

# Viral, fungal infections

MUDr. Vítá Žampachová

I. ÚP

# Viral infections - herpesviruses

- HSV-1, HSV-2: herpetic stomatitis
- Varicella-zoster (VZV, HHV-3): chickenpox, shingles
- EBV (HHV-4): inf. mononucleosis, hairy leukoplakia, ML
- CMV (HHV-5): lesions in immunodeficient p.
- HHV-6: roseola infantum, mononucleosis sy
- HHV-7: roseola infantum?, mononucleosis sy?
- HHV-8: Kaposi sarcoma, effusion lymphoma



# Herpetic lesions



copy

# Herpes simplex virus

- Mucocutaneous infection, retrograde infection along sensory nerves, latent infection in cranial nerve or dorsal spinal ganglia, mucocutaneous recurrences
- HSV-1
  - Mostly orolabial (cold sores, fever blisters)
  - 20-50% of initial genital herpes
- HSV-2
  - Mostly genital; oral infection with ↑ rate
  - >90% of recurrent genital herpes

# HSV – primary infection

- direct contact or droplet spread
- may be asymptomatic
- pharyngotonsillitis possible, mostly in adults
- primary herpetic gingivostomatitis – children 6 months – 5 years
- abrupt onset, fever, chills, nausea, lymphadenopathy
- multiple small vesicles on oral mucosa → ulceration → erythematous mucosa
- satellite vesicles on perioral skin (saliva)

# HSV – primary infection



# HSV - latency

HSV infects neurons that innervate the epithelial tissue

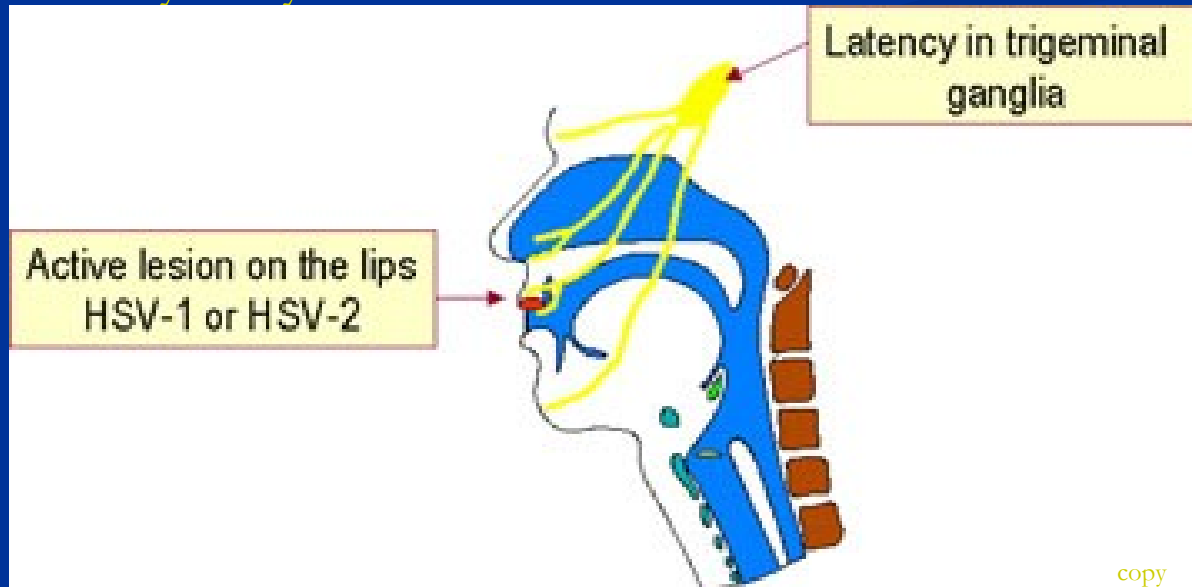
The virus travels along the neuron (retrograde transport on sensory nerves)

oral mucosa → trigeminal ganglia

genital mucosa → sacral ganglia

Blockage of viral DNA transcription → latent infection.

↓ of host immunity – dysbalance - reactivation





# HSV - reactivation

Several agents may trigger recurrence:

stress, fatigue, menstruation, pregnancy  
exposure to strong sunlight, local trauma  
fever – respiratory or GIT infection

**Recurrent infection** – at the primary site or near area (same involved ganlion). Vesicles with infectious virus formed on the mucosa → spread.

Recurrent infection usually less pronounced than the primary infection (without systemic signs) and resolves more rapidly

# HSV- pathology

The virus replicates in the epithelial tissue → characteristic „fever blister“ or „cold sore“. The blister ulcerates → crusted lesion → healing without scar formation



# Herpes simplex

- Immunocompromised patients - lesions may occur throughout the mouth.
- Herpetic ulcer persisting >1 month without known immunosuppression - indicator of possible AIDS.
- Herpetic whitlow: a crusting ulceration on the fingers or hands, extremely painful. ! working on patients with active HSV

# Intraoral HSV



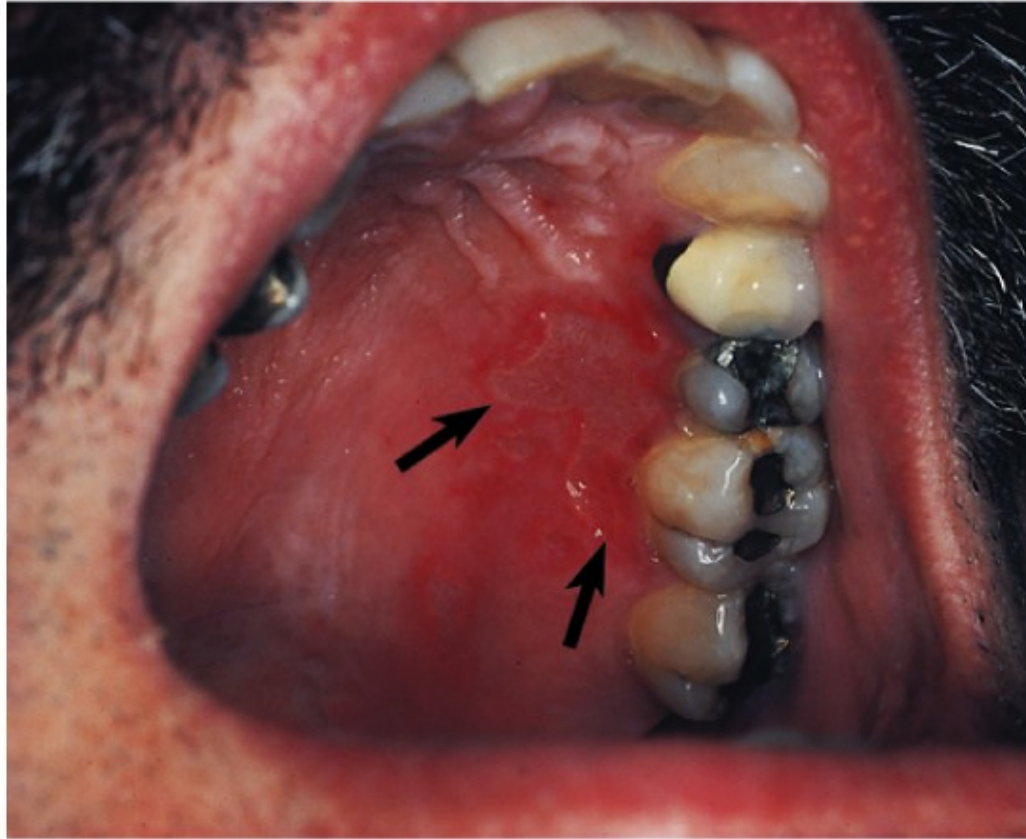
Linear vesicles → rupture →  
ulceration



# HSV in immunocompromised



# Hard palate HSV in AIDS



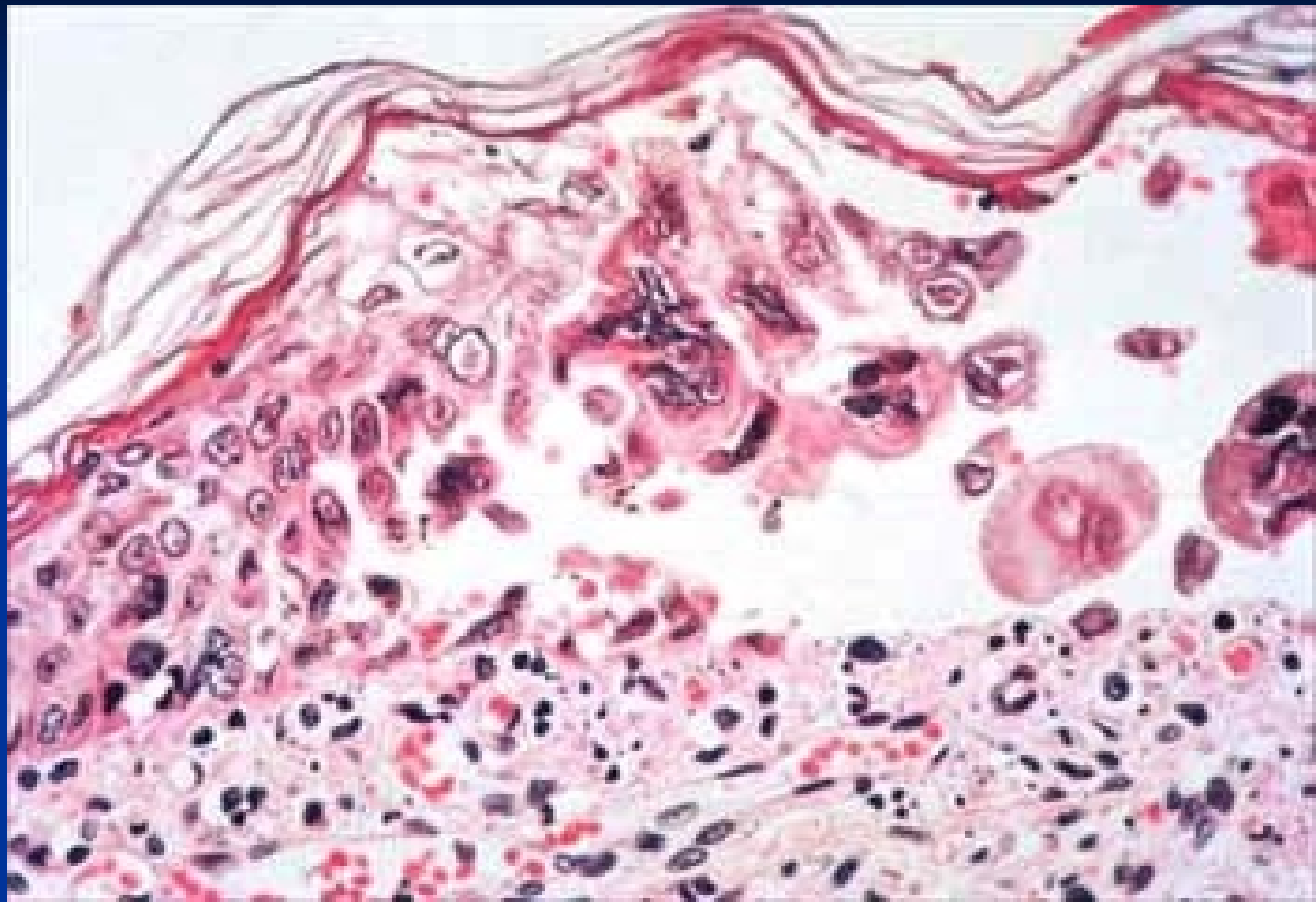
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# Herpes simplex

other localisations:

- herpetic keratitis → corneal blindness
- herpetic encephalitis
- skin herpetic lesions – in damaged skin (trauma, preexisting disease)

HSV





# Tzanck smear



# Varicella - Zoster

- **VZV primary infection:** chickenpox – fever, malaise, headache, rash: vesicle → pustule → ulcer → crust
- in oral cavity on buccal mucosa + hard palate, resembles aphthous ulcers, 7-10 days

# Varicella Zoster – Chicken pox



Photo Courtesy of CDC

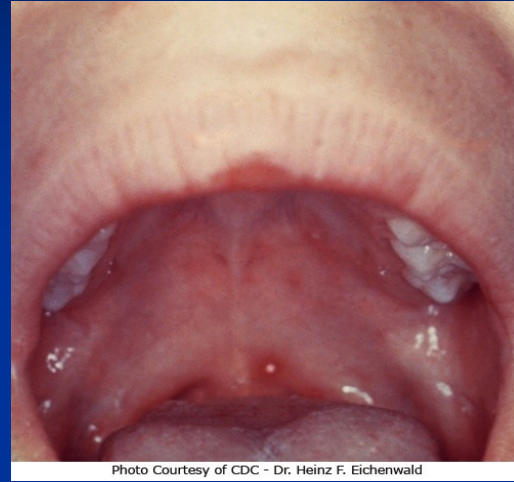


Photo Courtesy of CDC - Dr. Heinz F. Eichenwald



Photo Courtesy of CDC



Photo Courtesy of CDC - Dr. K.L. Hermann

# Herpes zoster

- Duration of the lesion is dependent on:
  - Age: young ~ 2-3wks, adults ~ 5-6wks
  - Severity of lesions
  - Immunosuppression
- Incidence increases with age (esp. >50 yrs) and immunosuppression.
- Vaccination of older people possible.
- Specific antiviral drugs.

