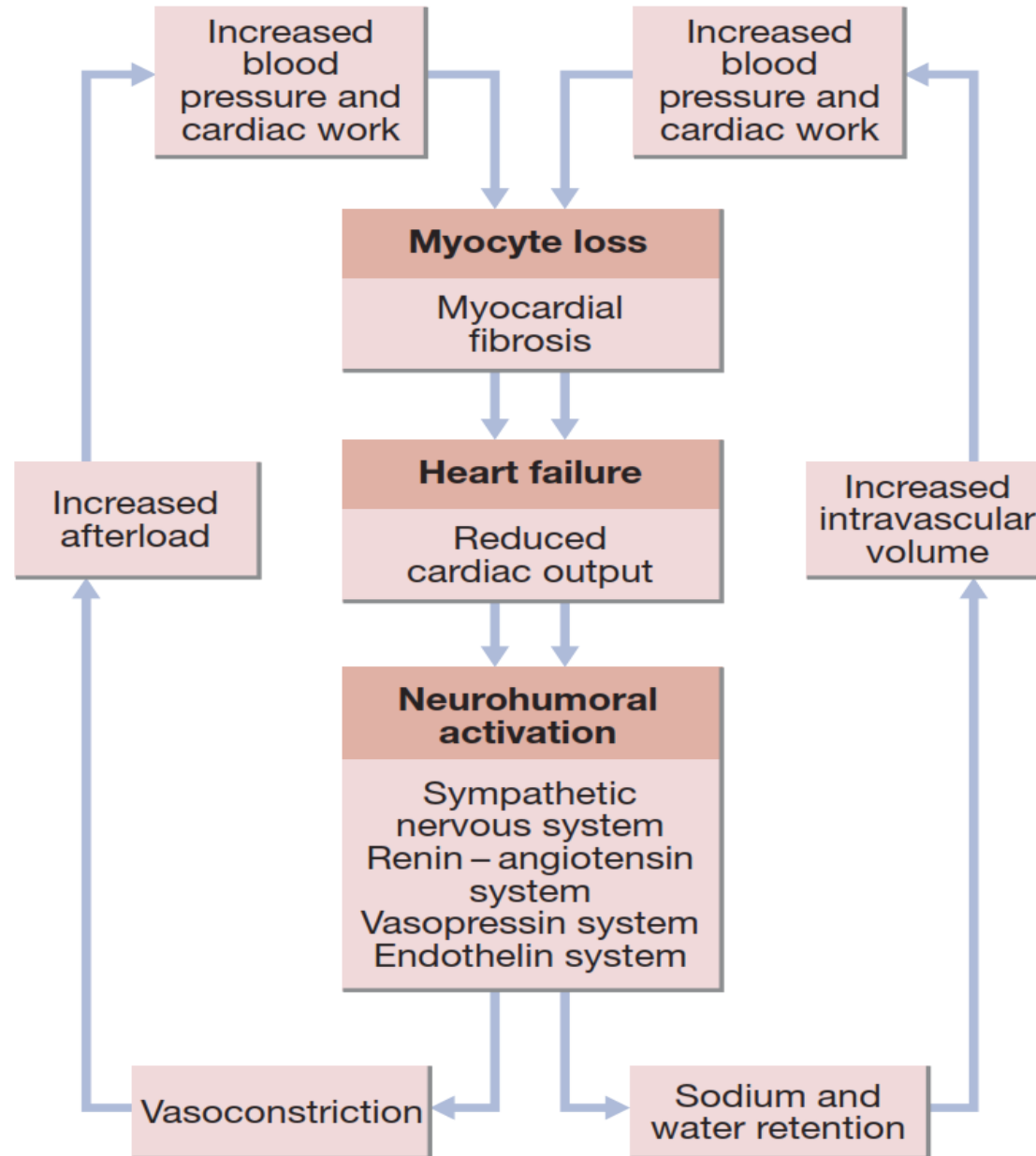
Increased in:  
Hypertension  
Vasoconstriction

### DECREASE:

- Antihypertensive
- Arterial dilators



↑ AFTERLOAD



↑ PRELOAD

**Fig. 16.25** Neurohumoral activation and compensatory mechanisms in heart failure. There is a vicious circle in progressive heart failure.





## 16.15 Management of acute pulmonary oedema

Action	Effect
Sit the patient up	Reduces preload
Give high-flow oxygen	Corrects hypoxia
Ensure continuous positive airway pressure (CPAP) of 5–10 mmHg by tight-fitting mask	Reduces preload and pulmonary capillary hydraulic gradient
Administer nitrates: IV glyceryl trinitrate (10–200 µg/min) Buccal glyceryl trinitrate 2–5 mg	Reduces preload and afterload
Administer a loop diuretic: Furosemide (50–100 mg IV)	Combats fluid overload
*The dose of nitrate should be titrated upwards every 10 mins until there is an improvement or systolic blood pressure is <110 mmHg.	





### **Intravenous opiates:**

Like morphine, can be of value in distressed patients but must be used WITH CAUTION sparingly, as they may cause respiratory depression

### **Inotropic agents :**

such as dobutamine may be required to augment cardiac output, particularly in hypotensive patients.



## **Chronic heart failure**

Patients with chronic heart failure commonly follow a relapsing and remitting course, with periods of stability and episodes of decompensation, leading to worsening symptoms that may necessitate hospitalisation.

