The Circulatory System

Consists of 2 systems:

- The blood
- The heart and network of vessels
Hypertension is a chronic condition characterized by persistently high blood pressure. High blood pressure can damage the heart, blood vessels, kidneys, and brain. It is often asymptomatic, with no symptoms until complications arise.

Mechanisms of Hypertension:
1. Resistance to the heart's ability to pump blood
2. Increased blood volume
3. Increased peripheral resistance
4. Renal resistance
5. Aortic stiffness

Factors Contributing to Hypertension:
- Age
- Blood pressure
- Race
- Diet
- Physical activity

Complications of Hypertension:
- Heart attack
- Stroke
- Kidney failure
- Vision problems

Treatment of Hypertension:
- Lifestyle changes: diet, exercise, weight loss
- Medications: diuretics, ACE inhibitors, beta-blockers

Understanding the electrical and mechanical events of the heart's contraction and relaxation is crucial in understanding the pathophysiology of hypertension.
Functions of blood:

- Transport of oxygen and carbon dioxide
- Transport of nutrients and waste
- Transport of hormones (signalstoffer)
- Transport of cells in the immun systeme
- Assist in temperature controle
Composition of blood 1 (liquid)

- Liquid for cells
- Glukose og amino acids
- Proteins
- Hormons
- Enzymes
- Salt

Plasma
Composition of blood 2 (cells)

- Red blood cells
  (average lifetime of 108 days)
- White blood cells
- Platelets
In the bone marrow

- **Pluripotent stem cell**
  - Myeloid stem cell
  - Lymphoid stem cell

- **Myeloid stem cell**
  - CFU-MEG
  - Megakaryocyte
  - Thrombocyte
  - Platelets
  - Erythrocytes
  - BFU-E
  - CFU-E
  - CFU-Ba
  - Basophils
  - Monocytes
  - Granulocytes
  - Monoblasts
  - Myeloblasts
  - Myelocytes
  - CFU-GM

- **Lymphoid stem cell**
  - Lymphoblast
  - CFU-B
  - CFU-T
  - Thymus
  - B-lymphocytes
  - T-lymphocytes
  - B-cells
  - T-cells
  - Plasma cells
  - Lymph nodes
The heart
Chambers of the heart

**Atria:**
Collects the blood and pumps it into the ventricles

**Ventricles:**
Pumps the blood to lungs (right) and the mail systeme (left)
- Right Atrium
- Tricuspid Valve
- Right Ventricle
- Pulmonic Valve
- Pulmonary Arteries
- Pulmonic Veins
- Left Atrium
- Mitral Valve
- Left Ventricle
- Aortic Valve
- Aorta
Vessels leading into and out of the heart

- Arteries: High pressure and oxygenated blood. Leading blood from the heart.

  *(OBS. Not pulmonary artery)*

- Veins: Low pressure and deoxygenated blood. Leading blood to the heart.

- Coronary arteries: Leading blood to the muscle of the heart. Center for the major diseases of the heart.
Ways of electric impulses

- Sinus node
- AV node
- Puchinje fiber
Electrocardiogram (ECG)
ECG - normal
Cardiac output
(hjertets minutvolumen)

- The puls rate (P) is 70 beats/min (depending on demand for oxygen and activity in the Sympathetic/Parasympathetic nerve system)

- The stroke volume (SV) of the heart is 80 ml

- Cardiac output = P x SV
  (normal at rest 5,0 – 5,5 l/min)
The vessels
The Circulation 1

- **Carriage of oxygen to the tissues**
- Removal of $\text{CO}_2$ and waste from the tissues
- Carriage of nutrients (carbohydrates, proteins and fats)
- Carriage of hormones
- Assist in temperature control of the body
The circulation 2

Energy supply to tissues by oxydation of carbohydrates:

Carbohydrates + Oxygen \rightarrow \text{Energy} + \text{CO}_2 + \text{H}_2\text{O}
Transport of oxygen and carbon dioxide

- Oxygen is carried dissolved in the plasma and in the red blood cells (oxyhaemoglobin)

- Carbon dioxide (CO₂) is carried dissolved in the plasma and as carbonic acid:
  \[ \text{CO}_2 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{CO}_3 \]