# Varicella Zoster - Shingles



# VZV - unilaterality



Fig. 65.4. Herpes zoster (shingles): painful oral lesions.

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# Varicella - Zoster

- **Secondary infection (Shingles)**
- Latency within the dorsal root ganglia
  - Rare in the immunocompetent
  - Presentation: Prodrome of burning or pain over dermatome. Over 1-5 days new lesions, typically along a dermatome with some overflow to adjacent dermatomes.
  - Maculopapular rash, development similar to primary form (vesicles → crust). Oral lesions typically after skin involvement

# VZV pathology

## Trigeminal nerve reactivation

- uveitis, keratitis, conjunctivitis

## Cranial nerve reactivation

- **Bells palsy:** weakening or paralysis of facial muscles, involvement of the 7th cranial nerve, not permanent.
- **(Ramsay-Hunt syndrome:** virus spreading to facial nerves. Characterized by intense ear pain, a rash around the ear, mouth, face, neck, and scalp, and paralysis of facial nerves. Symptoms may include hearing loss, vertigo, and tinnitus.)



# VZV pathology

**Post-herpetic neuralgia:** chronic burning or itching pain;  
hyperesthesia (increased sensitivity to touch)

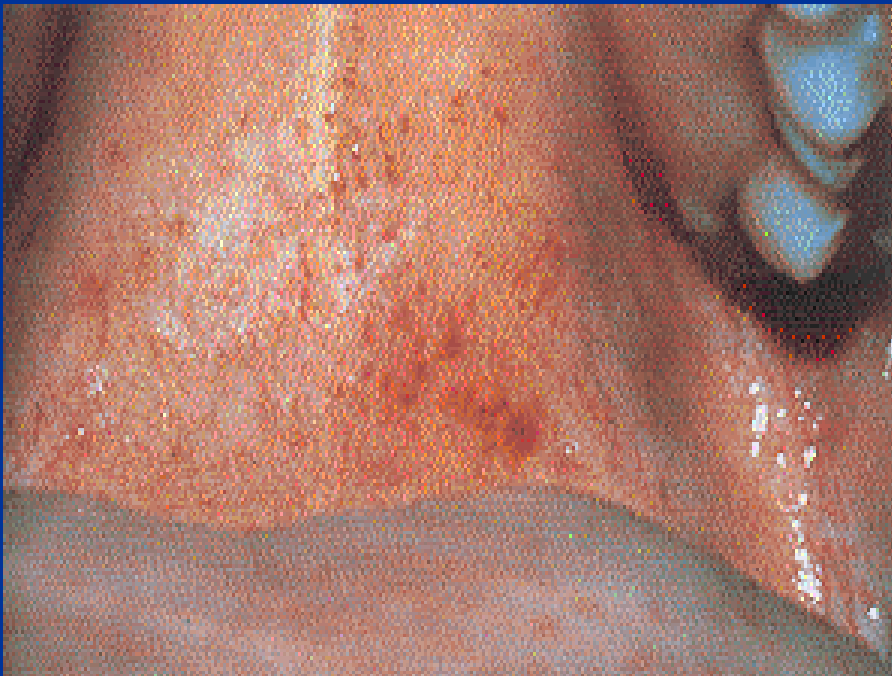
# Epstein Barr virus

## Infectious mononucleosis

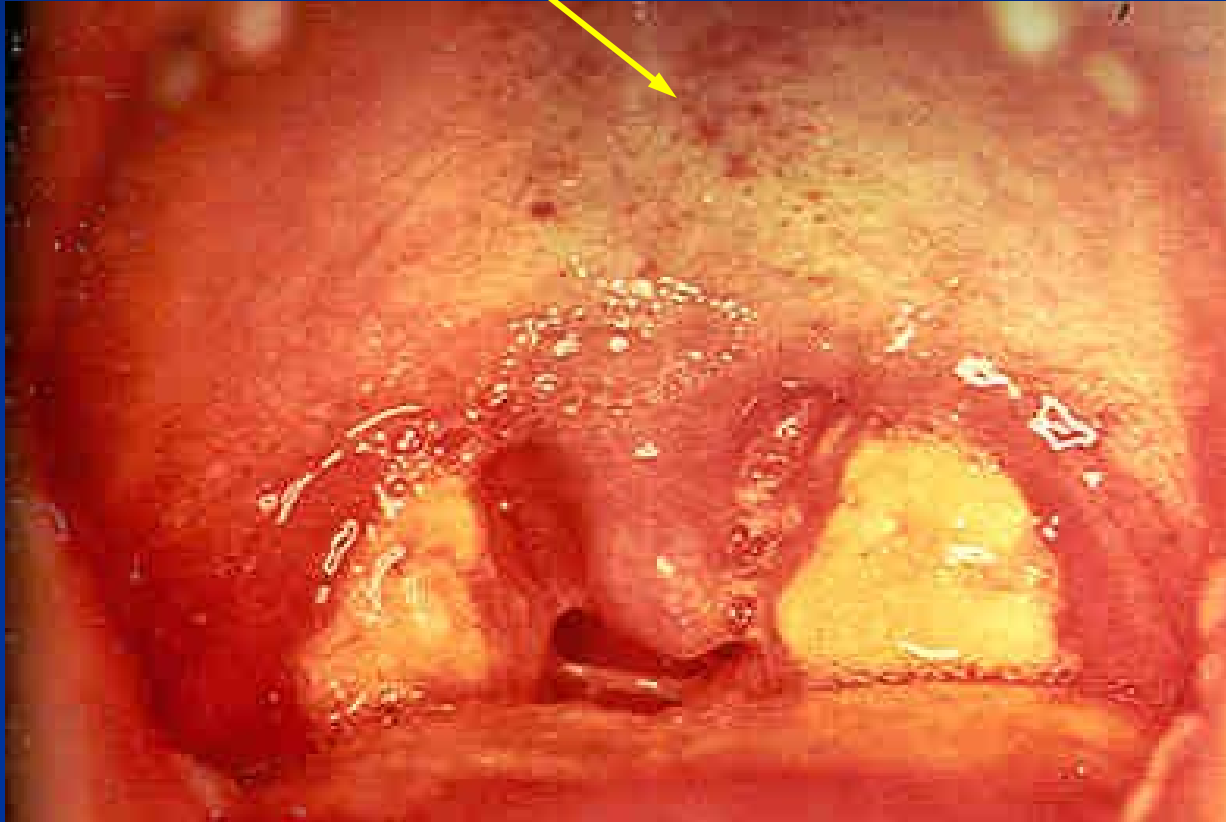
- **General:** After 3-7 week incubation period, bilateral enlargement of cervical and other LN, fever, malaise, possible splenomegaly. Pharyngitis with hyperplasia of lymphoid tissue, pseudomembranous tonsillitis. Atypical lymphocytes in the blood.
- **Cutaneous presentation:** edema of eyelids, macular or morbilliform rash. Macular eruption on trunk.
- **Mucous membranes** with 5-20 pinhead sized petechiae at junction of soft and hard palate. (Forsheimer spots). Stomatitis with erythema and ulceration.
- Spread by saliva!

# Infectious mononucleosis

- Palatal petechial bleeding – Forsheimer spots
- Necrotizing ulcerative gingivitis during mononucleosis possible, ! diff. dg.



# Forsheimer spots



Pseudomembranous tonsillitis in inf. mononucleosis

# Oral hairy leukoplakia

- Associated with chronic shedding of EBV in the oral cavity in profound immunodeficiency.
- Presentation: Poorly demarcated, irregular, white plaques on lateral aspect of tongue.
- Cannot be removed by scraping (x thrush).
- In immunosuppression (esp. AIDS), HIV workup!
- Diagnosis: microscopy, in situ hybridization
- Management: diagnosis + immunosuppression treatment

# Oral hairy leukoplakia



# Human herpesvirus 6 and 7

- Roseola infantum (sixth disease)
  - Presentation: Onset of high fever resolving in about 4 days, followed by a morbilliform erythema of rose colored macules on neck, trunk and buttocks, less commonly on the face and extremities.
    - Lesions may be surrounded by halo.
    - Complete resolution in 1-2 days.
- HHV 6 infection is nearly universal.
- HHV 7 similar to 6. May occur later.
- In adults may resemble to mononucleosis.

# Roseola infantum





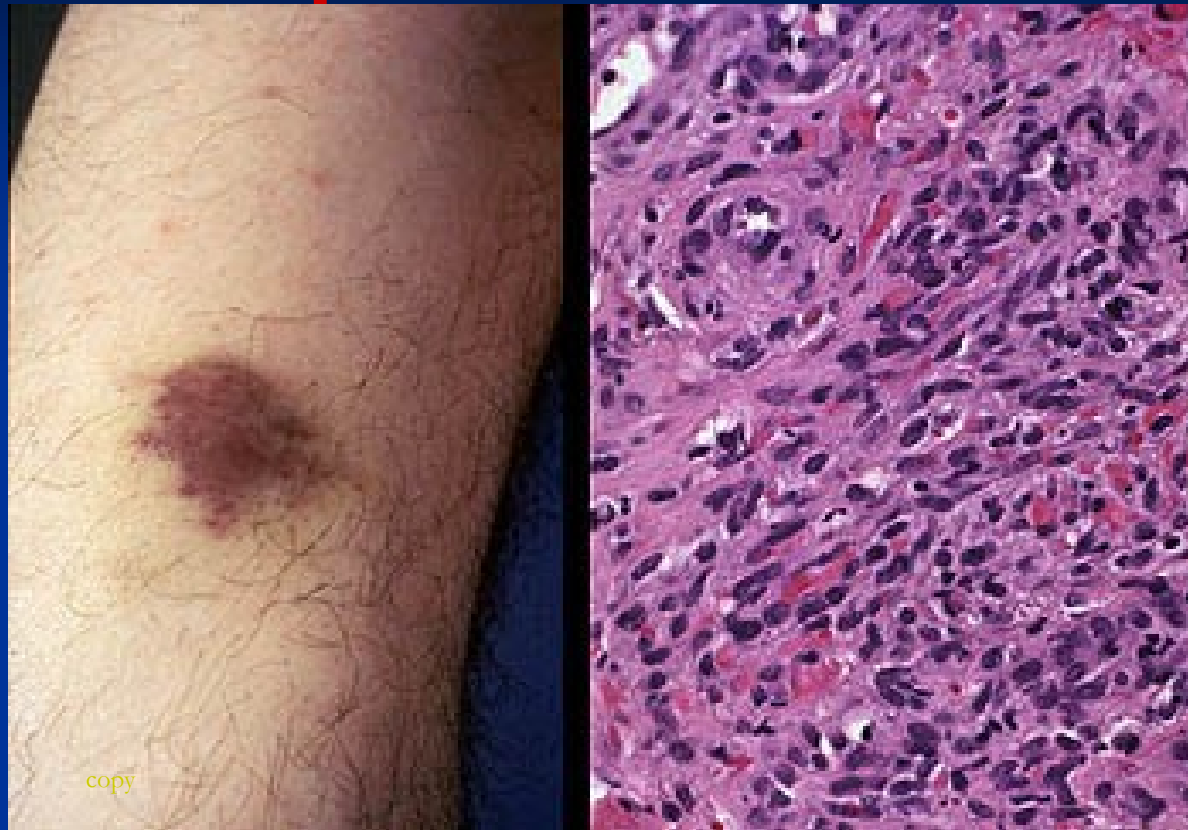
# Human herpes virus 8

- HHV-8 associated with Kaposi sarcoma in virtually all cases.
  - Includes AIDS, post-transplant, African and Mediterranean cases.
  - HHV-8 is found in KS lesions, saliva, blood and semen of infected individuals.
- Associated with body cavity based B-cell lymphoma.
- Lesions on mucosal membranes possible, usually starts on skin.

