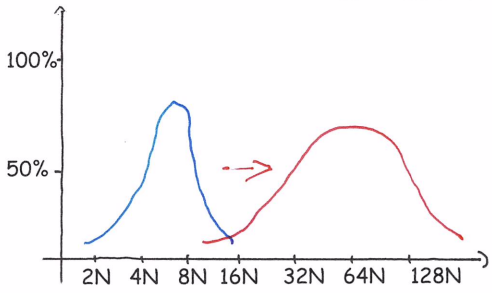
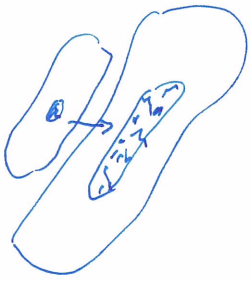
CELLULAR ADAPTATION
(Hypertrophy, hyperplasia, atrophy, metaplasia, dysplasia)

- Responses of cells to stimulations
- Adaptation - modulate structure and function to escape injury
- Adaptations are reversible

A/ HYPERTROPHY

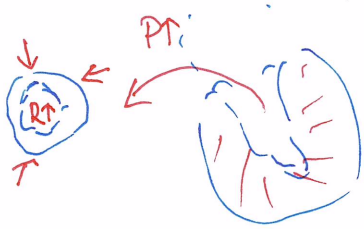
- Increase of cell size and functional capacity
- Increase of size of cells and organs - increased structural proteins and organells
- There are no new cells, just bigger cells
- Hypertrophy acts on cells which have limited or no capacity to devide
- Hypertrophy is generated by a/ Functional demand (mechanical triggers)
  b/ Hormons (trophic triggers)
  c/ Growth factors
- Cellular remodelling
  a/ Proteins not needed are degraded
  b/ Increased protein translation
  c/ Increased gene expression (growth promoting transcriptional factors)
  d/ Increased cell survival (decreased apoptotic cell death)
  e/ Remodelling extracellular matrix
  f/ Increased DNA content (polyploidity)

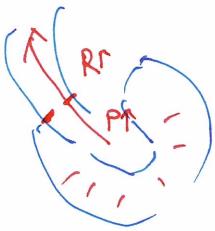


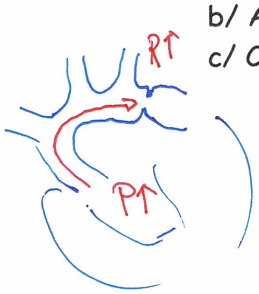


1. Concentric left-sided hypertrophy of the heart

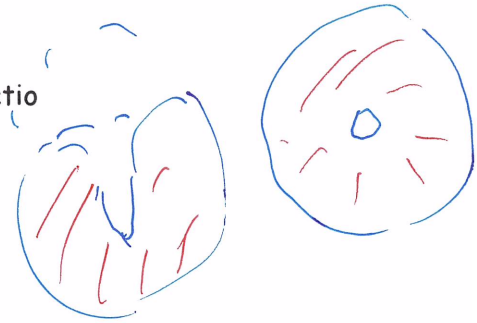
- Pressure overload (working against increased resistance)
  a/ Hypertension
  b/ Aortic stenosis
  c/ Coartatio aortae



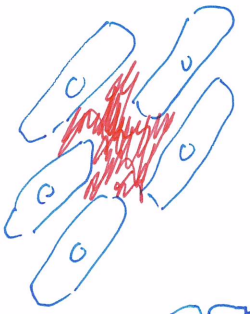


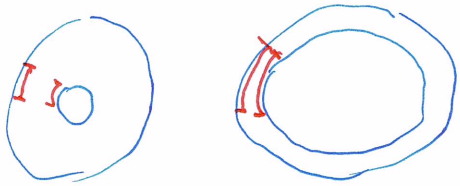


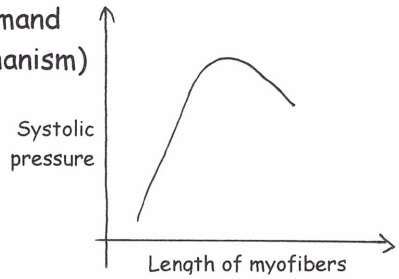
- Morphology:- Large heart > 500g
  - Thickness of the wall
  - Stiffness of the ventricular lumen – diastolic dysfunctio



- Concequences: a/ CIHD – limited vascular supply but increased demand
  - terminal dilatation (Frank-Starling mechanism)