- In the capillaries: Tissue (Oxygen out / CO₂ in)
  Lungs (Oxygen in / CO₂ out)
Blood pressure

2 type of pressure: **SYSTOLIC**
**DIASTOLIC**

Normal: 120/80
Hypertension (WHO): >160/90
Unfit for flying (JAR-FCL3): >160/95
Regulation of Blood pressure 1

\[ BT = R \times P \]

- **R**: resistance in vessels
- **P**: puls rate (depending on factors such as exercise, altitude, temperature, emotion, flight or fight, shock)
Regulation of Blood pressure 2
(maintain HOMEOSTASIS)

- Pressorereceptors in sinus caroticus
- VMC (vasomotoric center in brain stem)
Det diastoliske og systoliske BT
Homeostasis (BT increasing/decreasing)

- Pressoreceptors
  - Sympathetic nervous system ↓
  - Parasympathetic nervous system ↑
  - Reduction of the heart rate P ↓

- VMC
  - Sympathetic nervous system ↓
  - Adrenalin ↓
  - Relaxation of the vessels R ↓

- BT ↓
- AERODOC
Homeostasis (BT increasing/decreasing)

- **Sympathetic nervous system** ↑
- **Parasympathetic nervous system** ↓
- Increase of the heart rate

- **Pressor receptors**
- Tightening of the vessels

- **Adrenalin** ↑

- **BT** ↑

- **BT** ↓
Hypertension

Main cause to:

Heart failure and Stroke
Causes of hypertension

- Stress
- Smoking
- Dietary factors
- Age
- Obesity
- Lack of exercise
- Narrowing and/or hardening of the arteries
Symptoms

- Heart palpitations
- Shortness of breath
- Angina (chest pain)
- Headaches
- Nose bleeds
- Red eye
Treatment

- Life style
- Exercise
- Drugs
Hypotension

Very low pressure may lead to a shortage of oxygen to the tissues (hypoxia)
Causes

- Shock (bleeding – infection – burning)
- Dehydration
- Drugs
- Positive G forces
Symptomes

- Lethargy/tiredness
- Faint or collapse (reduced resistance to the effect of shock)
- Shortage of breathing (congestion of the respiratory system/or water logging of the lungs)
- Symptoms of Circulatory Shock
- Stagnation in the blood supply
- Reduced capability to withstand positive G Forces
Treatment

- Liquid
- Lying down
- Blood
- Saline water in veins
- Drugs
HYPOXIA

Shortage of oxygen to the tissue
Causes of hypoxia

- Fault of the heart
- Fault of the vessels
- Shortage of oxyhaemoglobin
Fault of the heart

- Fault in the electrical impulses
- Shortage of Oxygene in the coronary arteries (Angina)
- Coronary thrombosis (Heart Attack)
Fault in the electrical impulses

- Congenital
- Arteriosclerosis
ECG - normal
ECG - ischaemia
ECG – Heart infarct
Myocardial infarct (Heart Attack)

- Death (50%)
- Cardiac Arrest
- Ventricular Fibrillation
Without treatment a cardiac arrest is "FATAL" in 4 minutes.
First care

Cardiac massage
Assisted ventilation

If possible:

DC-defibrillation
Treatment of coronary stenosis

Stent
Coronary disease is responsible for 70% of pilot deaths during their careers.
Factors predisposing to heart attack
(in order of importance)

➤ Family History
➤ Age
➤ Previous history of cardio-vascular problems
➤ Raised blood pressure
➤ Smoking
➤ Raised blood cholesterol
➤ Lack of exercise (”Bus driver syndrome”)
➤ Diabetes
Causes of hypoxia

- Fault of the heart
- Fault of the vessels
- Shortage of oxyhaemoglobin
Fault of the vessels

- Inadequate blood volumen to the tissues
- Arteriosclerosis
- Heart disease
- Bleeding
- Burns
- Blokage of vessel
  (pulmonary embolism)