.



# Management of chronic heart failure



## A-RENIN ANGIOTENSINE PATHWAY

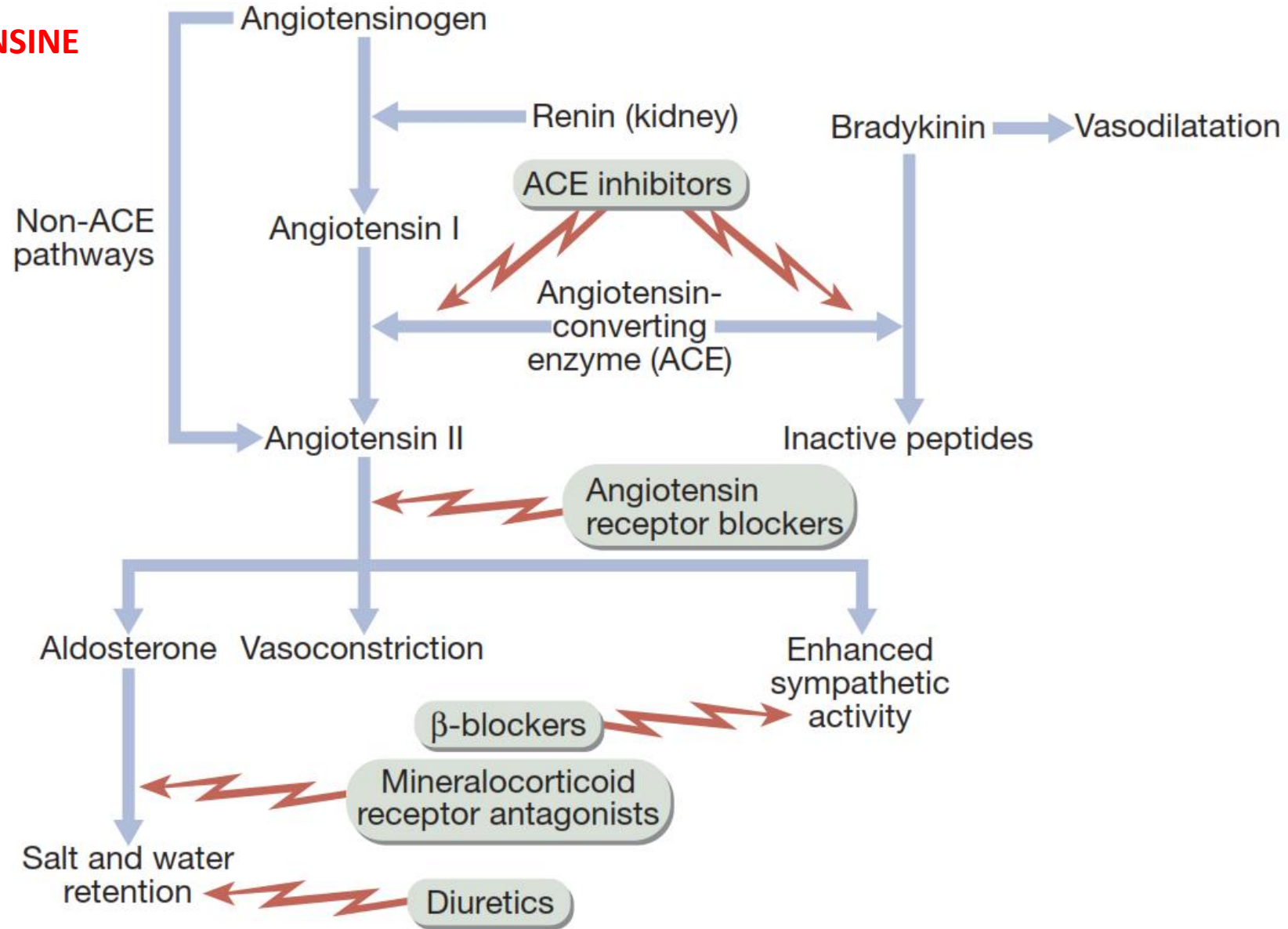
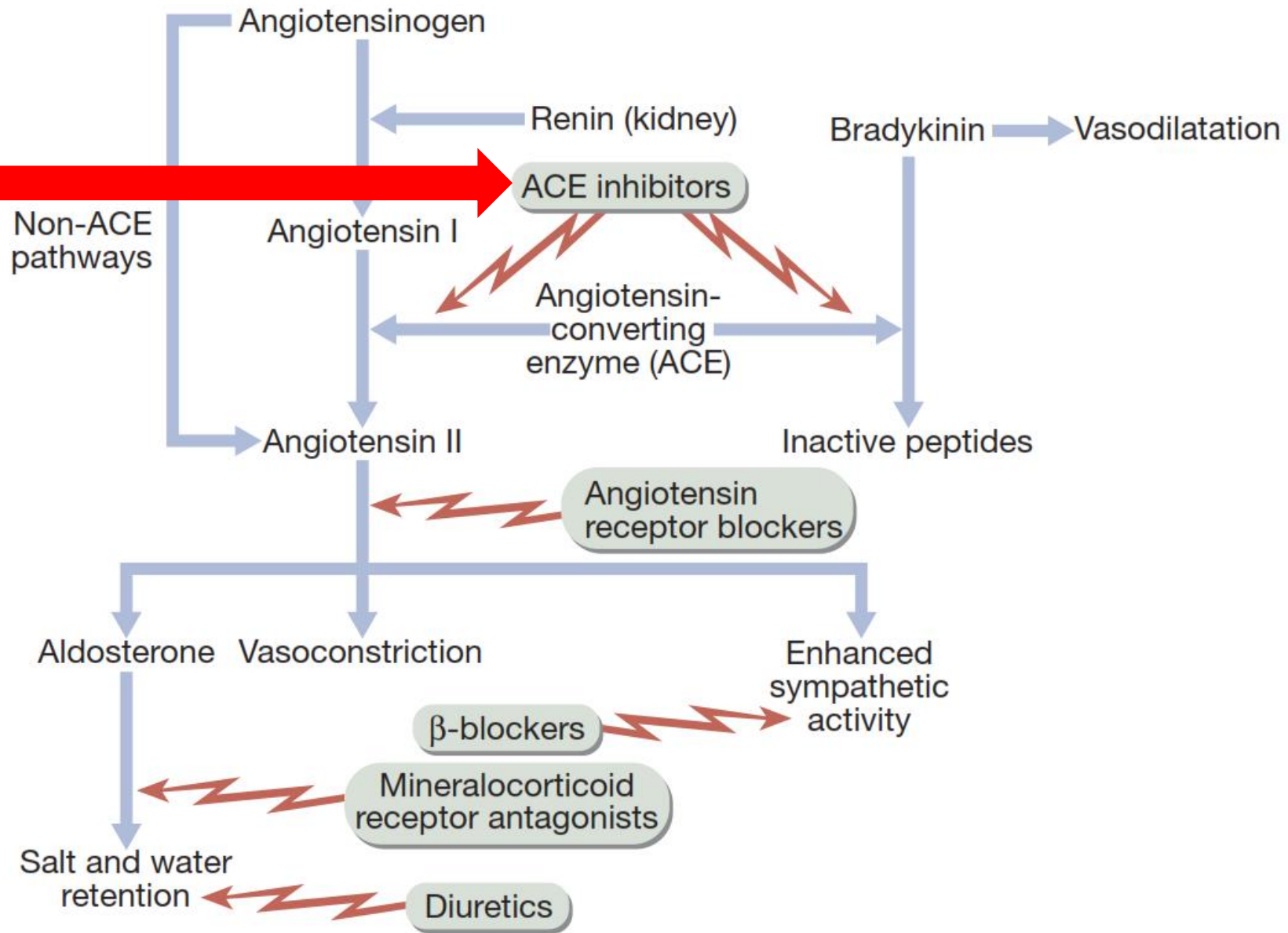