# Kaposi's sarcoma



# Kaposi's sarcoma

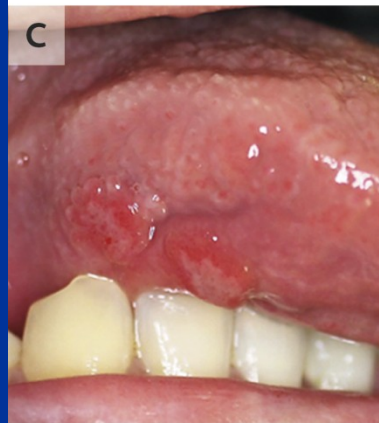


Plump spindled cells  
outlining vascular spaces

# Enteroviruses – Coxsackie A

- herpangina
- hand-foot-and-mouth disease; acute lymphonodular pharyngitis
- Transmission: fecal-oral
- 50-80% of infections are asymptomatic
- Possible skin rash, mimics other virus infections
- Common cause of meningitis, myocarditis
  - Children <10
  - Sore throat (herpangina) + vesicles; fever; cutaneous lesions including hand and feet (hand, foot and mouth disease)

# Hand-foot-and-mouth disease



# Hand, foot and mouth disease herpangina



In mouth similar lesions: red macules → fragile vesicles → ulcerations.  
Healing in 7-10 days

# Measles

- Rubeola
- Transmission: direct droplet contact; incidence greater in winter-spring months
- Incubation: 2 weeks
- Rash evolves from face to trunk to extremities (including palms and soles)
- Fever and the three Cs: cough, coryza and conjunctivitis
- **Koplik spots:** multiple little white-bluish macules on red background, on the oral (buccal) mucosa opposite to the molar teeth; prior to exanthema; epithelial necrosis
- In malnutrition – necrotizing ulcerative stomatitis, noma, candidiasis
- in early childhood – odontogenesis affected, enamel hypoplasia

# Measles

- Complications common (20%), in children and young adults:
- Malnutrition esp. vitamin A deficiency is a major cause of mortality
- Complications include:
  - Otitis media
  - Pneumonia
  - Encephalitis (incl. subacute sclerosing panencephalitis)
- Vaccination



# Rubella

- German measles, togavirus
- Transmission: respiratory droplets
- Incubation period: 2-3 weeks
- Infections may be sub-clinical esp. in young children
- Mild to no prodromal phase;
- Rash (nonspecific, difficult to make a clinical diagnosis)
- Adenopathy (swollen lymph nodes)
- **Oral lesions:** small dark red papules on soft palate
- Adults may also get mild arthritis

# Rubella



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Department of Dermatology  
Phone: (+49) 9131- 85 - 2727



# Rubella

- Congenital rubella - the most severe complication
- Most infections and complications occur in the first 16 weeks of pregnancy (90% transmission rate to fetus)
- Infants are born with numerous defects
  - Cardiac abnormalities
  - Cataracts
  - Deafness
  - Brain, liver and organ damage

# Human papillomavirus

- Estimated: 10-30% of oral cancers positive for HPV
- Rising tendency in younger patients
- Possible gradual decrease due to vaccination
- +/-70 subtypes documented, high risk types 16, 18; low risk 6, 11
- Vaccination

# Human papilloma viruses

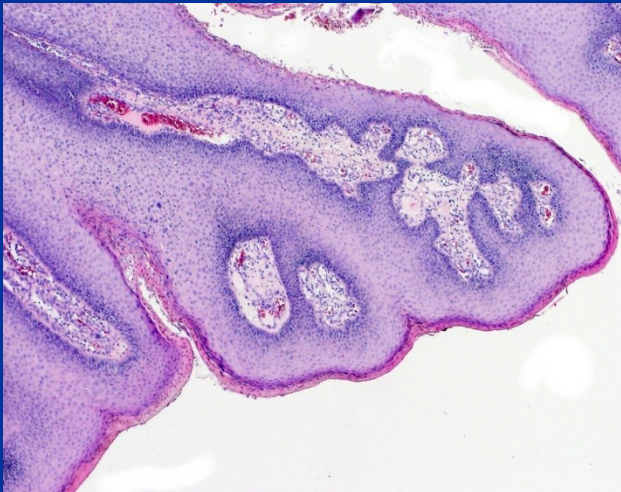
- HPV lesions commonly self-limited in immunocompetent people.
- Long-standing HPV lesions most commonly in immunocompromised individuals.
- Diagnosis based on history, clinical appearance, and biopsy.
- Common in early HIV infection.
- Spiky warts, raised, cauliflower-like appearance.

# Papilloma lesions of the oral cavity



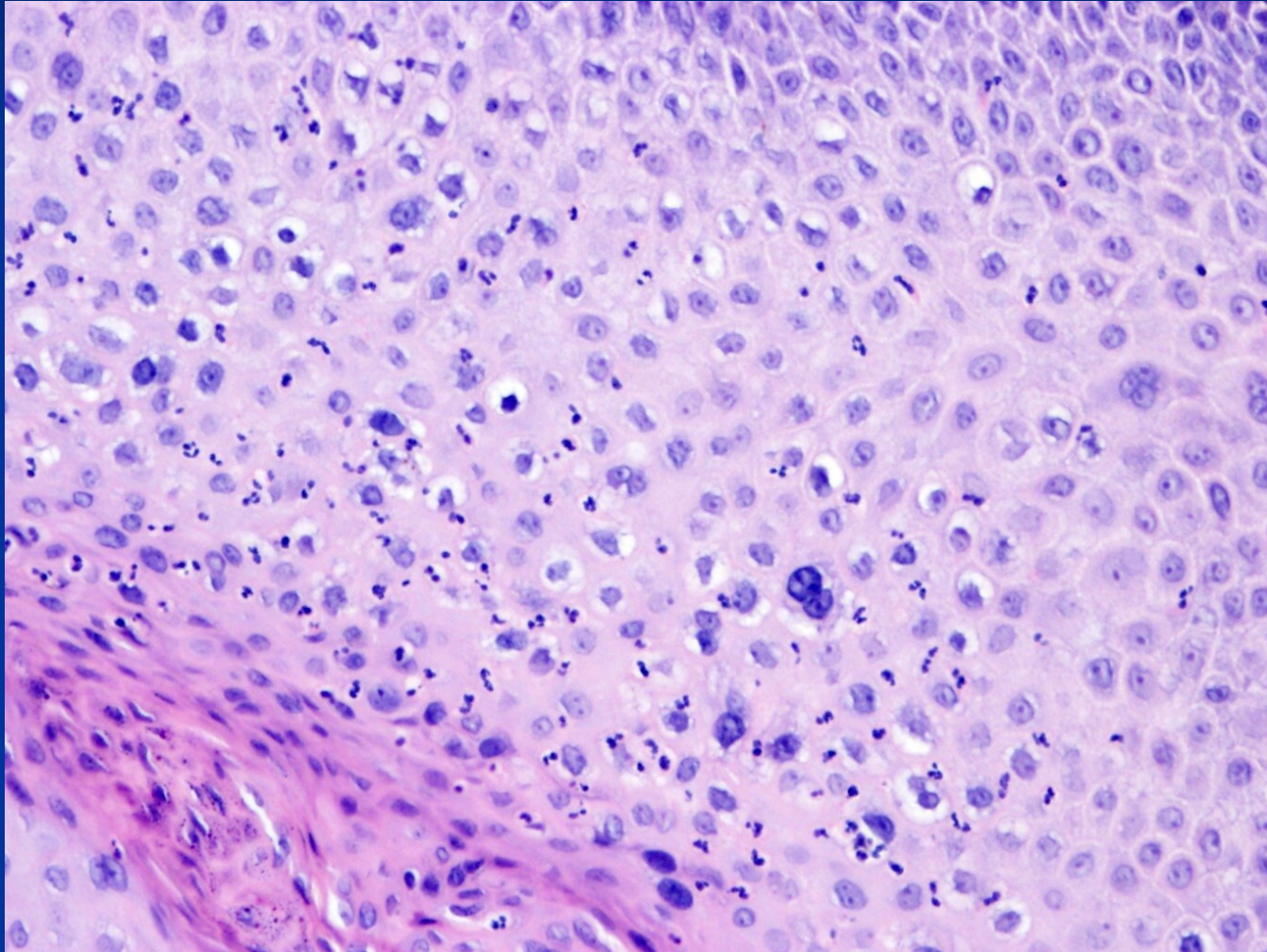
## Squamous papilloma:

- Most common in 30 - 50 yr old
- Possible in males and females
- HPV-6, 11 in 50% of the lesions
- Tongue and soft palate common sites



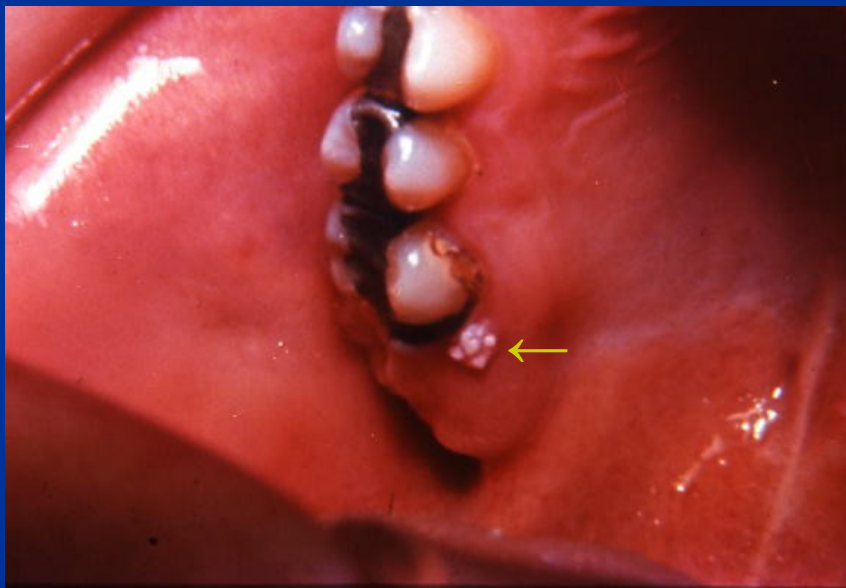
Finger-like projections  
with fibrovascular core