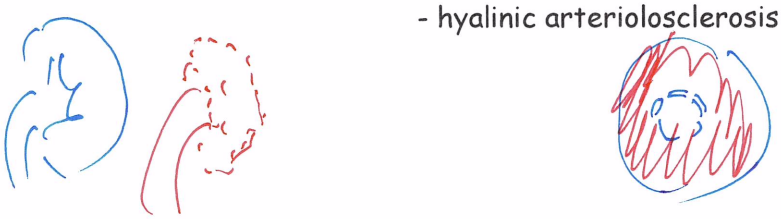






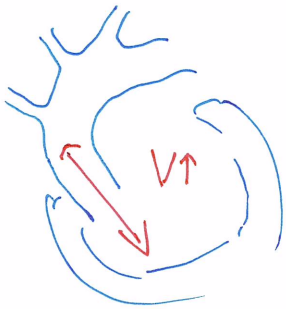
b/ Apoplexia – Charcot-Bouchard aneurysm
  - hyalinic arteriolosclerosis

c/ Renal failure – nephrosclerosis
  - hyalinic arteriolosclerosis



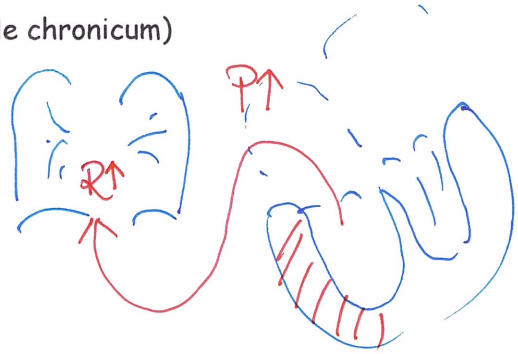
2. Excentric left-sided hypertrophy of the heart

- Volume overload A/ Mitral insufficiency
  B/ Aortic valve insufficiency

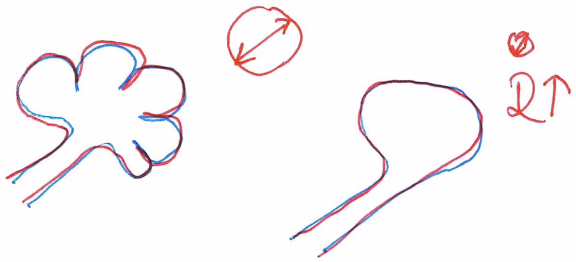


3. Right-sided hypertrophy of the heart (Cor pulmonale chronicum)

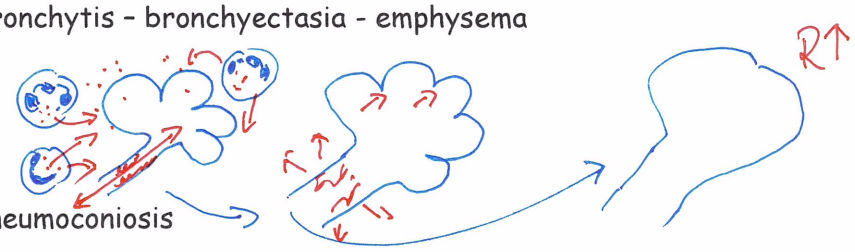
- Pulmonary hypertensive heart disease



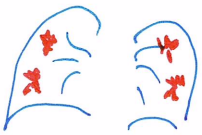
a/ Pulmonary diseases of the parenchyma
  - Emphysema



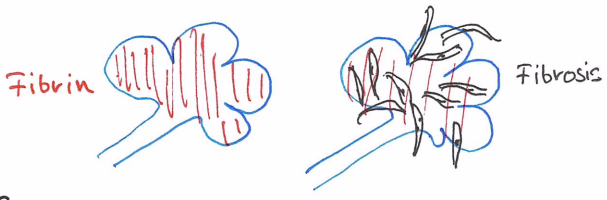
- Bronchytis – bronchyectasia - emphysema



- Pneumoconiosis

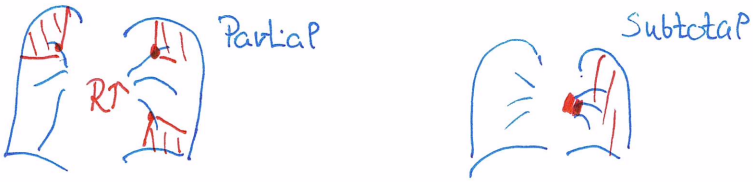


- Sarcoidosis
- Cystic fibrosis
- Pneumonia carnificans

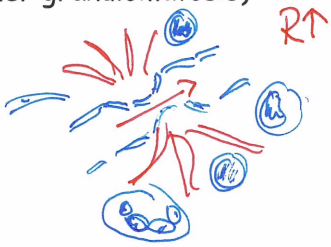


b/ Vascular diseases of the lung

- Pulmonary thrombembolism



- Pulmonary vasculitis (Wegener granulomatosis)