Fig. 16.29 Neurohumoral activation and sites of action of drugs used in the treatment of heart failure.

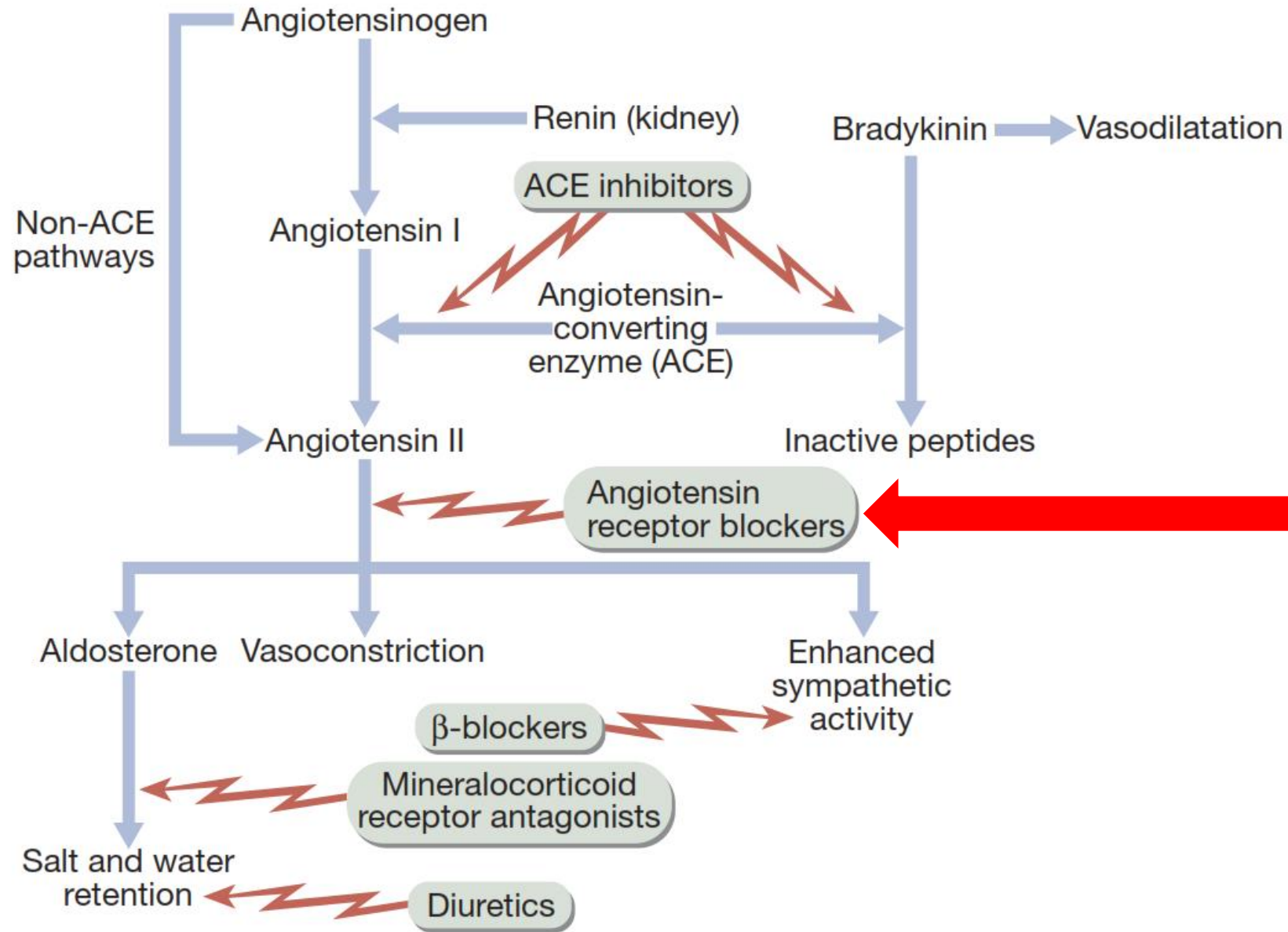


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**Fig. 16.29** Neurohumoral activation and sites of action of drugs used in the treatment of heart failure.