**HPV:** koilocytic change of epithelia (perinuclear halo, shrunken nucleus)

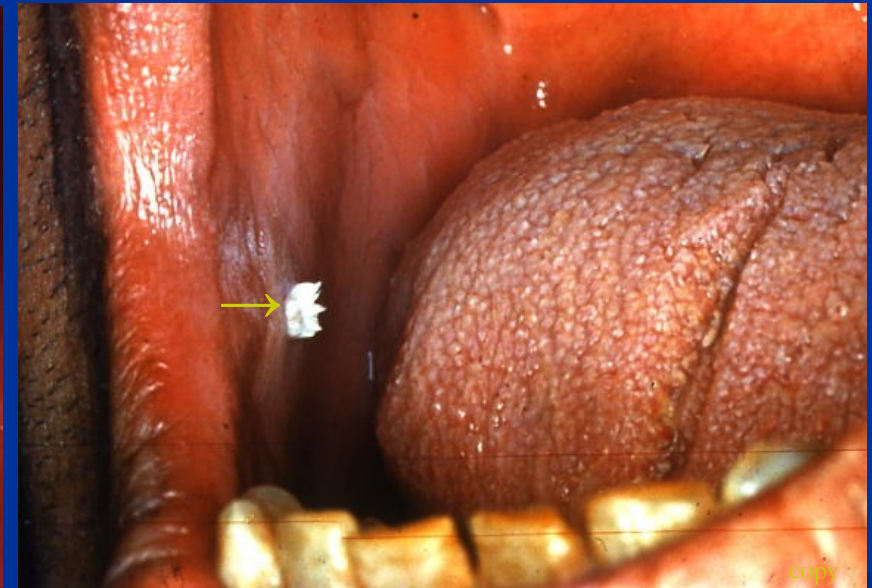


# Verruca vulgaris

Attached gingiva

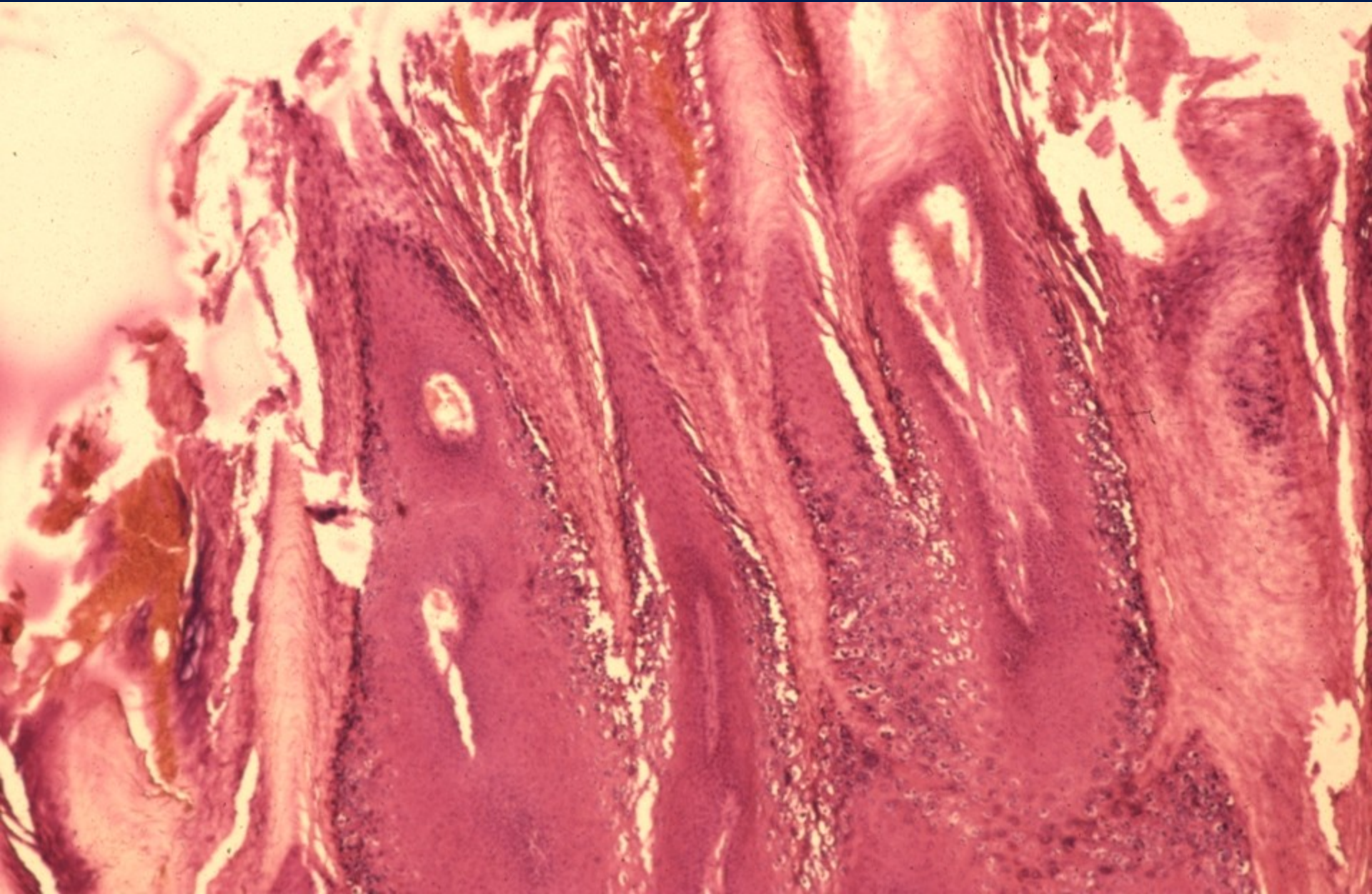


Labial/buccal mucosa





# Verruca vulgaris



# Condyloma acuminatum (venereal wart)

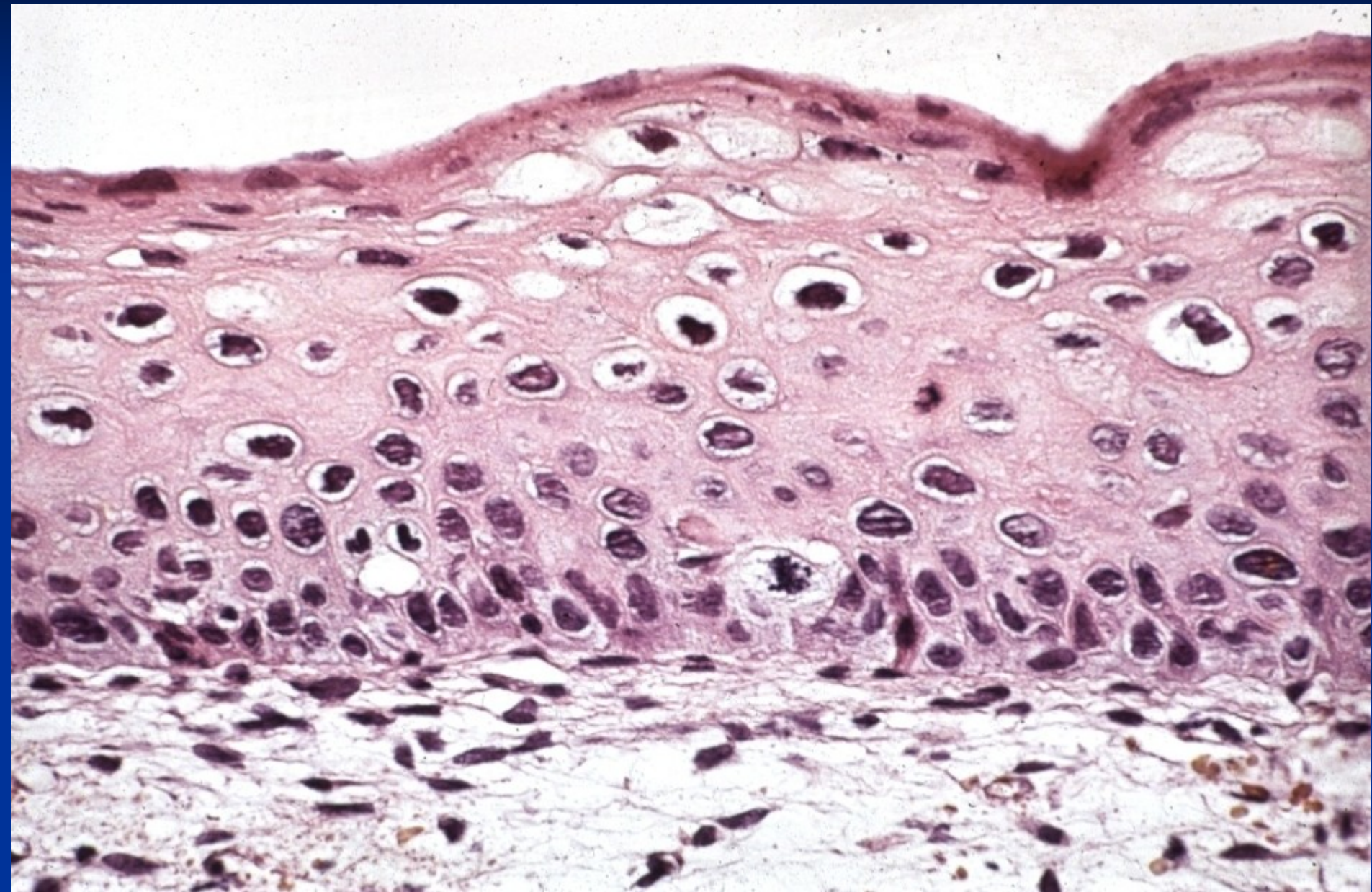
STD associated lesion.

Mouth and genitalia.

HPV- 6, 11, ...

Complete virions produced

# HPV mild dysplasia, koilocytes

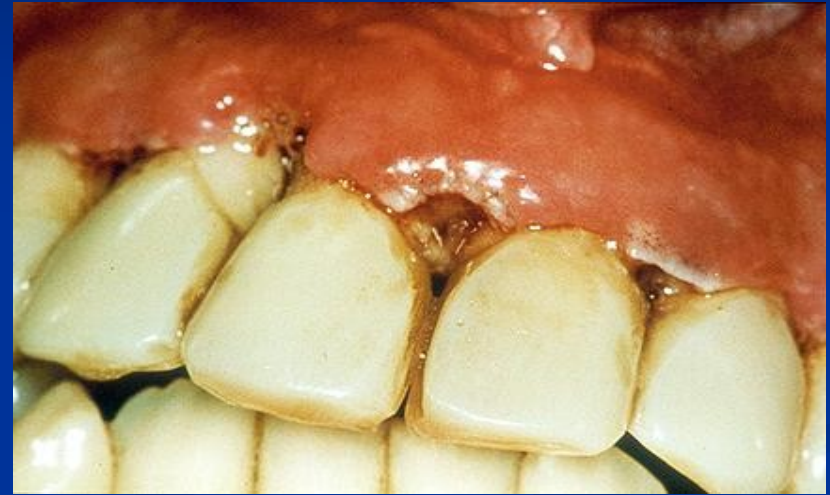


# Acquired immunodeficiency syndrome (AIDS)

- Oral lesions - prominent features of AIDS and HIV infection.
- Oral lesions due and according to the rate of loss of T-helper cells.
- Early studies: approximately 90% of HIV+ patients will present with at least one oral lesion in the course of their illness.
- Current studies report the prevalence of oral lesions has significantly declined (HAART – highly active antiretroviral therapy)

# Special importance of oral health in HIV patients

Oral lesions in patients with HIV may be particularly large, painful or aggressive



Necrotizing ulcerative periodontitis



Aphthous ulcerations

copy

# HIV/AIDS oral-pharyngeal syndromes

- Interferes with oral hygiene
  - more oral+pharyngeal pathology
- Interferes with nutritional intake
  - wasting syndrome
  - HIV treatment compliance** may be impacted by oral pain, xerostomia, dysphagia
- Psychosocial dimensions
  - Avoidance of social contact due to facial appearance
  - Depressive effects of persistent oral pain

# Medications

- HIV patients frequently on numerous antiretroviral medications with complex dosing regimens.
- Numerous drug-to-drug interactions documented.
- Complete list of all medications essential to minimize potential adverse drug interaction to medications that may be prescribed by the dental provider.

# Lesions strongly assoc. with HIV

- Candidiasis – erythematous, hyperplastic, pseudomembranous
- Hairy leukoplakia (EBV)
- HIV-associated periodontal disease – HIV gingivitis, NUG, HIV periodontitis, necrotizing stomatitis
- Kaposi sarcoma (HHV-8)
- Non-Hodgkin malignant lymphoma (EBV)



# Lesions less assoc. with HIV

- Atypical ulceration (oropharyngeal)
- Idiopathic thrombocytopenic purpura
- Salivary gland lesions – xerostomia, major salivary gland enlargement
- Opportunistic viral infections (CMV, HSV, VZV, HPV)
- Opportunistic bacterial infections (*Mycobacterium avium-intracellulare*)
- Opportunistic fungal infections (aspergillosis, histoplasmosis)

# Lesions possibly assoc. with HIV

- Bacterial infections other than gingivitis/periodontitis
- Melanotic hyperpigmentation
- Neurologic disorders (n. facialis palsy, trigeminal neuralgia)
- Squamous cell carcinoma (HPV)

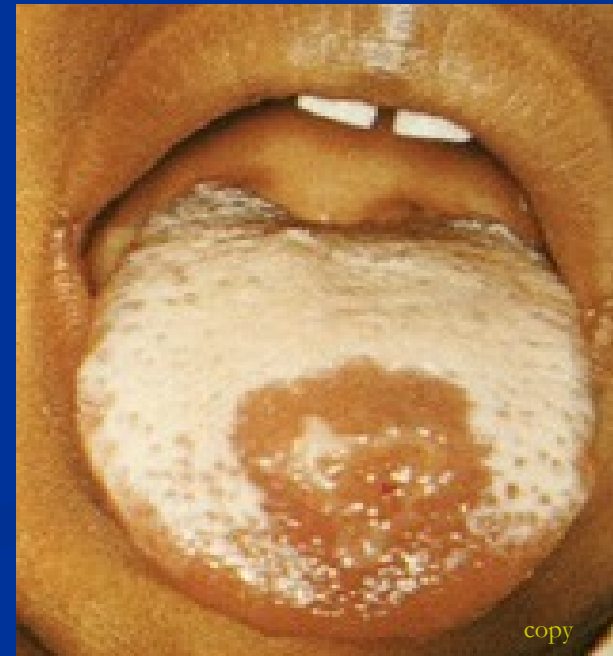
# HIV/AIDS oropharyngeal syndromes – most common

- Candidiasis 28%-75%
- Necrotizing gingivitis
- HSV, CMV, HIV, EBV ulcers
- Recurrent aphthous ulcers
- Drug-derived ulcers
- Kaposi sarcoma
- Dental abscesses

# Candidiasis

- *Candida albicans* in immunodeficient patients (HIV, iatrogenic – chemo/radiotherapy, posttransplant, other immunosuppressive therapy)
- Commonly chronic multifocal lesions
- **Forms:** pseudomembranous
  - erythematous (palate, tongue ~ median rhomboid glossitis)
  - hyperplastic (cheeks)
  - angular cheilitis

# Oral-pharyngeal candidiasis



# Hairy leukoplakia

- Possible *early* manifestation of AIDS status.
- Filamentous white plaque (hyperkeratotic, non-removable) uni-/bilaterally on lateral borders, anterior portion of the tongue.
- Borders irregular or jagged in contour, sharply delineated.
- Possible on entire dorsal surface of the tongue. On buccal mucosa flat appearance.
- Micro: acanthosis, parakeratosis

