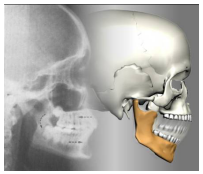
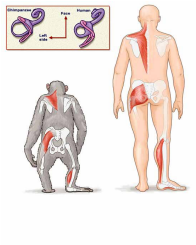


Biomechanics





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Types of motion

translation + rotation

translation Forces!

Torques! **rotation**

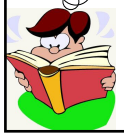
2

2

Force and torque

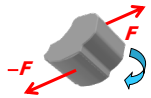
$F = mg$

movement of uniform acceleration

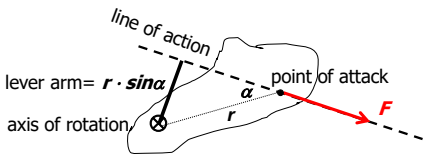


For rigid bodies:

rotation occours if torqu is present (even without translation)



$\sum \vec{F}_i = 0$



Torque (τ):

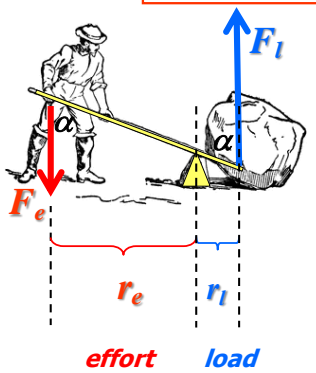
$$\tau = F \cdot r \cdot \sin \alpha \quad \text{(Nm)}$$

3

3

The concept of a lever

equilibrium $\Leftrightarrow \Sigma F_i = 0$ and $\Sigma \tau_i = 0$



$$\tau_e = F_e \cdot r_e \cdot \sin \alpha$$
$$\tau_l = F_l \cdot r_l \cdot \sin \alpha$$

$$\tau_e = \tau_l$$
$$F_e \cdot r_e = F_l \cdot r_l$$

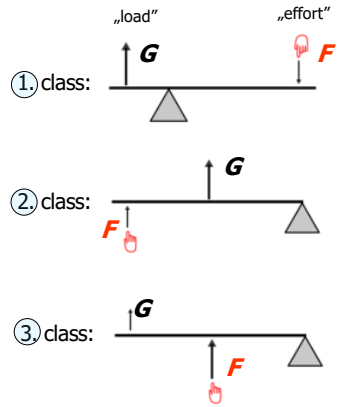
$$\frac{F_e}{F_l} = \frac{r_l}{r_e}, or\ F_l = F_e \cdot \frac{r_e}{r_l}$$

force amplification

4

4

Types of levers



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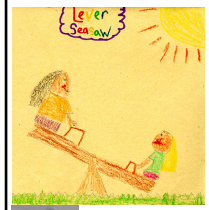
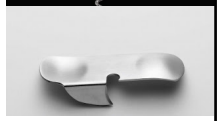
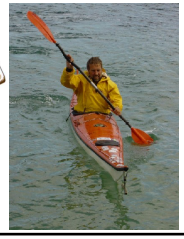
Levers







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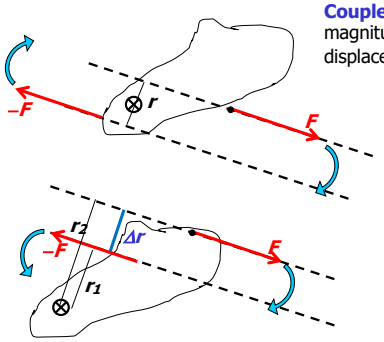
Dental levers

7

7

Force couple



Couple: a pair of forces, equal in magnitude, oppositely directed, and displaced by perpendicular distance.