Acut $\rightarrow$ circulatory shock
Symptoms of Circulatory shock

- Fast and weak pulse
- Pale skin with a bluish tinge (cyanosis)
- Anxiety and confusion
- Sweating of the hands and feet although the body temperature may be reduced
- Severe muscle weakness
- The veins can seen to be collapsed and may be in spasm
- Urine flow decreases
- Haggard features
- Loss of consciousness
Arteriosclerosis
Åreforkalkning type I+II læsion
Åreforkalkning type III læsion
Åreforkalkning type IV læsion
Åreforkalkning type IV læsion
Heart attack
Heart infaction
Dannelse af blodprop 1
Dannelse af blodprop 2
Ballon udvidelse
Risk of coronary heart disease
Causes of hypoxia

- Fault of the heart
- Fault of the vessels
- Shortage of oxyhaemoglobin
Insufficient oxygen carried

- Insufficient haemoglobin or red blood cells (Anaemia)

  Note rules for donation blood

- Insufficient pressure of oxygen in the air

- Carbon monoxide in the breathing air
Oxygen in environment

By increasing altitude the pressure of oxygen decrease

STRATOSPHERE

PRESSURE SUIT NEEDED
OXYGEN UNDER PRESSURE NEEDED

TROPOPAUSE

Mt Everest 29,028 ft

TROPOSPHERE

Andes

Mt Whitney

OXYGEN NEEDED

Highest Human Habitation...18,000 ft
Environmental Requirements

Oxygen

- Lack of oxygen will affect the brain and cause fatigue, sleepiness, headache, dizziness, blurred vision and will eventually cause you to lose consciousness.
- Oxygen must be provided at high altitudes.

10,000 MSL

HYPOXIA
Carbon monoxide

The dangers of a presence of carbon monoxide cannot be emphasised too strongly
Haemoglobin has a much greater affinity for carbon monoxide than for oxygen making carboxy-haemoglobin.

Affinity 210-250 times greater
Symptomes of carbon Monoxide Poisoning

- Headache, tightness across the forehead, dizziness and nausea
- Impaired vision
- General feeling of lethargy or weakness
- Impaired judgment
- Personality change
- Impaired memory
- Slower breathing rate and weakening pulse rate
- Loss of muscular power
- Flushed cheeks and cherry-red lips
- Convulsions
- Death
Treatment of Carbon Monoxide Poisoning

- Turn off cabin heat
- Stop all smoking
- If oxygen available, it should be inhaled by those effected
- Increase the supply of fresh air through vents and windows
- Land as soon as possible
Smoking

Increases the amount of carbon monoxide in blood leading to decreased oxygen carriage.

OXYGEN CARRIAGE
20 cigarettes a day will have a raised CO-haemoglobin by 7%

This equates to a reduction in oxygen carrying capacity of 4000-5000 ft.

With normal cockpit altitude of 6000-8000 ft this will give the smoker an altitude up to 12000 ft with resulting Anaemic hypoxia
Effect of smoking 20 cigarettes

CoHb Symptoms

20%  Headache

20%-50%  Weakness, dizziness, shortness of breath, nausea, mental confusion, poor muscular ability

Over 50%  Unconsciousness

Flying true altitude of 10,000 with 8-10% CoHb saturation equals physiological altitude of 15,000 feet.
<table>
<thead>
<tr>
<th>ALTITUDE (FT)</th>
<th>NONSMOKER</th>
<th>SMOKER</th>
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<tbody>
<tr>
<td>4,000</td>
<td>SEA LEVEL</td>
<td>20</td>
</tr>
<tr>
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<td>5</td>
<td>25</td>
</tr>
<tr>
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<td>14,000</td>
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<td>55</td>
</tr>
<tr>
<td>16,000</td>
<td>40</td>
<td>50</td>
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</tbody>
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Smoking can lead to:

- Lung cancer
- Breathing problems (COLD)
- Circulatory problems
- Reduced tolerance of G forces
- Increased risk of heart attack
- Increased level of adrenaline
- Addiction
- Degradation of night vision (20%)
IF YOU SMOKE – STOP
IF YOU DON´T SMOKE – DON´T START

Getting Quit

NO SMOKING
DON´T EVEN THINK OF SMOKING HERE
Risk of pulmonary embolism

Long-haul flights may predispose to the formation of blood clots in the lower limbs (monkey class syndrome)