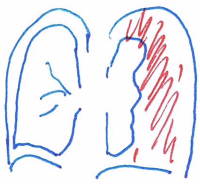


c/ Chest deformity

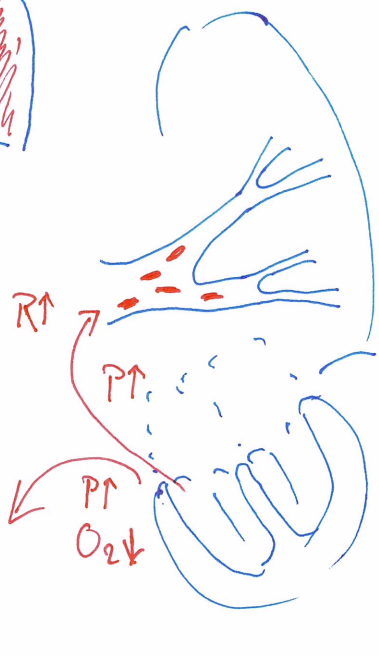
- Muscular dystrophy
- Obesity
- Kyphoscoliosis

d/ Pleural disease

- Pleural adhesion
- Plaural exudation (hydrothorax)



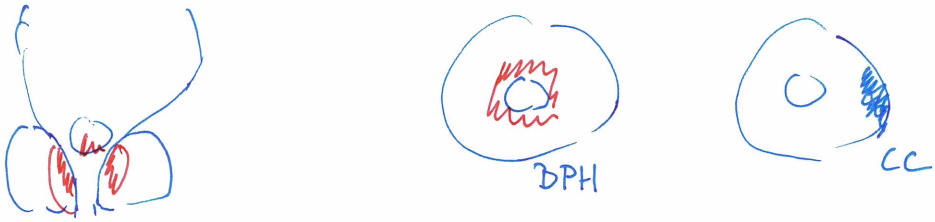
- Morphology: - Heart right-sided hypertrophy + dilatation
  - Pulmonary sclerosis (pulmonary hypertension)
  - Backward failure – congestion liver, spleen, GI



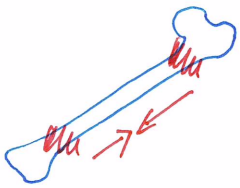
B/ HYPERPLASIA

- Hyperplasia take places of tissues have the capacity to replicate
- Hyperplasia iniciate resting cells (G_0) to enter the cell cycle (G_1)
- Hyperplasia and hypertrophy may occure together
- Hyperplasia – cell proliferation is under controll
- Cell proliferation without controll – neoplasia
- Pathologic hyperplasia is fertile soil for neoplasia (endometrium)
- Hyperplasia is respond to

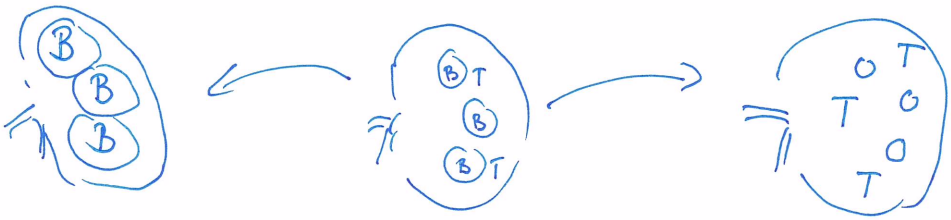
a/ Hormonal stimulation
- Endometrial hyperplasia
- Prostate hypeplasia



b/ Increased functional demand
- Polycythaemia (hypoxia, blood losss, hemolysis)



- Lymph node hyperplasia (follicular, paracortical)

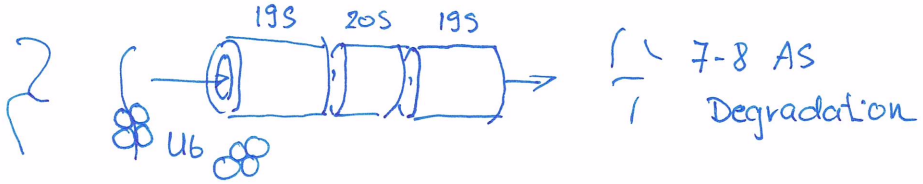


c/ Chronic injurry
- Chr. cystistis – hyperplasia of the bledder epithelium

C/ ATROPHY

- Adaptive respond whereby cells accomodate to changes of enviroment
- Reduction in size + loss of cell substances + deminished function
    - Organ atrophy – reduction in size
    - Cellular atrophy – loss of cells
    - Atrophy is caused by
        a/ Reduced functional demand
            - immobilization of fractured extremities
        b/ Inadequate O_2 and nutrition supply
            - partial ischaemia – heart, brain, kidney
        c/ Interruption of trophic signals
            - resected hormon secreting glands
            - innervation of organs
            - cancer treatment (deprivation of OE in breast cancer)
        d/ Aging
            - brain, heart, muscle