**Fig. 16.29** Neurohumoral activation and sites of action of drugs used in the treatment of heart failure.



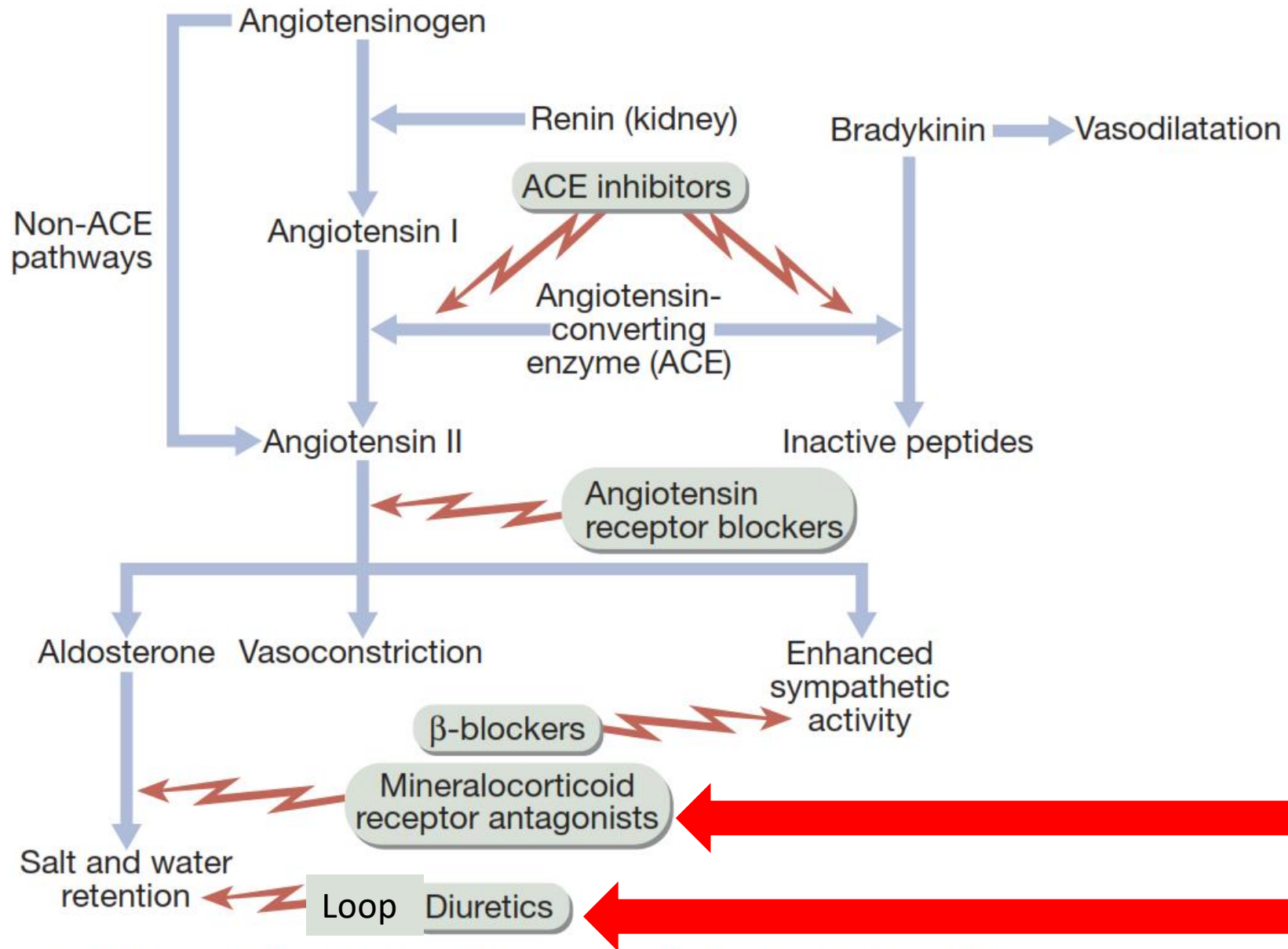