Resultant force: 0

Resultant torque (τ):

$$\tau = F \cdot (r_2 - r_1) = F \cdot \Delta r$$

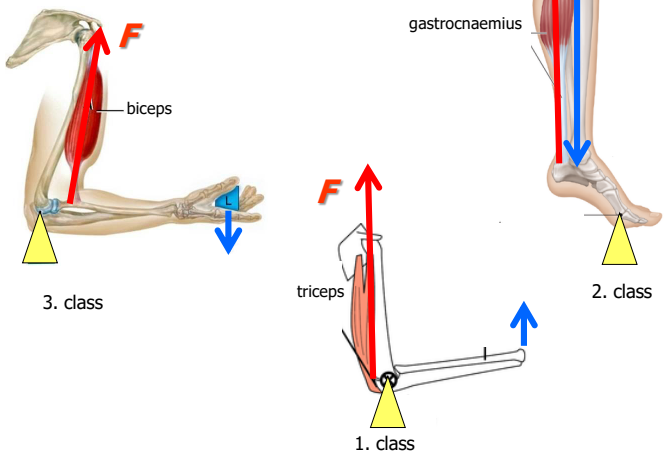
⇒ „couple = torque"

Any set of forces on a body can be replaced by a single force and a single couple.

8

8

Levers in the human body



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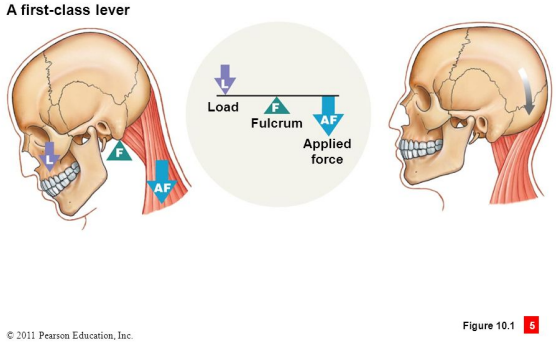

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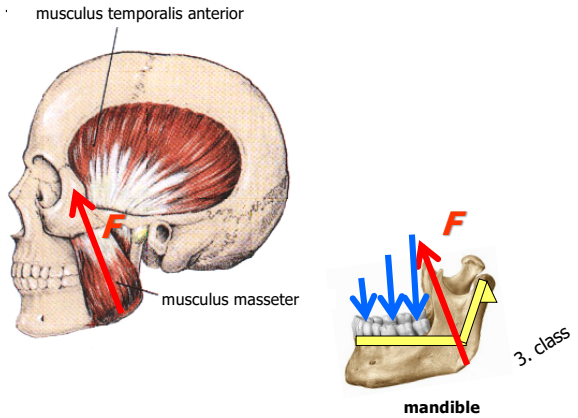
10

The mandible as a lever



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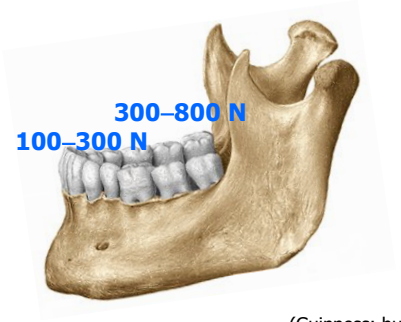
11

Masticatory forces



(Guinness: human - 4000 N)

12

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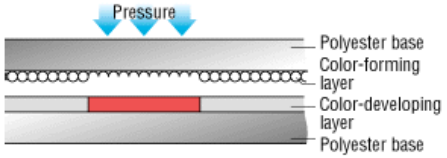
Measuring masticatory forces

Pressure indicator film:



piezoelectric sensor:

13

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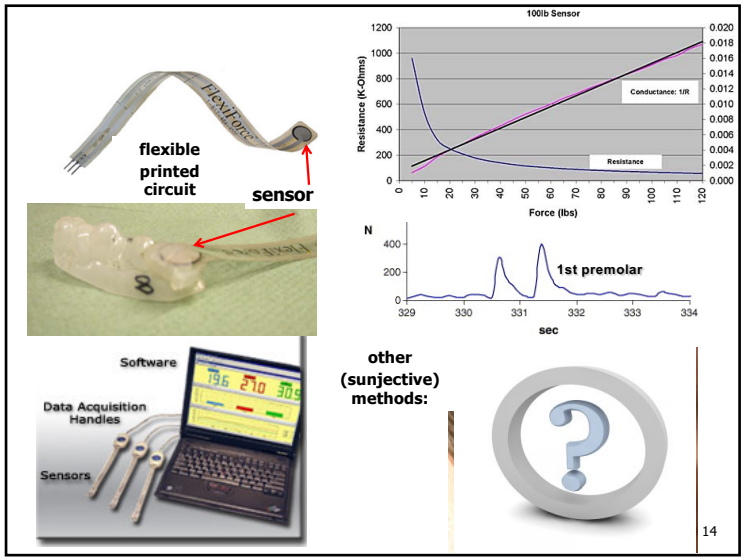
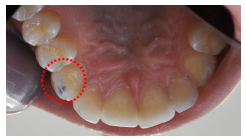


