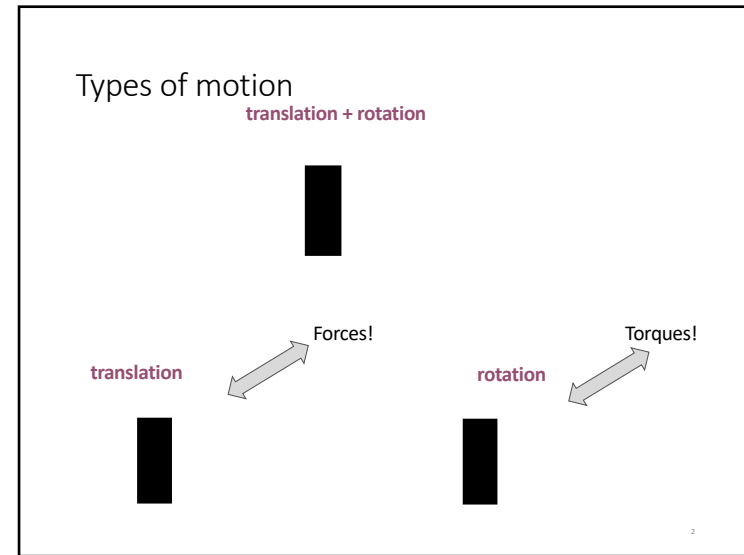
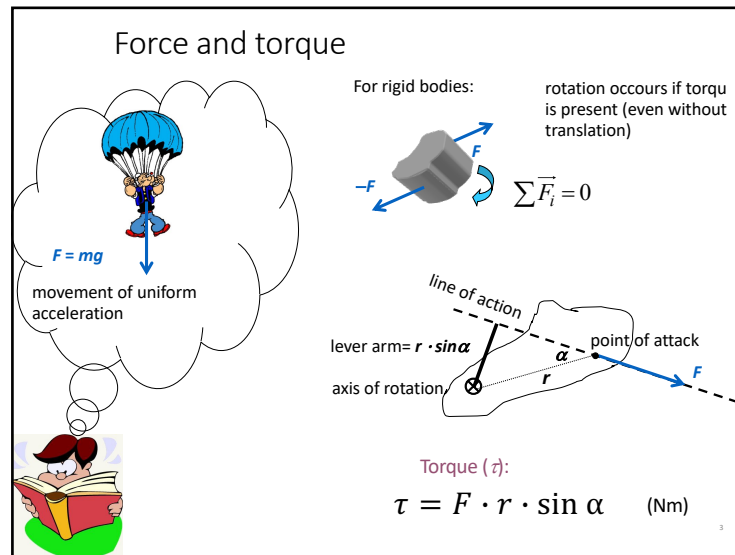