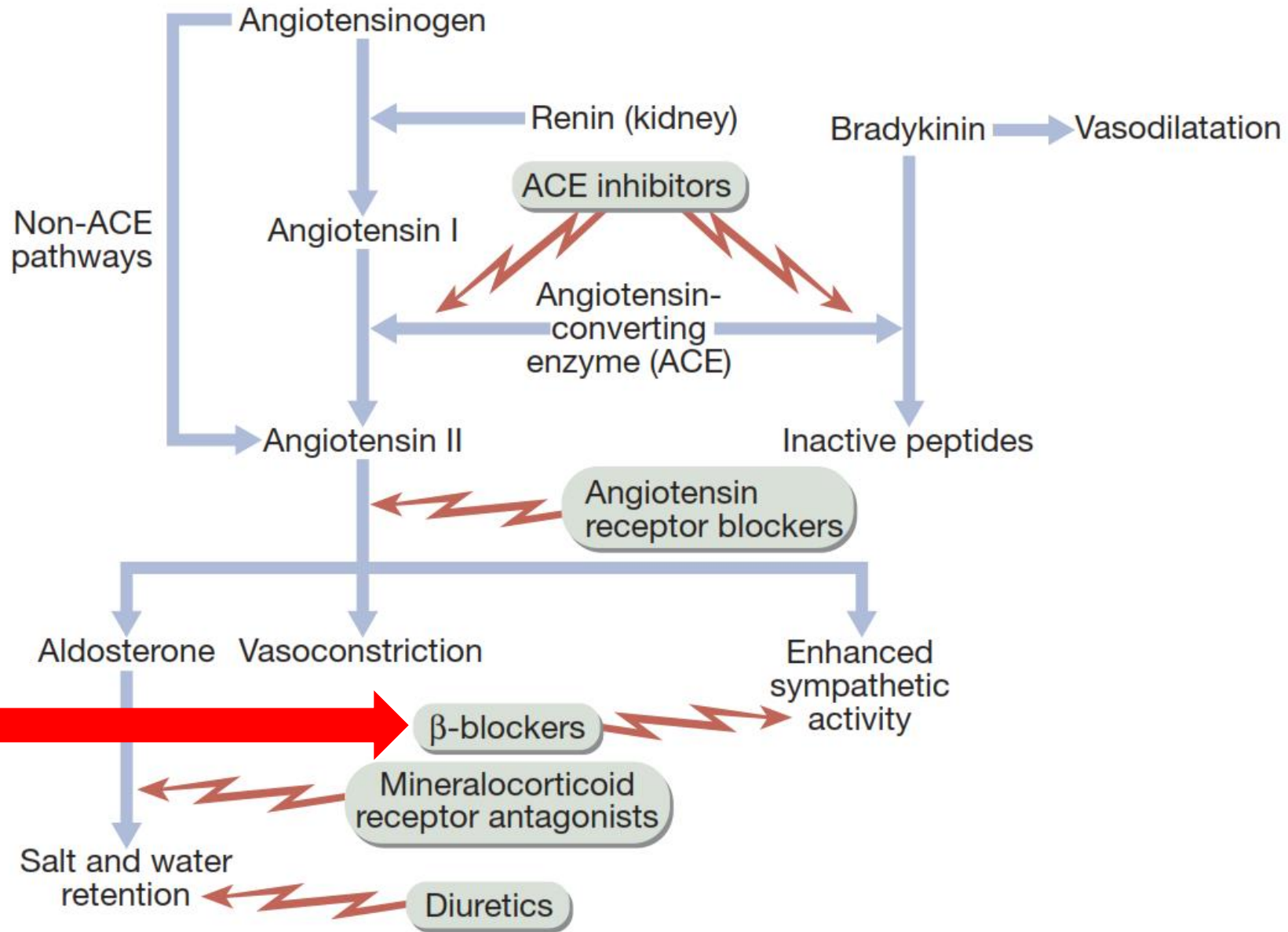
Fig. 16.29 Neurohumoral activation and sites of action of drugs used in the treatment of heart failure.