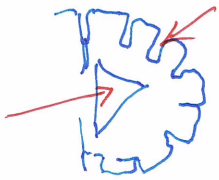
    - Mechanism of atrophy
        a/ Protein synthesis decreses
        b/ Protein degradation – proteosome – ubiquitin related degradation



        c/ Decreased gene expression
        d/ Increased autophagia

1. **Atrophia brunea cordis**

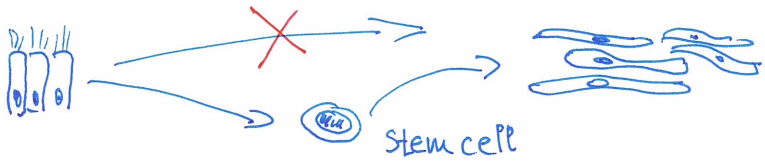
2. **Atrophia cerebri**



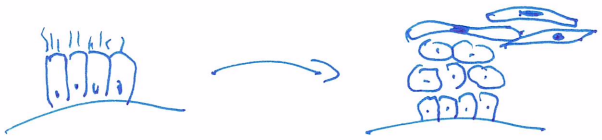
3. **Cachexia** – tumorous atrophy

D/ METAPLASIA

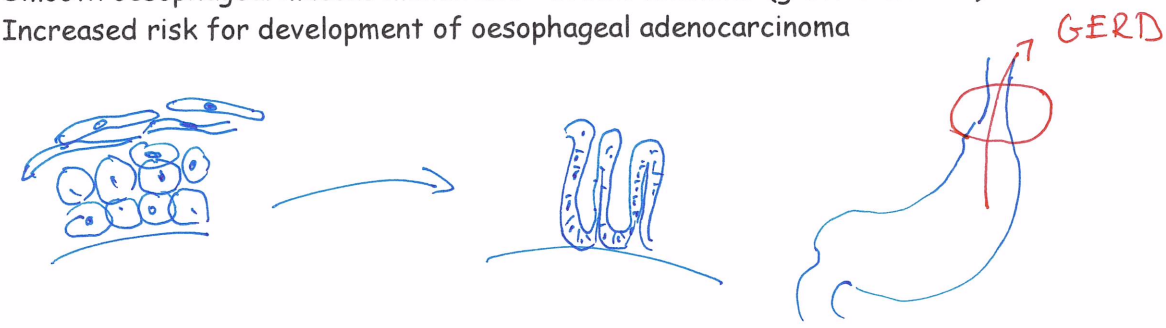
- Metaplasia is an adaptive respons to chronic persistant injury
- Metaplasia is reversible
- In metaplasia one adult cell type is replaced by another adult cell type
- Metaplasia is a reprograming of stem cell differenciation
- Long standing metaplasia predispose to malignant transformation



1. **Squamous cell metaplasia of the bronchus**
   - Bronchial ciliar epithelium transform to squamous cell epithelium
   - After long standing smoking
   - High risk for dysplasia and squamous cell carcinoma



2. **Barett oesophagus**
   - Associated with gastrooesophageal reflux disease (GERD)
   - Oesophagus squamous mucosa - gastric or intestinal metaplasia
   - Presence of globlett-cells – intestinal metaplasia
   - Smooth oesophageal mucous membrane – brown columnar (gastric mucosa)
   - Increased risk for development of oesophageal adenocarcinoma



E/ DYSPLASIA

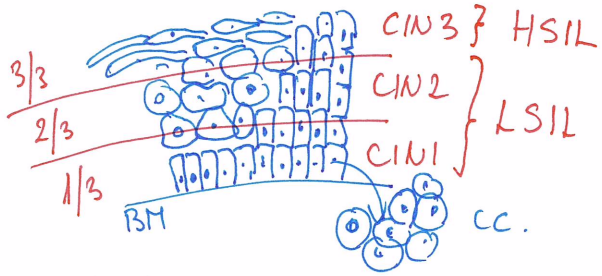
- Dysplasia is a morphologic expression of the disturbance of growth and differenciation
- Featores a/ Dedifferenciation
  b/ Variation in cell size and shape
  c/ Nucleus/cytoplasm ratio increase
  d/ Disarray in the arrangement

- Sequence of response

Normal → Metaplasia → Dysplasia → Neoplasia

Adaptation to injurry — Accumulation of mutation — Clonal selection

1. Cervix dysplasia



2. Bronchus dysplasia