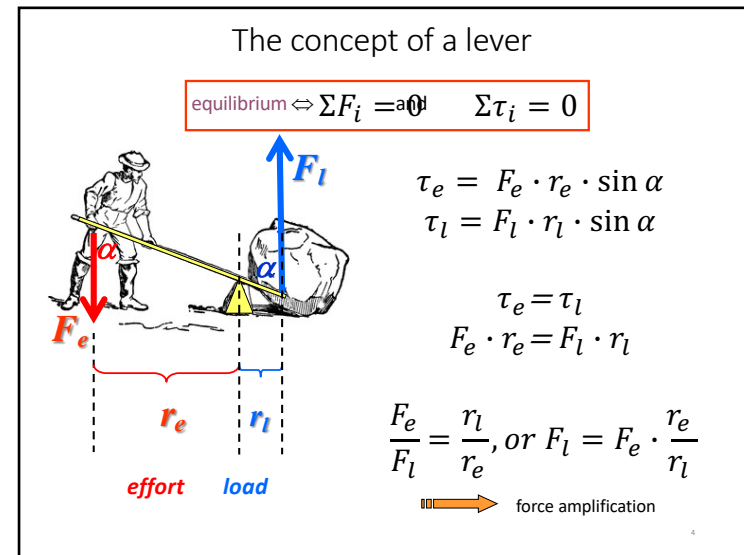
1



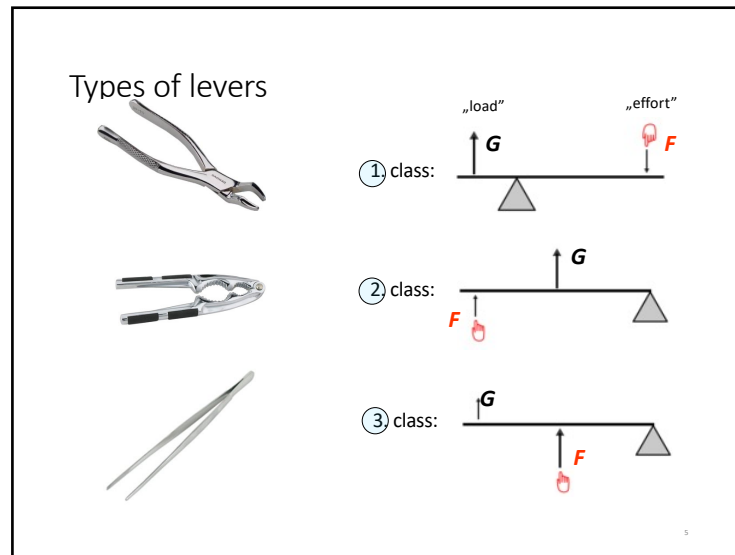
2



3



4



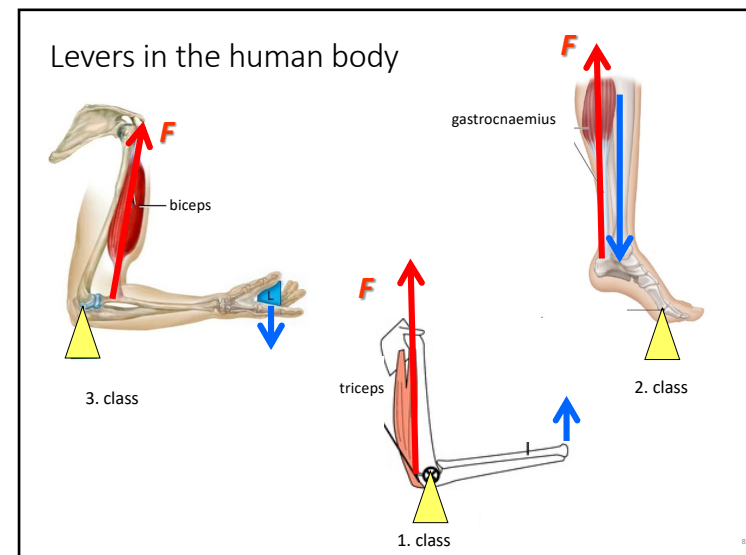
5



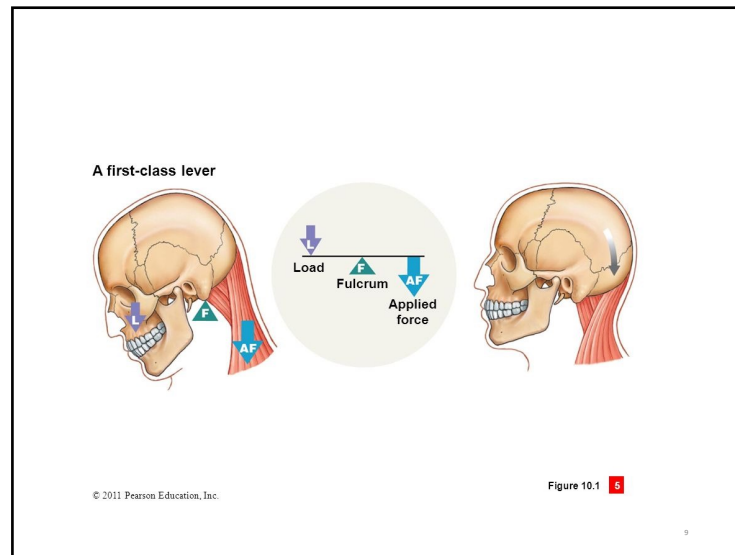
6



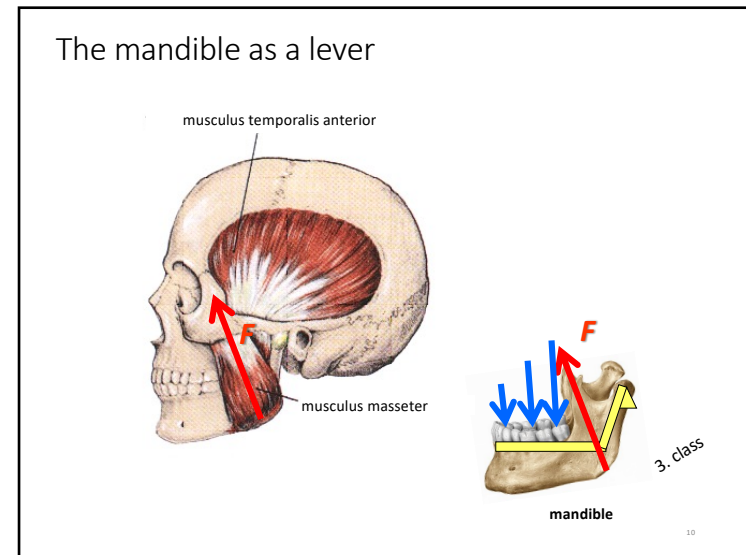
7



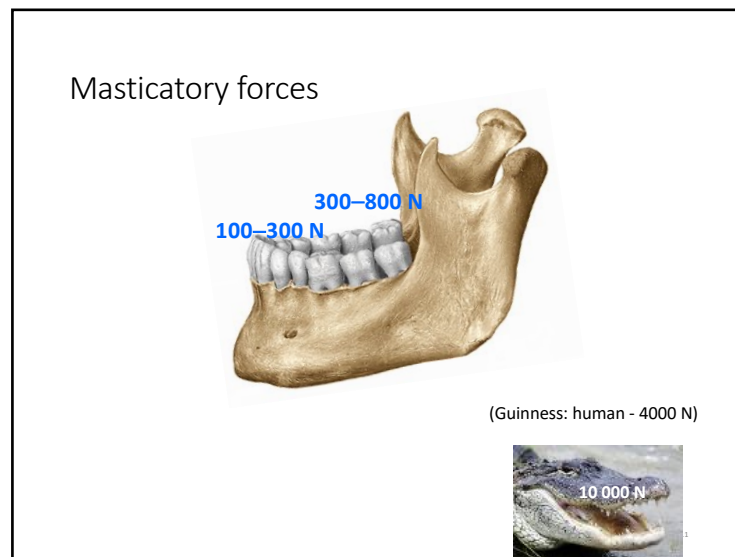
8