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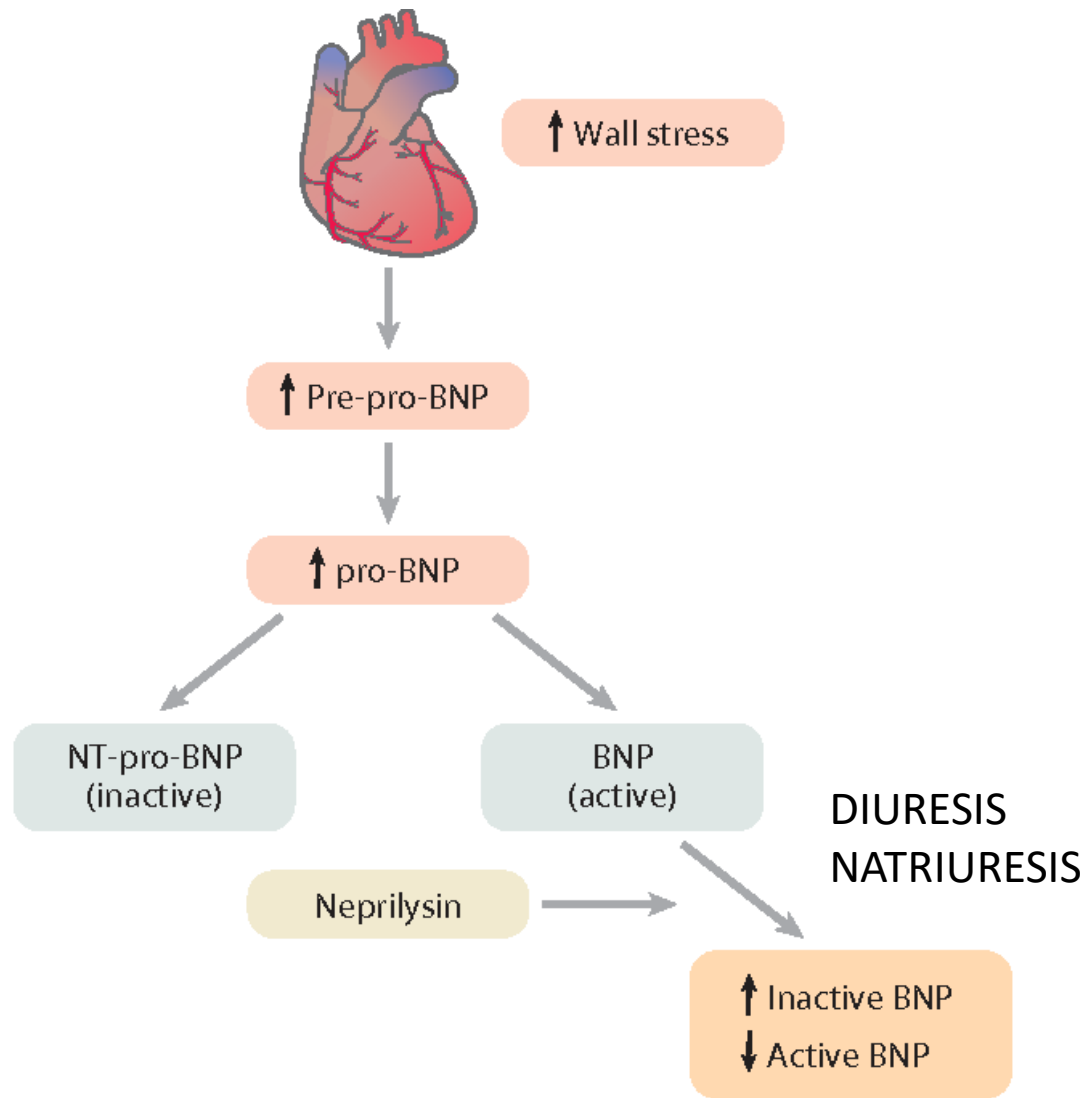




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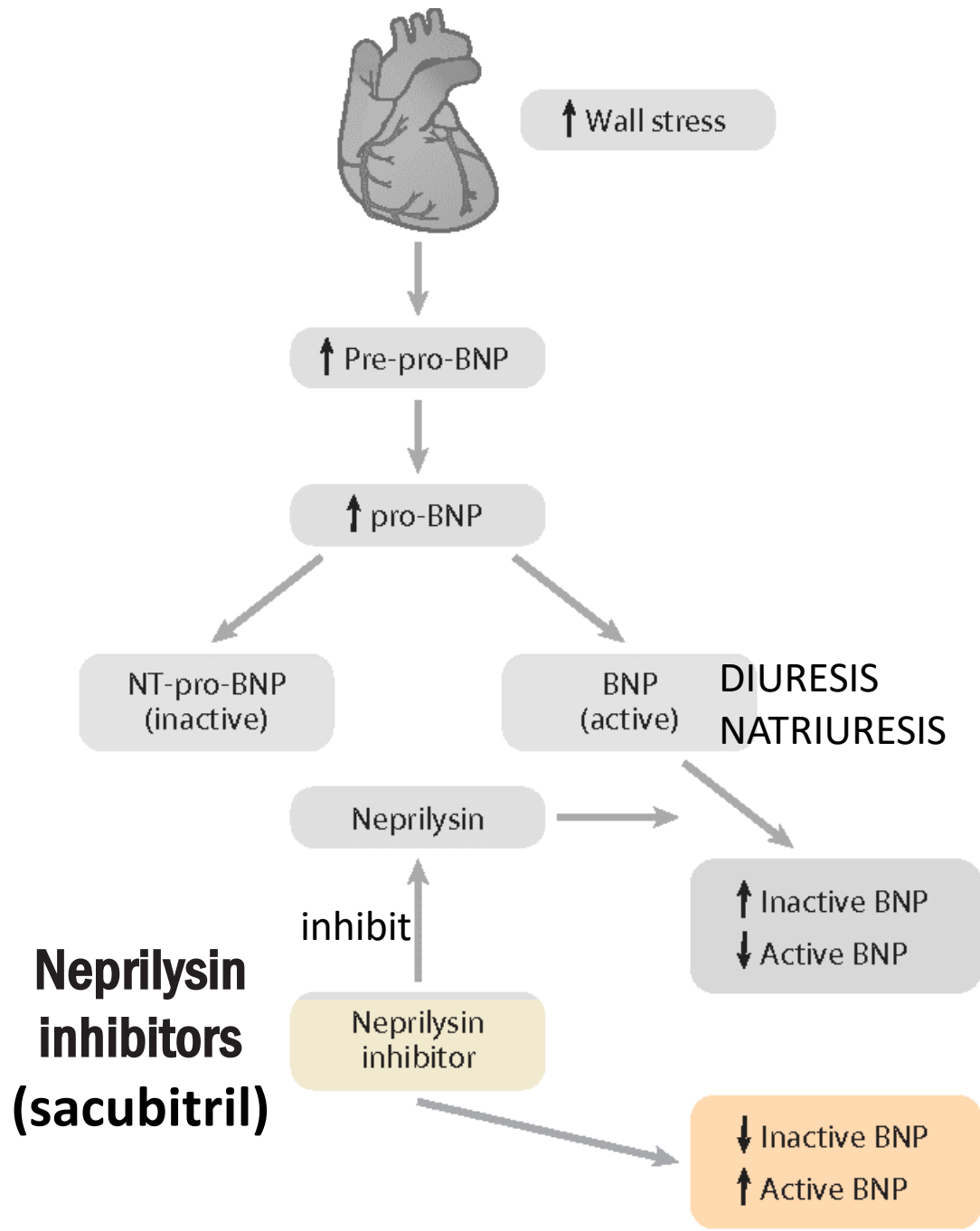
Fig. 16.29 Neurohumoral activation and sites of action of drugs used in the treatment of heart failure.