# Hairy leukoplakia

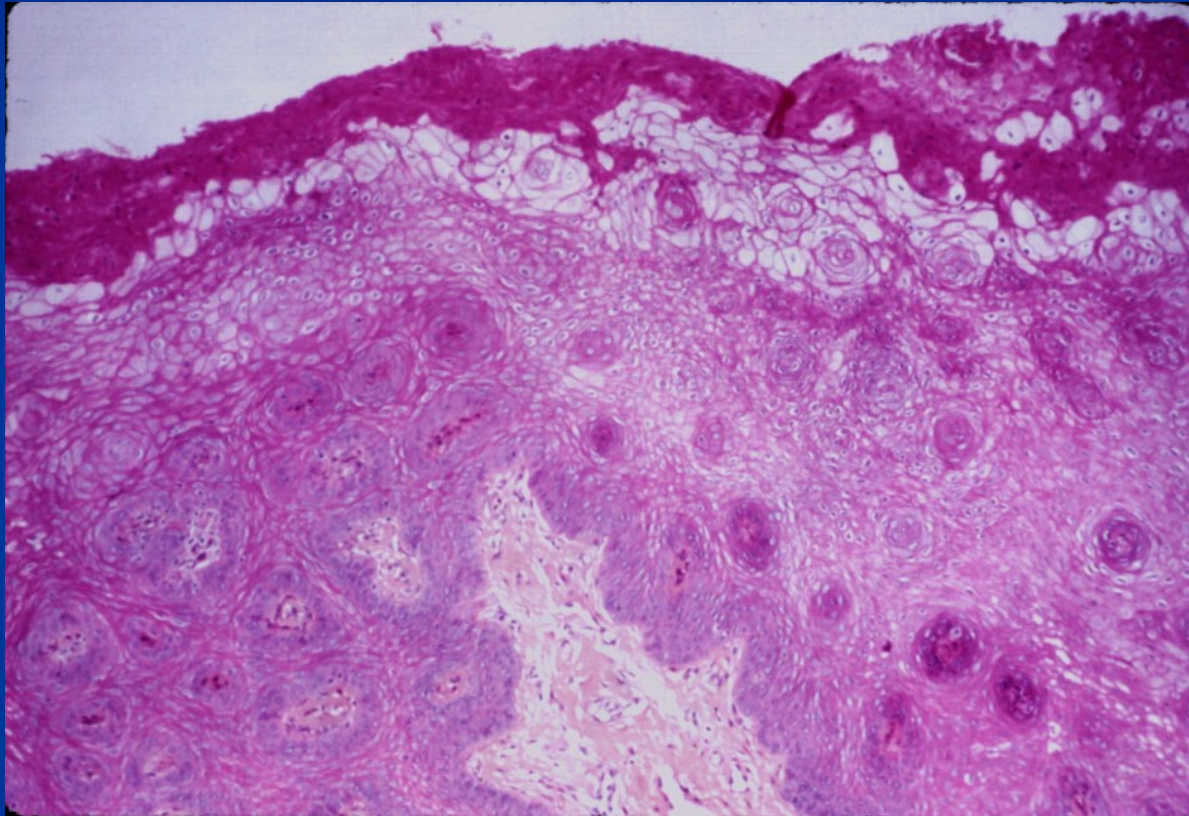


The surface texture is grainy, rough or „shaggy“ in appearance.





# Oral hairy leukoplakia



# Differential diagnosis

- Physiologic hyperkeratosis.
- Idiopathic leukoplakia.
- Lichen planus.
- Hyperplastic candidiasis.

# HIV-associated periodontal disease

- HIV-associated periodontitis resembles acute necrotizing ulcerative periodontitis superimposed on rapidly progressive (necrotizing ulcerative) gingivitis, possible progression into necrotizing stomatitis.
- Other symptoms include:
  - Interproximal necrosis and cratering
  - Marked swelling
  - Intense erythema over the free and attached gingiva
  - Intense pain
  - Spontaneous bleeding and bad breath

# Atypical periodontal disease in a patient with HIV infection.



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# HIV-associated gingivitis

- **Linear gingival erythema:** a bright red line along the border of the free gingival margin (atypical gingivitis).
- Possible progression over the attached gingival and alveolar mucosa.
- Not specific for HIV, possibly due to hyperemia, candidiasis?

# HIV gingivitis



copy

# Opportunistic infections

- Important for diagnosis and prognosis (type according to the CD4+ T-cell count)
- Common antibiotic/antiviral/antifungal prophylaxis for opportunistic infections

- Inflammation

- Malignancies

Kaposi sarcoma (KS – HHV-8)

Non-Hodgkin lymphoma (NHL - EBV)

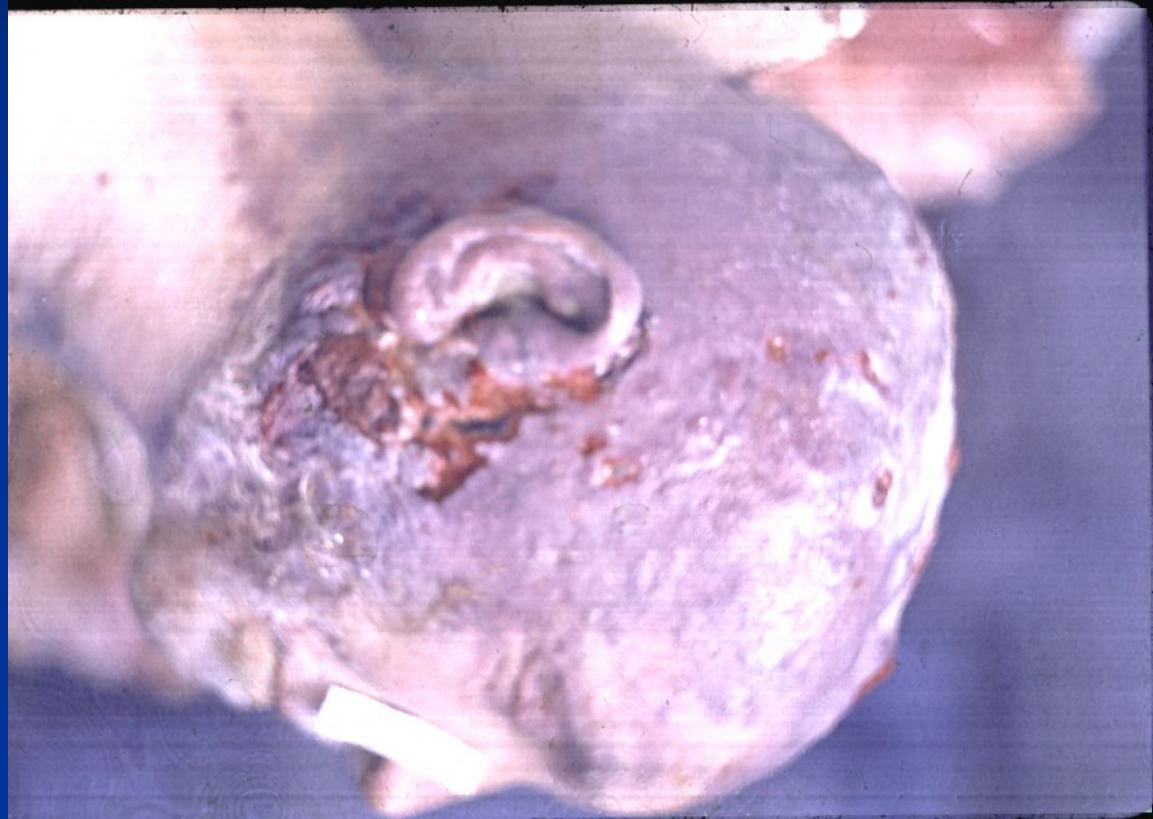
Squamous cell carcinoma (SCC – HPV)

# Kaposi sarcoma

- Kaposi sarcoma: HHV-8 opportunistic infection in immunodeficiency
- Vascular – endothelial sarcoma
- Solitary or multiple bluish, blackish, or reddish macules – elevated lesions - ulcerations.
- Kaposi sarcoma is one of the intraoral AIDS– defining lesions.



# Kaposi sarcoma



# HIV cervical lymphadenopathy

- Enlargement of the cervical (neck) nodes.
- Lymphadenopathy frequently seen in association with HIV – PGL  
– persistent generalized lymphadenopathy
- Diff. dg. x ML, metastasis

# HIV cervical lymphadenopathy



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# HIV lymphoma

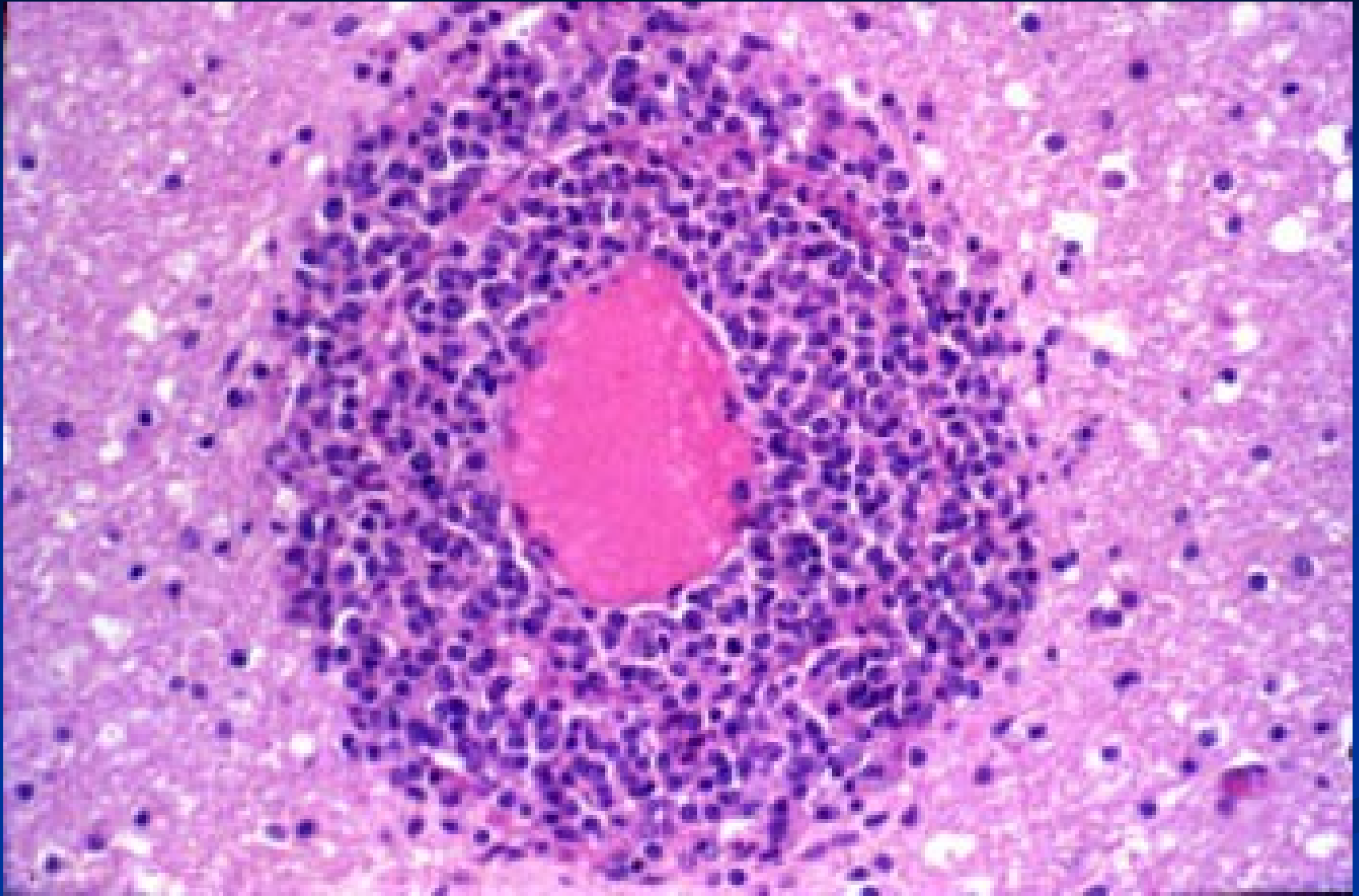
- Solitary lump or nodule, swelling, or nonhealing ulcer anywhere in the oral cavity.
- The swelling possibly ulcerated or covered with intact, normal-appearing mucosa.
- Usually painful, the lesion grows rapidly in size, may be the first evidence of lymphoma.
- Common association with EBV
- Several histopathologic types, atypical localization

# HIV lymphoma



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# Primary malignant lymphoma (brain)



# HPV lesion on the lip of a patient with AIDS.



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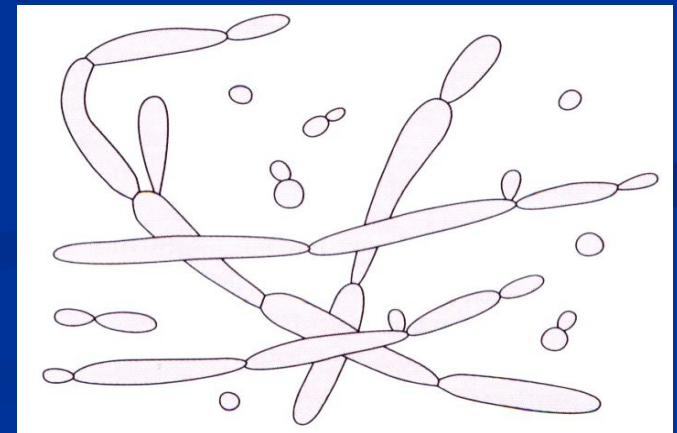
# Fungal infections

- Candidiasis:
- Histoplasmosis
- Blastomycosis
- Cryptococcosis
- Aspergillosis
- ...