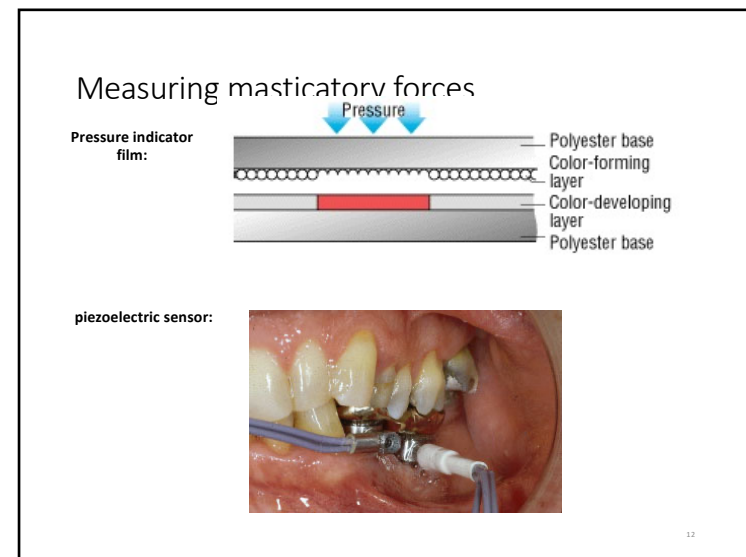
9



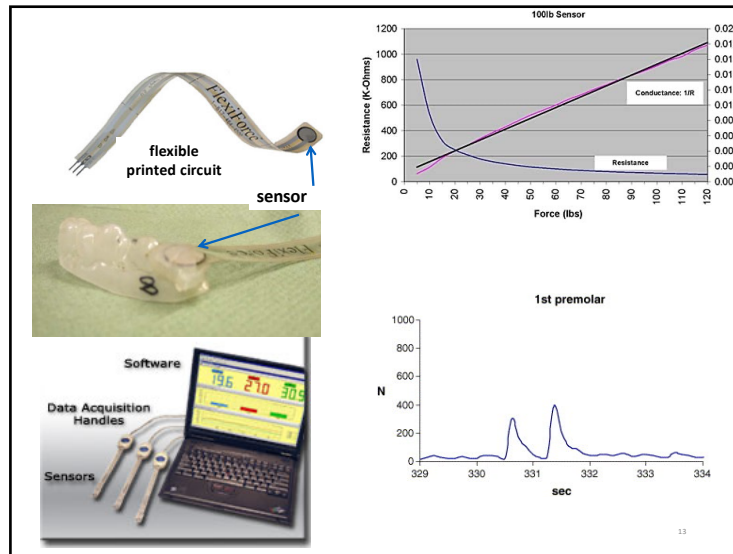
10



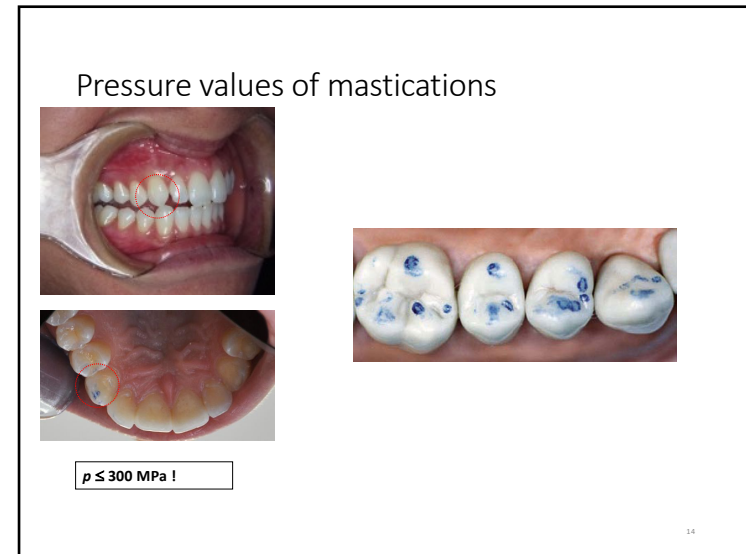
11



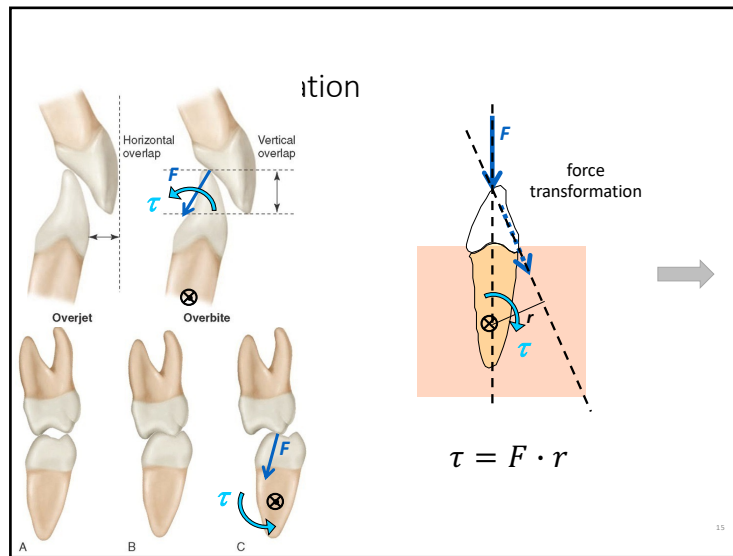
12



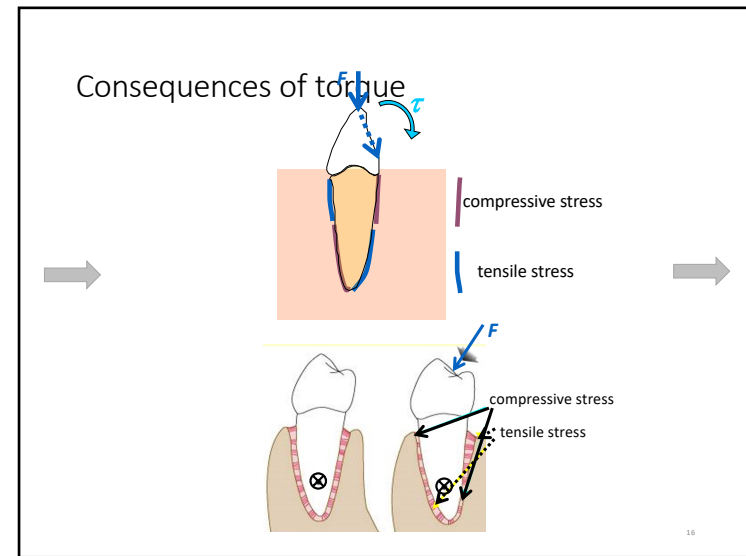
13



14



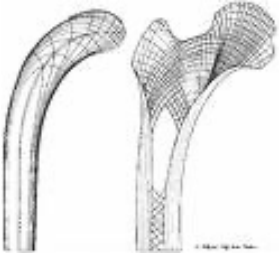
15



16

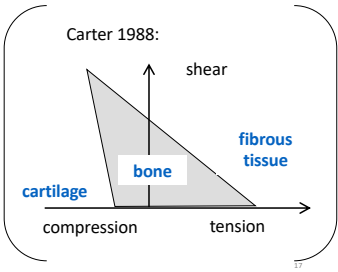