## B- NATRIURETRIC PEPTIDE PATHWAY





## Neprilysin + ARB (sacubitril / Valsartan)



# other drugs :

## 1- Vasodilators

when ACE inhibitors or ARBs are contraindicated. Venodilators, such as nitrates, reduce preload, and arterial dilators, such as hydralazine, reduce afterload .



## 2- Ivabradine

acts on the I inward current in the SA node, resulting in reduction of heart rate.

It is used when Beta blockers are contraindicated or ineffective in decrease heart rate

It is ineffective in patients with atrial fibrillation.



### 3- Digoxin

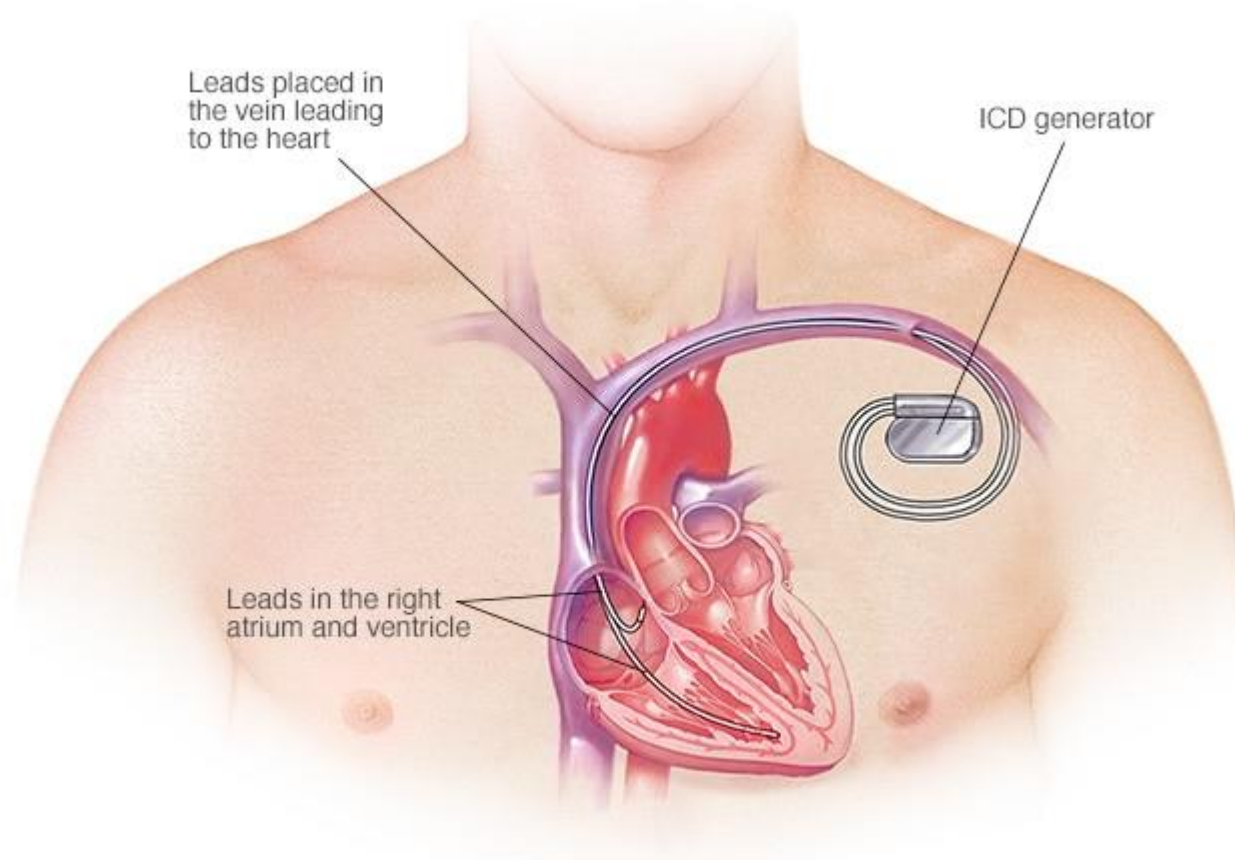
Digoxin can be used to provide rate control in patients with heart failure **and atrial fibrillation.**