# *Candida albicans* and other *Candida* species

- Harmless inhabitants of the skin and mucous membranes of all humans
- Normal immune system keeps candida on body surfaces - **skin and mucous membranes integrity**
- **Presence of normal bacterial flora**
- Opportunistic infection



# The most important risk factors

- Neutropenia, anaemia (acquired in leukemia, radio/chemotherapy, ...)
- Diabetes mellitus
- AIDS
- SCID + other inborn immunodeficiencies (myeloperoxidase defects)
- Broad-spectrum antibiotics, steroids
- Local factors – trauma incl. chronic (denture), hygiene, smoking, carbohydrate diet, xerostomia

# The most important risk factors

- Indwelling catheters
- Major surgery
- Organ transplantation
- Age dependent – neonates, very old
- Severity of any illness
- Intravenous drug addicts
- Poor nutritional status

# Candidiasis

- Confirmation with KOH smear, tissue PAS or silver stains
- Treatment - topical or systemic
- Primary problem treatment

# Candidiasis

- Symptoms: burning, dysgeusia, sensitivity, generalized discomfort
- Angular cheilitis, coinfection with staph. may be present
- Acute - atrophic red patches or white plaque-like surface colonies.
- Chronic - denture related form confined to area of appliance

# Candidiasis

- Acute (and chronic in immunocompromised)
  - Pseudomembraneous („Thrush“) - white
    - *DOES* scrape off
  - Atrophic („Erythematous“) - red
    - (Does *NOT* scrape off)
- Chronic
  - Hyperplastic („Candidal leukoplakia“) - white
    - (Does *NOT* scrape off)

# Candidiasis

- **Candida-associated primary oral lesions**

  - Denture stomatitis

  - Angular cheilitis

  - Median rhomboid glossitis

- **Secondary oral lesions in generalized candidiasis**

  - Systemic mucocutaneous c.

# Candidiasis: Acute pseudomembraneous

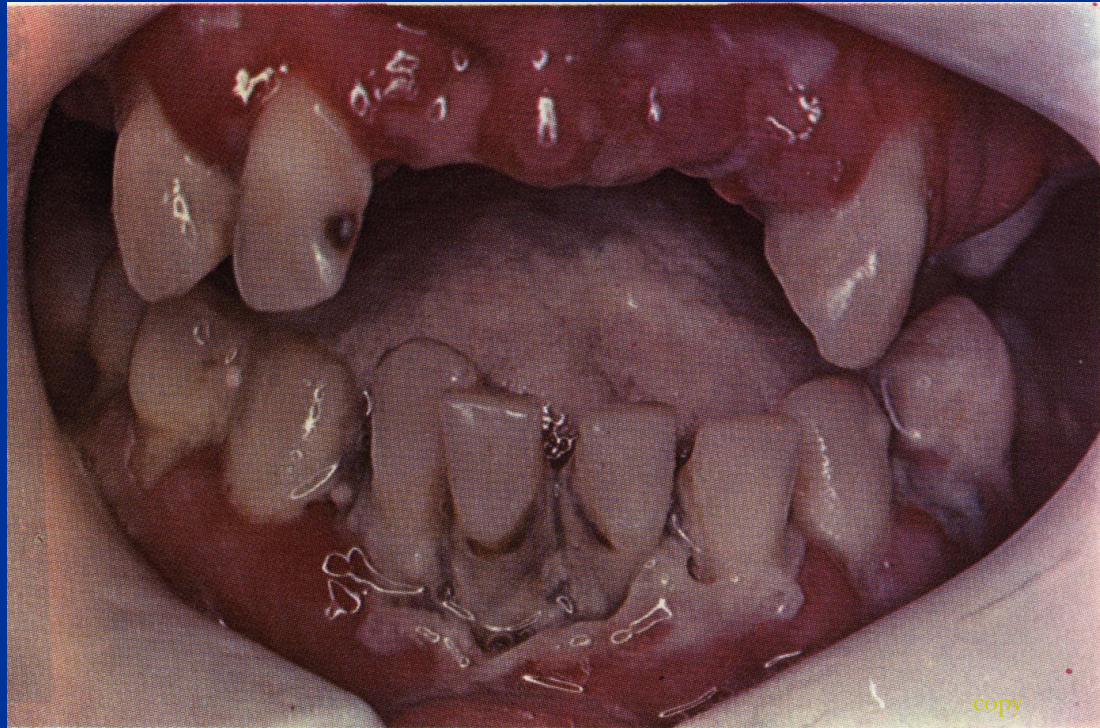
- White thick lesion - trush
- Underlying tissue: erythematous, haemorrhagic, pruritic
- Superficial necrosis + hyphae + yeast forms, infl. infiltrate – mostly neutrophils
- Newborns, old debilitated p., p. with risk factors



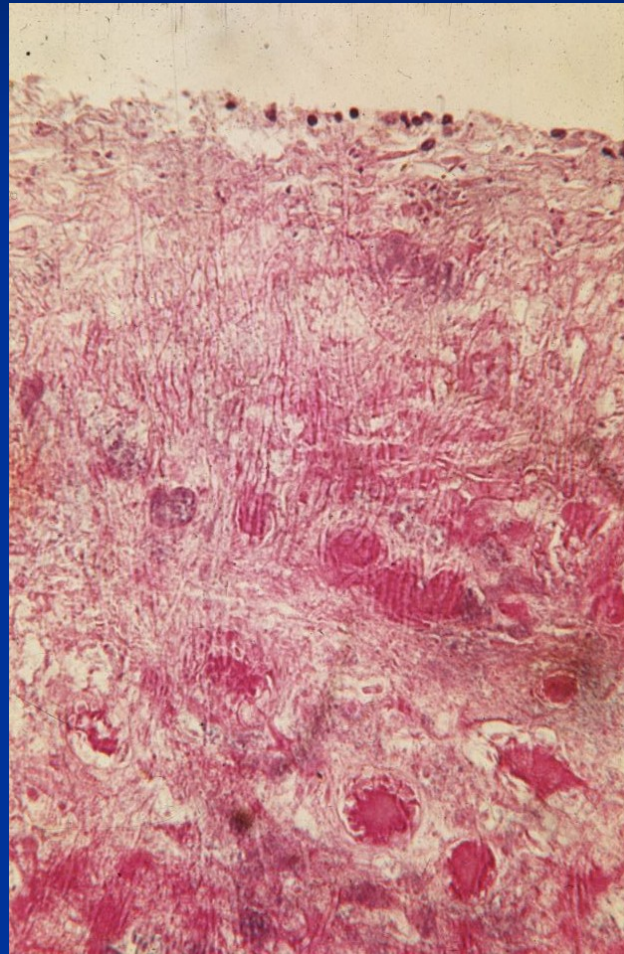
# Thrush/ Candidiasis



# Candidiasis



# Pseudomembrane with yeasts



# Erythematous candidiasis.

Mainly on tongue + palate,  
in ATB/corticosteroid therapy  
(ATB sore tongue) –  
microorganism dysbalance  
red, painful



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# Candidiasis: Chronic hyperplastic - candidal leukoplakia

- Keratotic plaques or papules, white, rough surface (no scraping off), erythematous background, vague borders
- Hyperkeratosis with acanthosis, oedema, neutrophils + microabscesses, plasma cells + lymphocytes in stroma
- Sites: labial commissure, labial, buccal vestibule
- Risk factors: smoking, poor oral hygiene (dentures), xerostomia
- Cancer risk: Biopsy mandatory of all speckled erythroplakia or erythroleukoplakia, ↑ SCC risk  
reactive atypia x dysplasia



# Candidiasis: Red chronic oral lesions

- Angular cheilitis – Perleche (poor oral closure, saliva accumulation)
- Median rhomboid glossitis
- Denture stomatitis – atrophic c. on palate

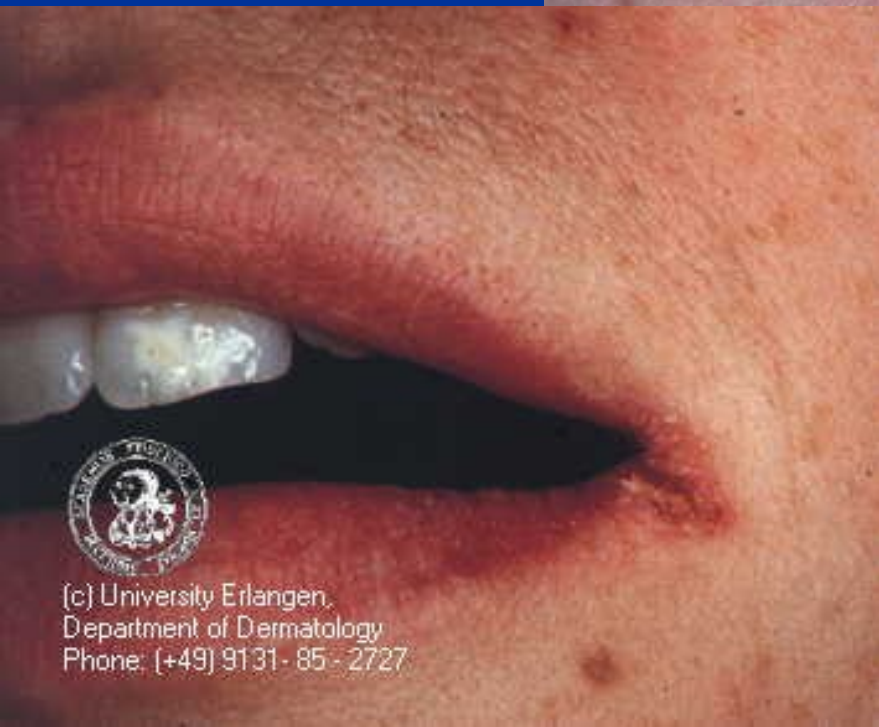
# Angular cheilitis (Perleche)

- Labial commisures, moist fissures
- Elderly – facial and dental architecture
- Youth – thumbsucking, lollipops
- Thrush in DM II or HIV
- Multifactorial: candida associated, Str., Staph., deficiency of iron, riboflavin, vitamin A, E, etc.
- Erythema, fissuring, pain





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Department of Dermatology  
Phone: (+49) 9131- 85 - 2727



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# Candidiasis



Angular cheilitis

# Median rhomboid glossitis

- Shiny oval or diamond shaped elevation, midline, directly in front of the circumvallate papillae. Asymptomatic.
- *Candida* species may be present + trauma
- Micro: Chronic inflammation with fibrosis with possible hyphae in areas of parakeratosis, loss of papillae



# Denture stomatitis

- Tissue trauma – dentures + poor hygiene → secondary c.
- Palate: erythema, oedema, symptomless
- Localized – spotty erythema
- Generalized – diffuse erythema
- Chronic inflammatory papillary hyperplasia – erythema + rough granular surface
- Micro: superficial overgrowth, no epithelial invasion by c.