Bone remodeling

Wolff's law 1870



compressive stress \Rightarrow resorption
tensile stress \Rightarrow formation

Carter 1988:

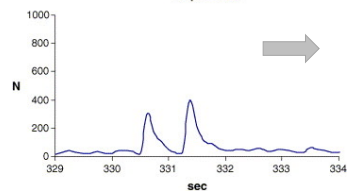


Every change in the function of a bone is followed by certain definite changes in its internal architecture and its external conformation.

17

Masticatory forces

1st premolar






$F = 100-800 \text{ N}$
 $t \leq 1 \text{ s}$!

If the force would be constant

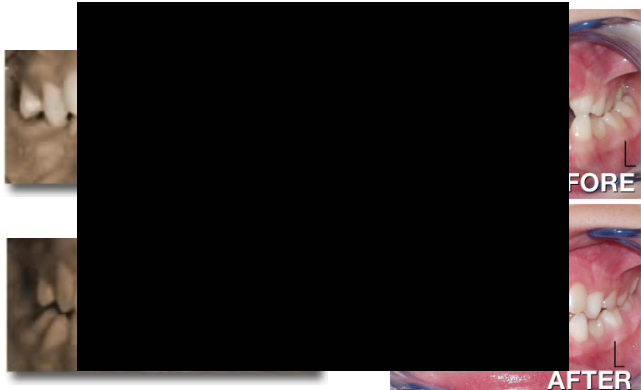
3-5 seconds	\Rightarrow	pain
\approx hours	\Rightarrow	tissue damage
7-14 days	\Rightarrow	loosening of teeth