# Non-pharmacological treatments



**1- Implantable cardiac defibrillators** These devices are indicated in patients with symptomatic ventricular arrhythmias and heart failure, since they improve prognosis and survival



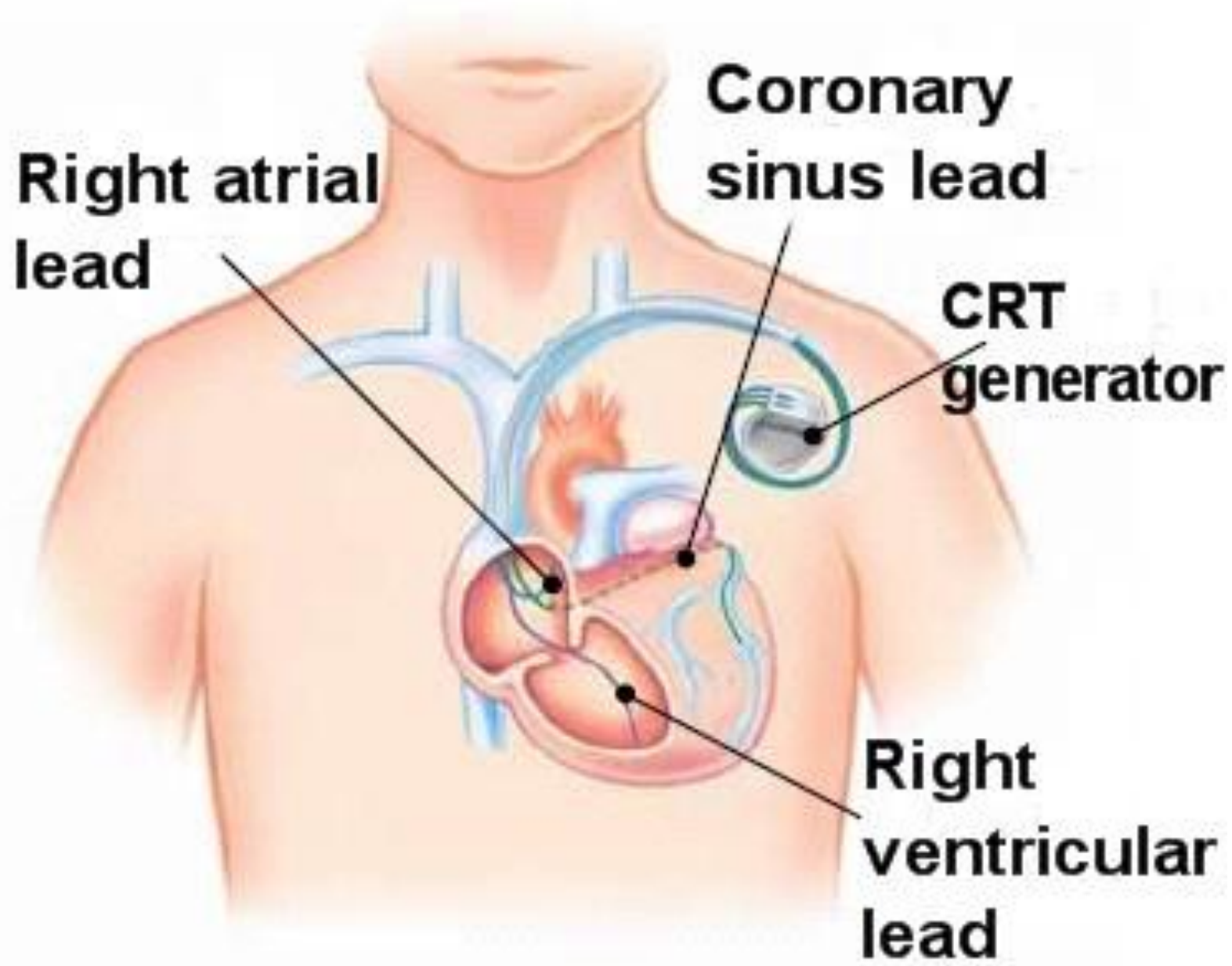


## **2- Resynchronisation devices (CRT)**

In patients with marked intraventricular conduction delay, prolonged depolarisation may lead to uncoordinated left ventricular contraction.

Here, both the LV and RV are paced simultaneously to generate a more coordinated left ventricular contraction and improve cardiac output.





### **3-Coronary revascularisation**

Coronary artery bypass surgery or percutaneous coronary intervention may improve function in **selected patients with heart failure and coronary artery disease.**



## **4-Cardiac transplantation**

Cardiac transplantation is an established and successful treatment for patients with intractable heart failure.



**i****16.16 General measures for the management of heart failure****Education**

- Explanation of nature of disease, treatment and self-help strategies

**Diet**

- Good general nutrition and weight reduction for the obese
- Avoidance of high-salt foods and added salt, especially for patients with severe congestive heart failure

**Alcohol**

- Moderation or elimination of alcohol consumption; alcohol-induced cardiomyopathy requires abstinence

**Smoking**

- Cessation

**Exercise**

- Regular moderate aerobic exercise within limits of symptoms

**Vaccination**

- Consideration of influenza and pneumococcal vaccination



**THANK YOU**