# Hairy tongue

- Diffuse elongation of the filiform papillae of the dorsum surface of the tongue
- Candida usually present (exfoliative cytology)
- Superficial candidiasis stimulates epithelial hyperplasia to produce the thickened layer
- Coffee, tea, tobacco - secondary staining - black hairy tongue



Hairy tongue

# Chronic mucocutaneous candidiasis

- Persistent superficial infection – oral + other mucosae, skin + adnexa
- Immunodeficiency, endocrine dysfunction



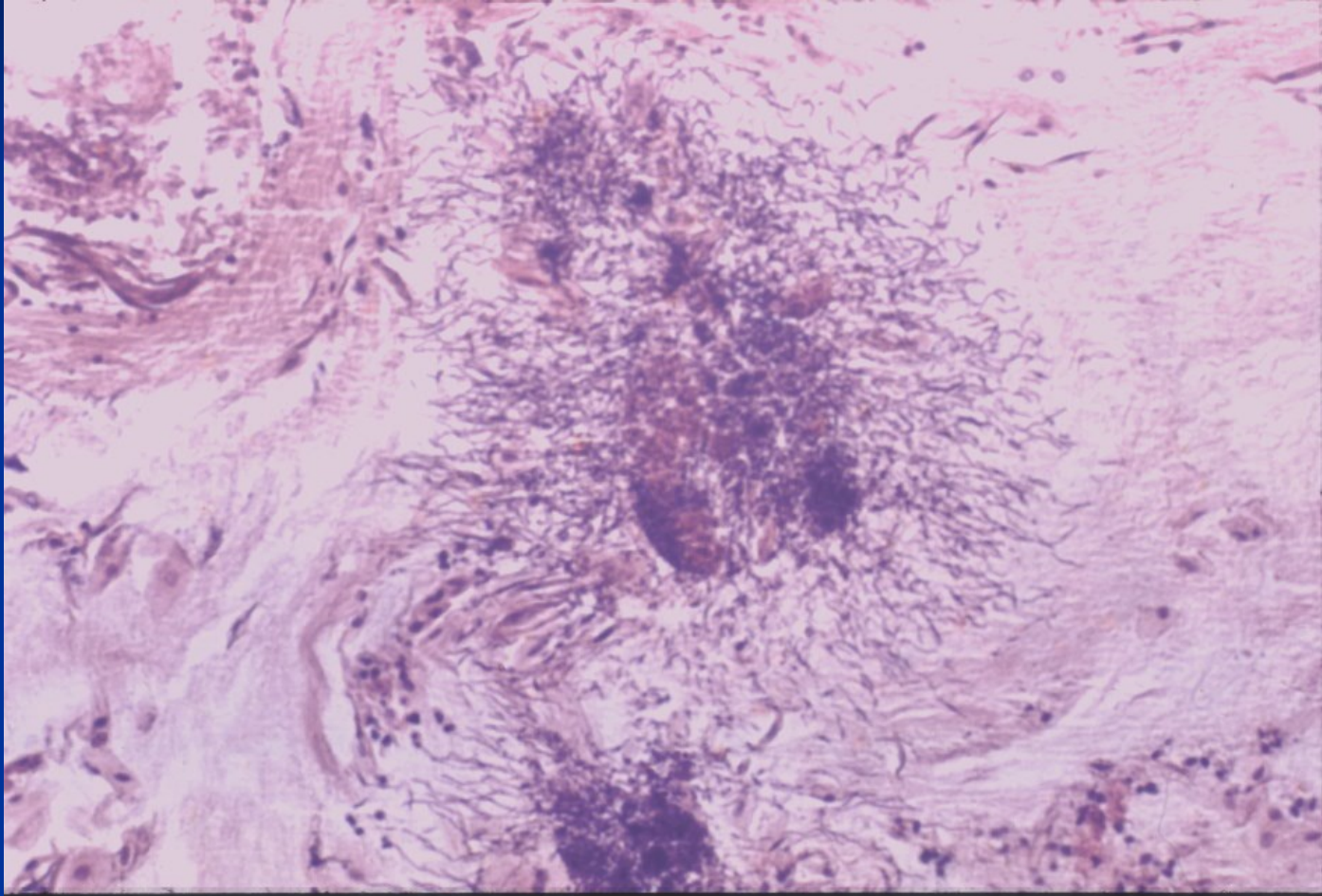
# Invasive fungal infections

- Fungi that commonly cause invasive infection can be divided into two groups:
  - Opportunistic fungi, (that occur widely)
    - e.g. *Aspergillus* spp., *Candida* spp., *Cryptococcus*, *Zygomycetes*
  - Geographically defined, „dimorphic fungi“
    - e.g. *Histoplasma capsulatum*
    - *Coccidioimycosis*

# Invasive fungal infections

- Diagnosis
  - Microscopic
    - Secretions, KOH
    - Histology
- Culture
  - ! may occur as a contaminant
- Laboratory (antigenes, PCR)

# Fungal colony



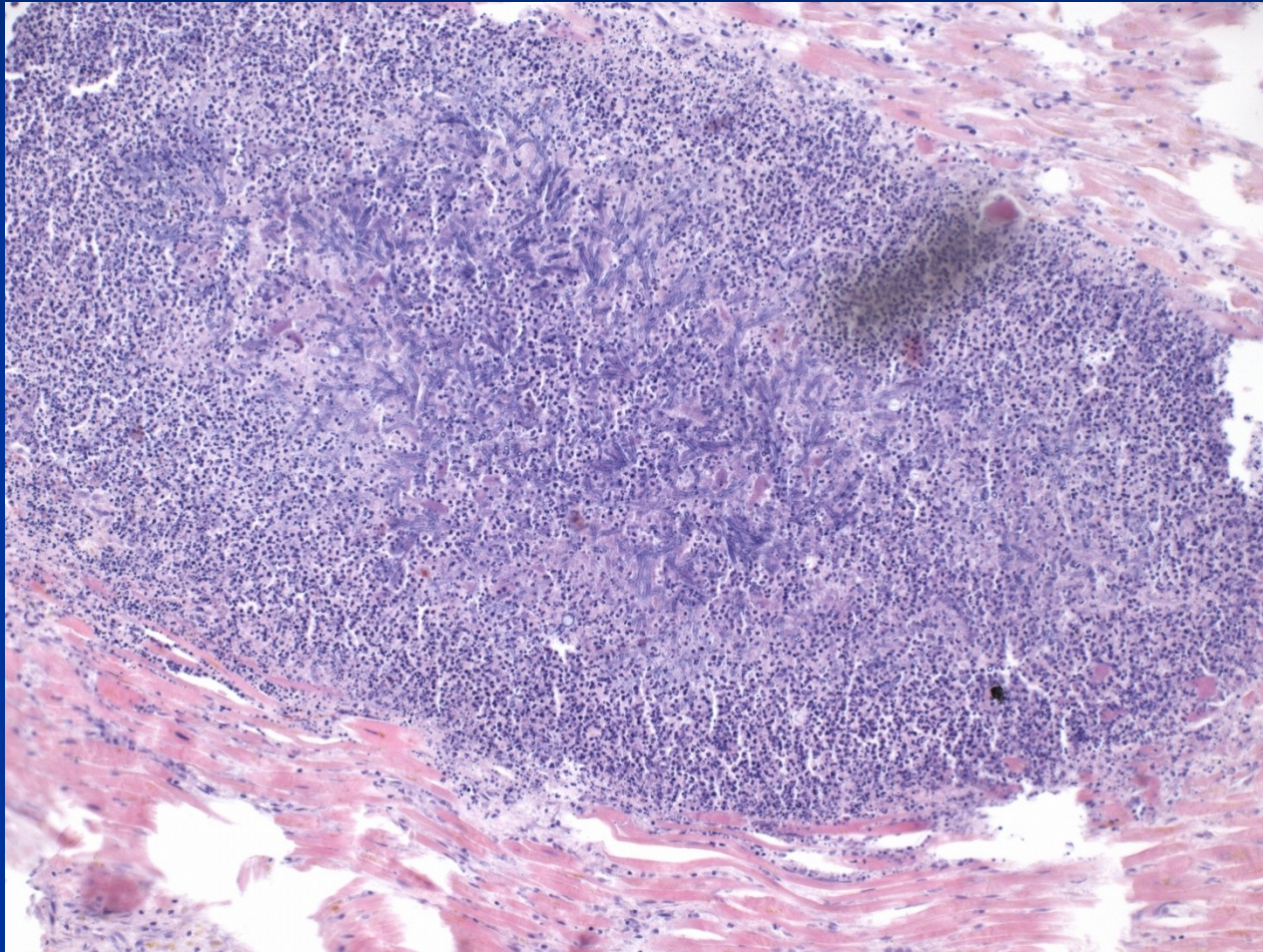
# Invasive candidiasis

- Usually begins with **candidemia** (but in only about 50% of cases candidemia can be proven)
- If phagocytic system normal, invasive infection stops in this stage
- Progression – secondary deep visceral candidiasis

# Invasive fungal infections

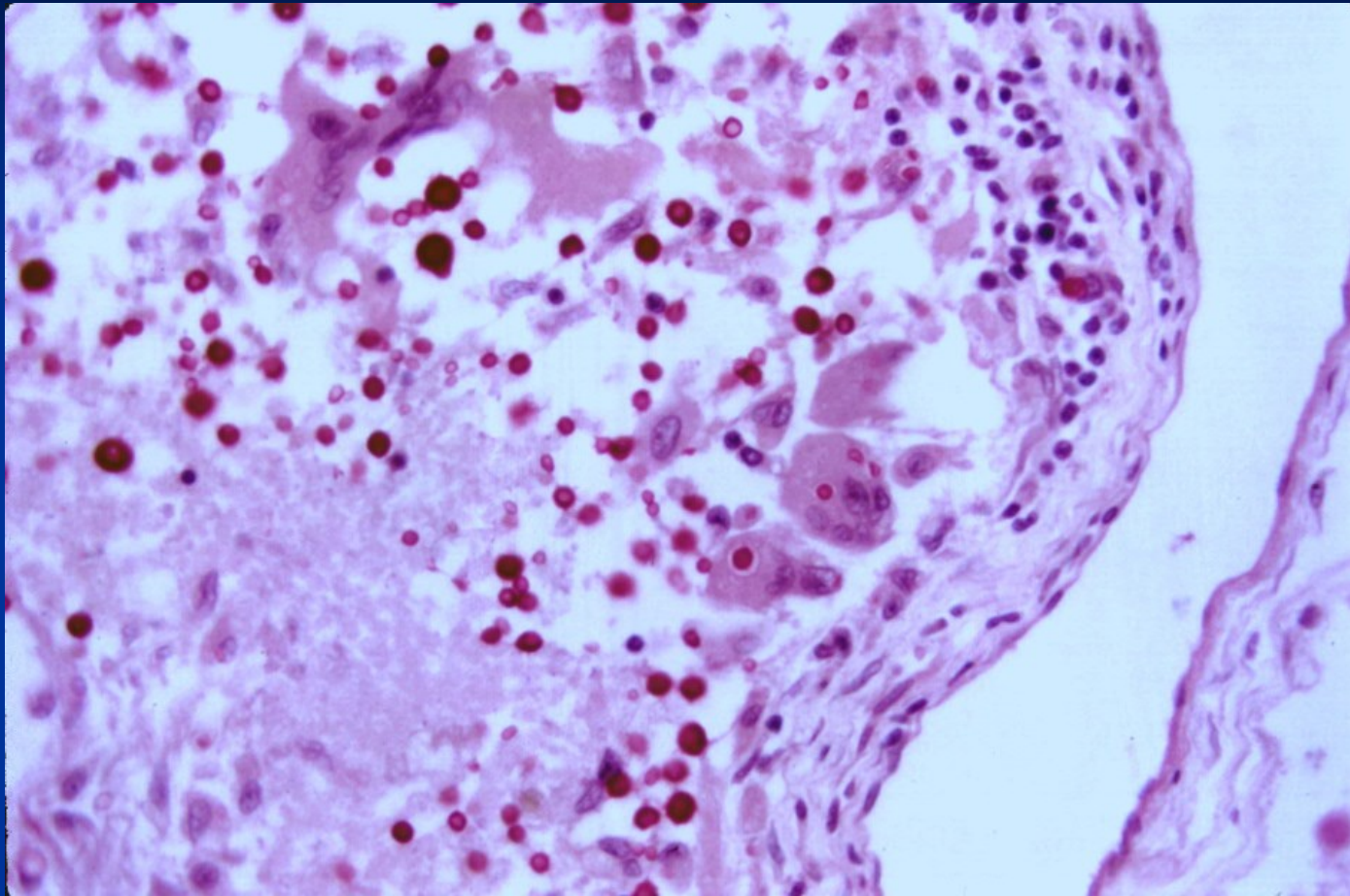
- *Aspergillus* spp (esp. *A. fumigatus*)
  - Epidemiology
    - Widespread, grows on rotting vegetation. Spores commonly present in air. Important predisposing factor: immunosuppression
  - Clinical presentations
    - Allergic bronchopulmonary aspergillosis - Asthma-like symptoms. - Fungus grows in bronchial secretions.
    - Aspergilloma (fungal ball) - develops in cavities (- lungs, sinuses).
    - Invasive disease - tissue destruction, pneumonia.