14

Pressure values of mastications

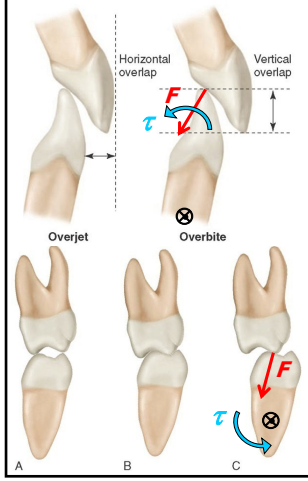


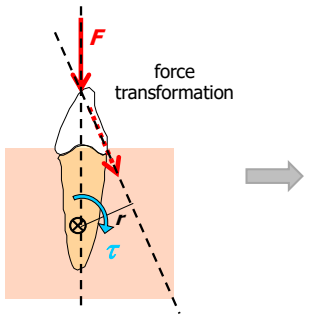
$p \leq 300$ MPa !

15

15

Torque of mastication



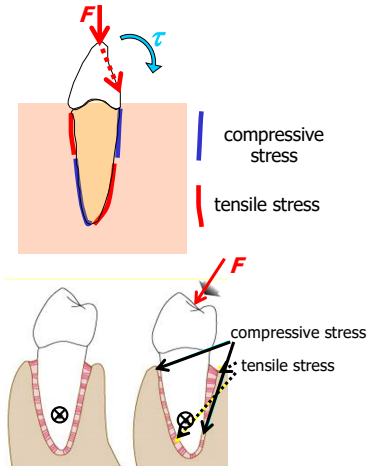


$$\tau = F \cdot r$$

16

16

Consequences of torque



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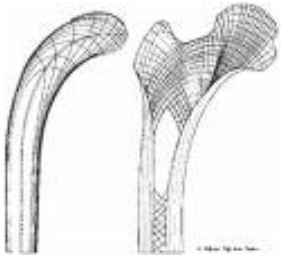
17

Bone remodeling

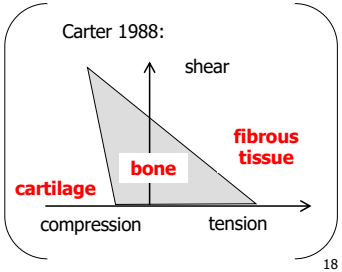
Wolff's law 1870



compressive stress ⇒ resorption

tensile stress ⇒ formation

Every change in the function of a bone is followed by certain definite changes in its internal architecture and its external conformation.



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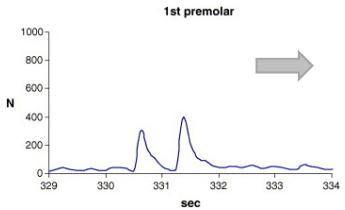
18

Masticatory forces



***F* = 100–800 N**

***t* ≤ 1 s !**

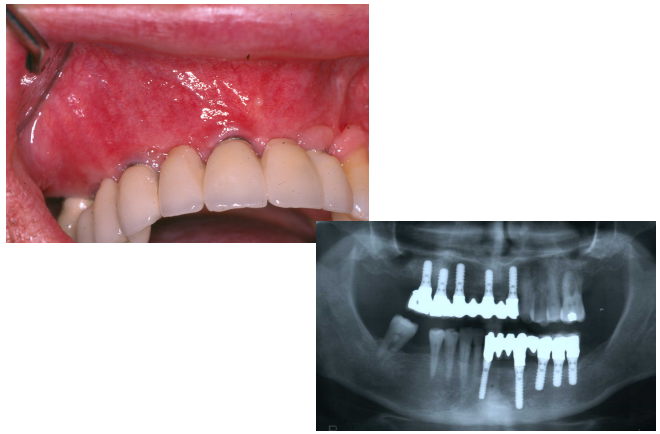
If the force would be constant

3–5 seconds	⟹	pain
≈ hours	⟹	tissue damage
7–14 days	⟹	loosening of teeth

19

19

Physical bases of implantology



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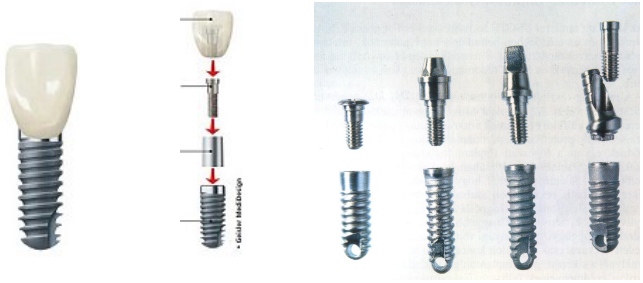
20

Dental implants



21

21

ImImplant materials

metals

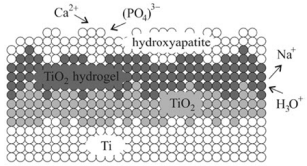
- titanium (Ti)

- titanium alloys (Ti-6Al-4V)
- kCobalt alloys (Co-Cr-Mo)

ceramics

- aluminium-oxide
- zirconia (zirconium-dioxide)
- HAP
- bioüglasses

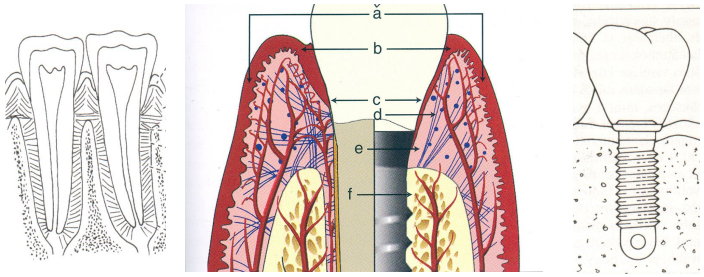
metals with ceramic coating



22

22

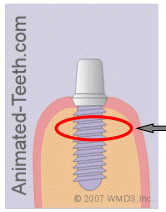
Tooth vs. implant



23

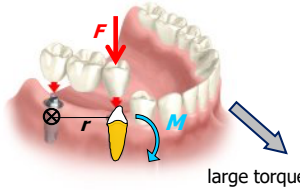
23

Force transition of implant



after integration

concentrated compression

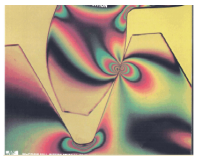


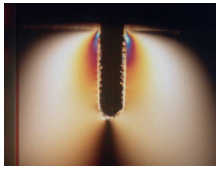
large torque

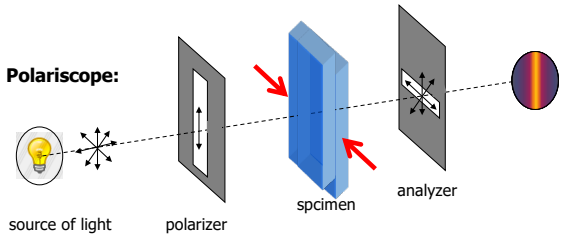
24

24

Optical method for stress analysis







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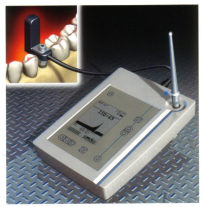
25

Methods for testing implant stability

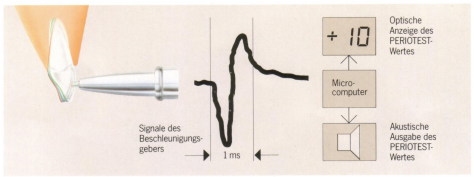
- Resonant Frequency Analysis (RFA)

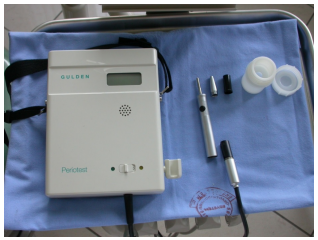


26

26

- Periotest





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27