# Invasive aspergillosis



# Cryptococcus

- Mostly in immunosuppressed
- Primary infection in the lungs
- Secondary dissemination (meninges, skin, bone)
- Oral lesions possible – nonhealing ulcers
- Dg. – biopsy – thick mucoid capsule



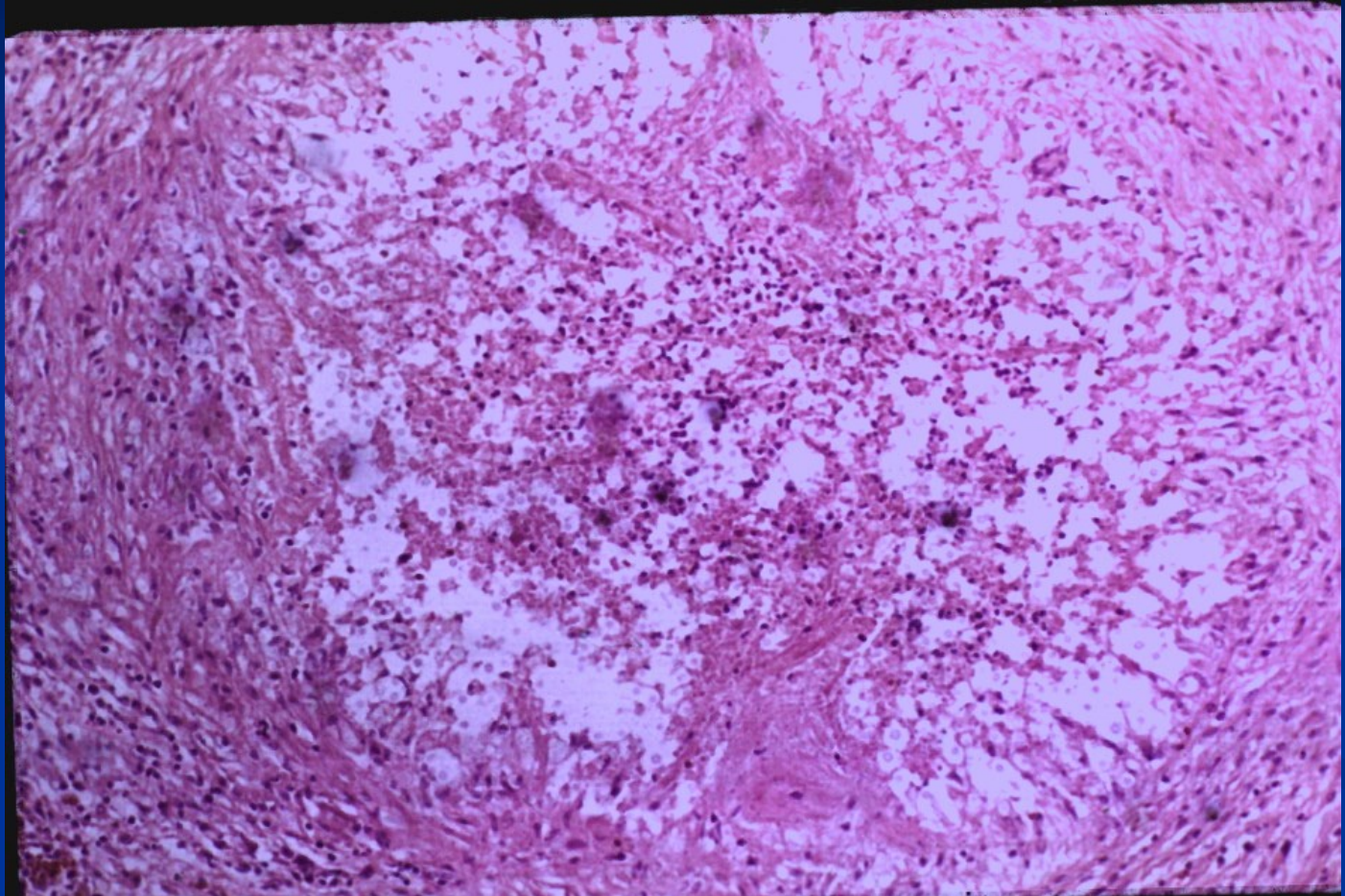
Cryptococcal meningitis



# Histoplasmosis

- In US the most common systemic fungal infection
- In non-immunocompromised: mild, self limited acute lung disease
- In immunosuppressed: chronic; disseminated – incl. oral lesions – ulcers (x ca!, biopsy)
- Micro – macrophagic reaction +/- granulomas

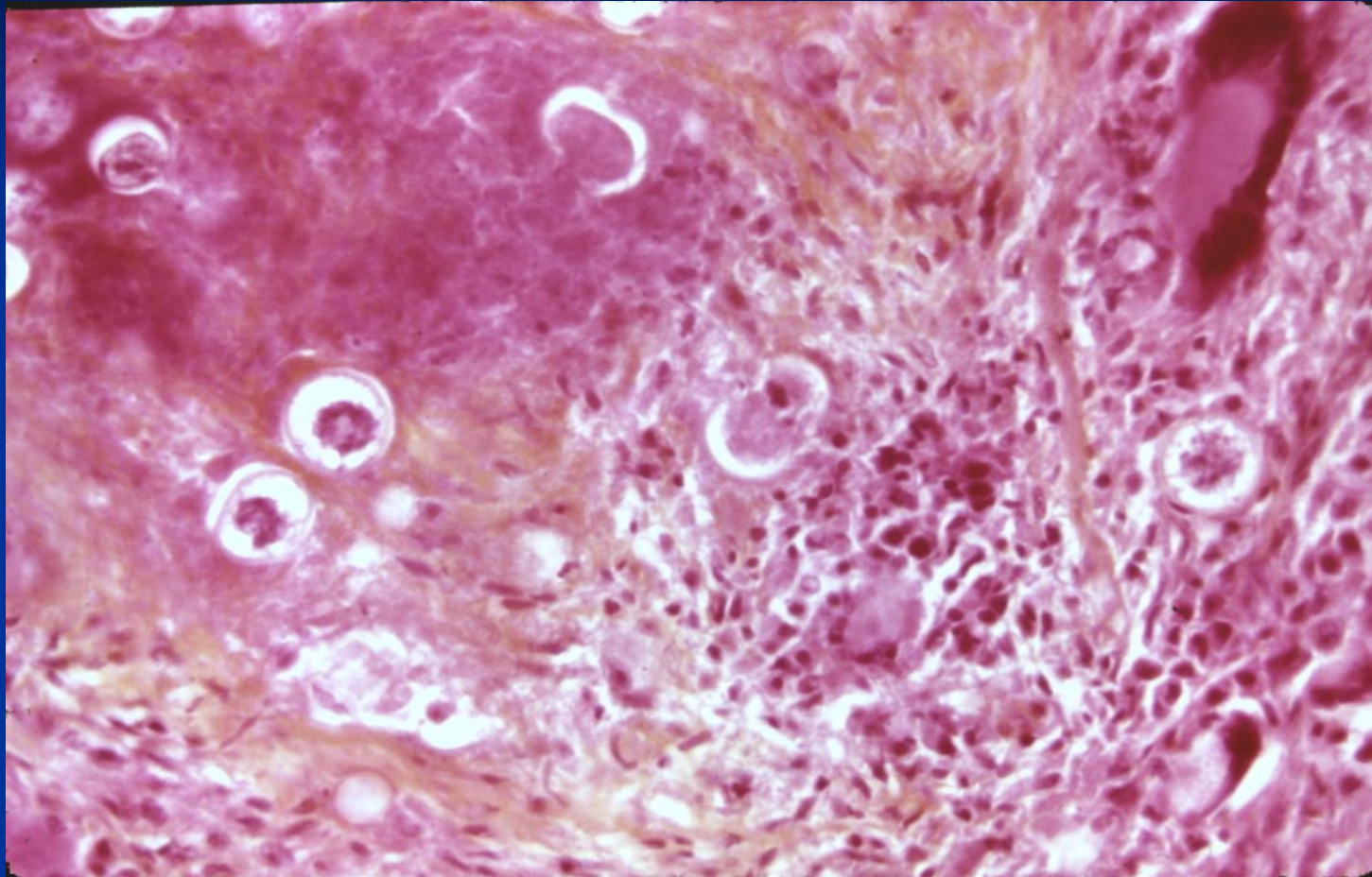
# Histoplasmosis



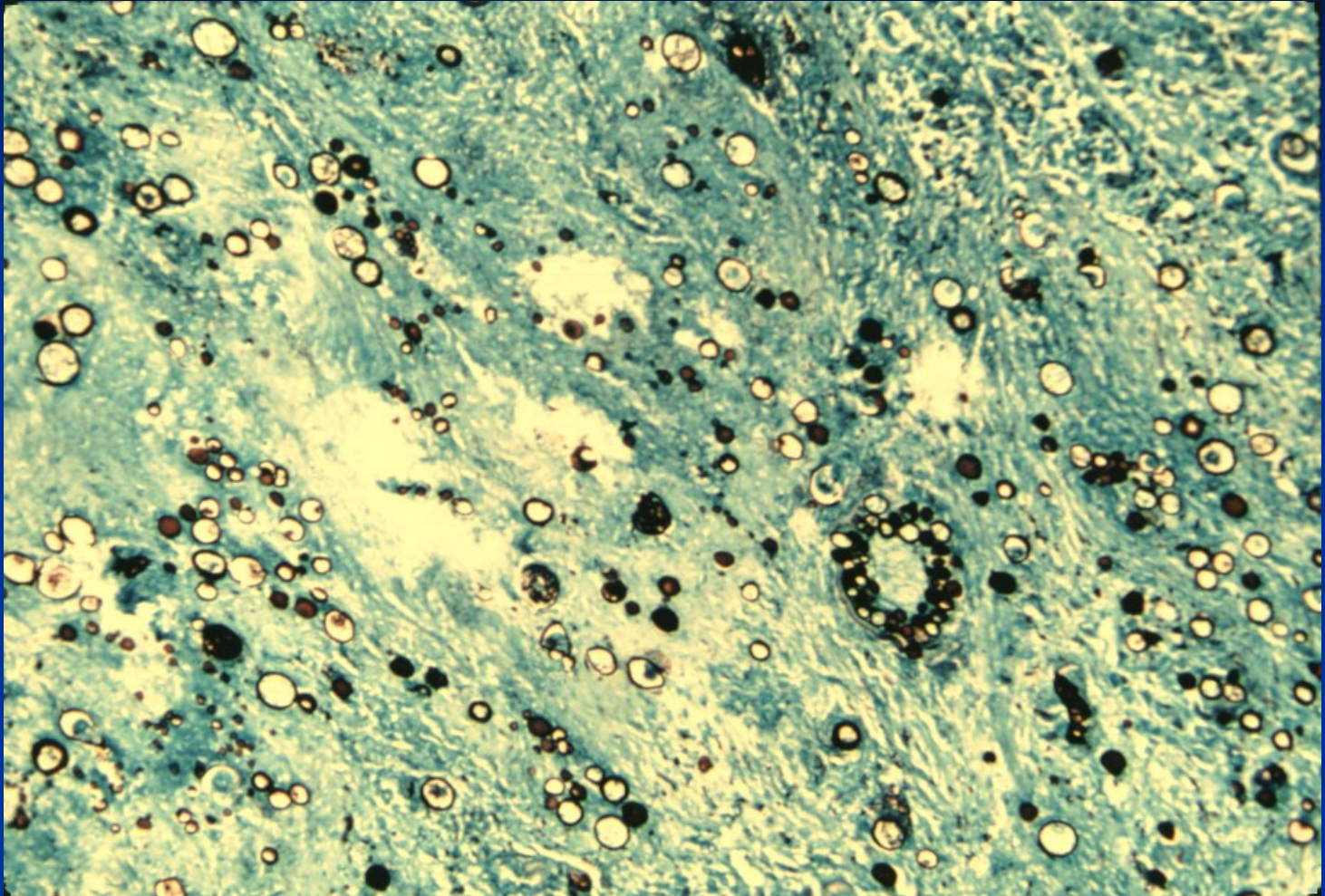
# Coccidiomycosis

- Endemic in Americas
- Types similar to histoplasmosis (acute lung dis. – „valley fever“; chronic pulmonary; disseminated)
- Perioral skin lesions possible – papules, abscesses, nodules
- Dg.: biopsy, culture

# Coccidiomycosis



# Coccidiomyces



# Zygomycosis

Invasive fungal infection (mucormycosis)

Opportunistic in the debilitated, immunocompromised, or acidotic patient.

## Aetiology:

Fungal spores in environment

## Clinical types

- 1) Rhino-orbito-cerebral
- 2) Pulmonary
- 3) Gastrointestinal
- 4) Cutaneous
- 5) Disseminated



copy

# Zygomycosis

## Pathogenesis:

Spore inhalation → germination (hyphae) → local invasion → nasal mucosa, paranasal sinus, palate, lung

## Spread:

- direct extension
- blood vessel invasion → to the orbit and intracranial → ischemia, necrosis, gangrene and brain abscess

# Clinical presentation

Fever, facial pain or headache, nasal discharge, epistaxis, visual disturbances, and lethargy





# Zygomycosis

**Diagnosis:** requires a high index of suspicion → risk factors + evidence of tissue invasion

**Biopsy:** using fungal stain → broad nonseptate hyphae with right-angle branches

**Imaging:** X-ray, CT-MRI.