18

Physical bases of orthodontics

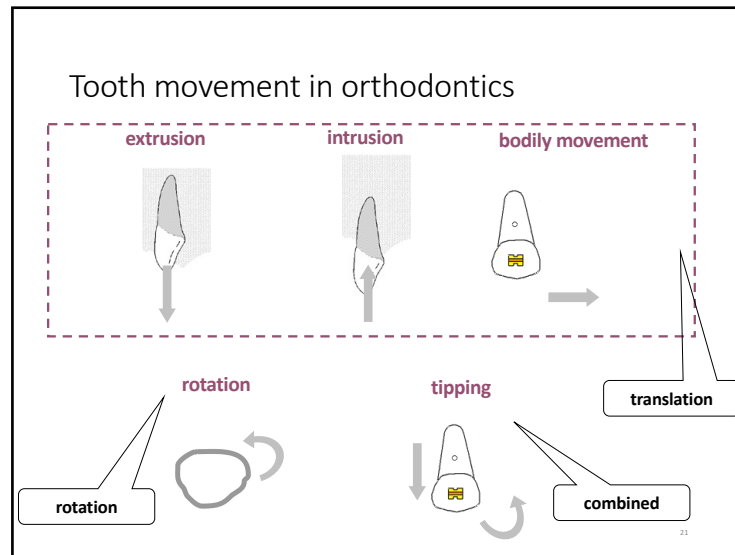
19



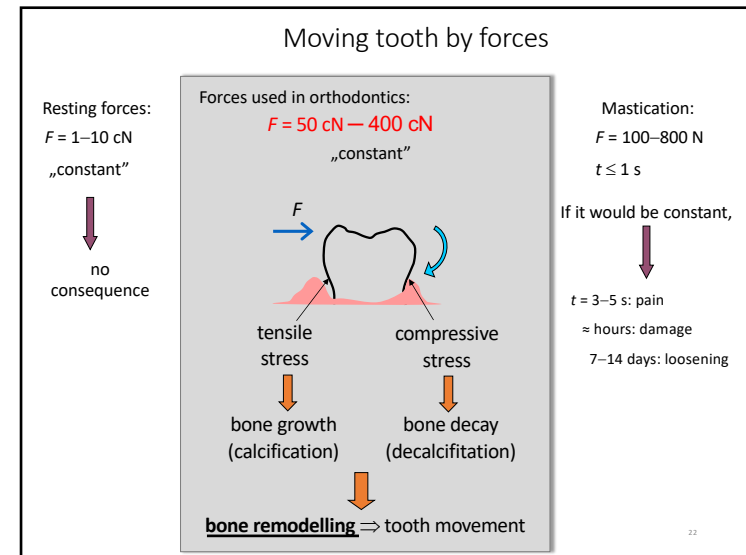
FORE

AFTER

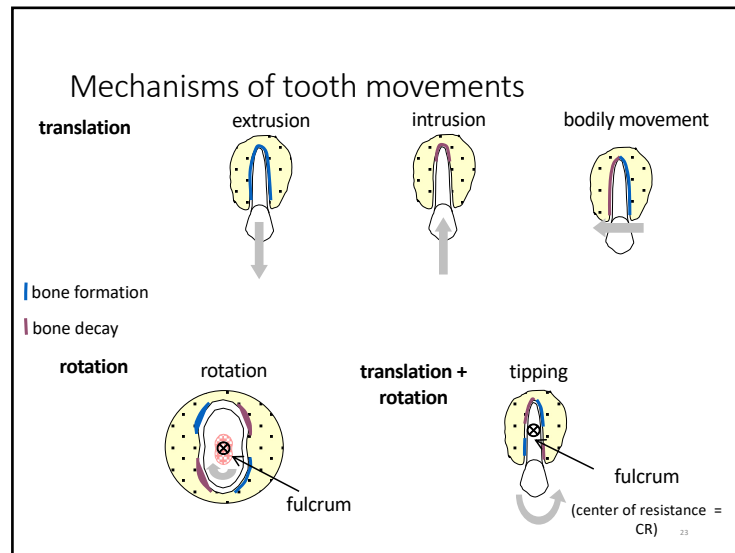
20



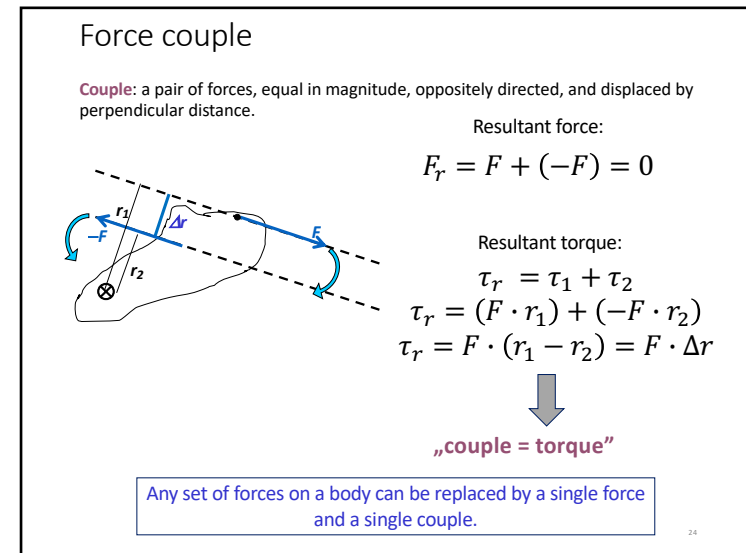
21



22



23



24

Forces required for tooth movements

extrusion:

F $\tau_F = 0$

intrusion:

F $\tau_F = 0$

single force without torque
⇒ translation without rotation

Example:

dental bracket

force distribution (I):

25

Rotation:

$\Sigma F = 0$ couple = c

Couple results in torque only without net force
⇒ rotation without translation

example:

26

Bodily movement:

By using only one force torque would be generated too.

force + couple
⇒ translation without rotation

$\Sigma F = F$
 $\Sigma M = 0$
translation only

$\tau_c = \tau_F$ ($\tau_c / \tau_F = 1$)

Example:

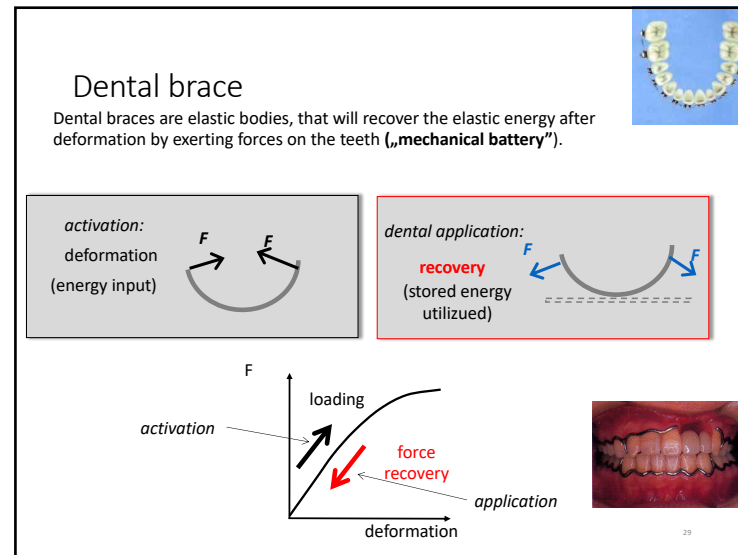
27

Tipping:

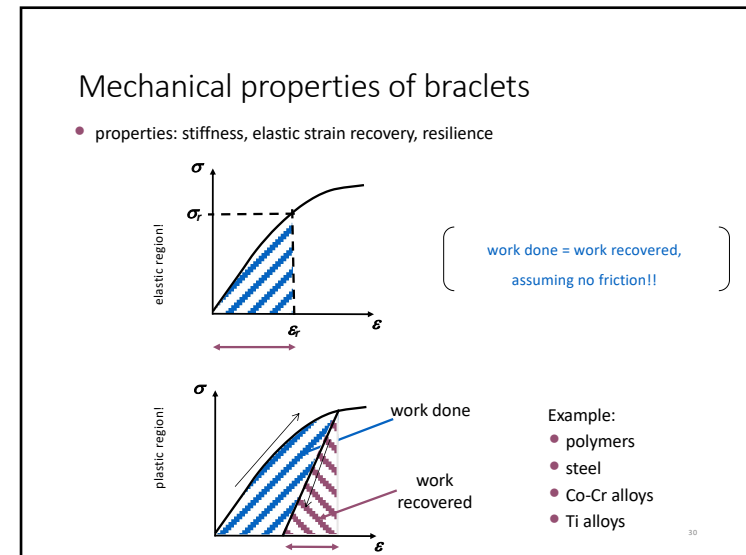
force	couple	ΣF	$\Sigma \tau$	
-	✓	0	τ_c	rotation
✓	-	F	τ_F	tipping: translation + rotation
✓	✓	F	$\tau_F - \tau_c$	controlled tipping: translation + rotation

$0 < \tau_F - \tau_c$ ($\tau_F - \tau_c < 1$)
 $\tau_F - \tau_c < 0$ ($1 < \tau_F - \tau_c$)

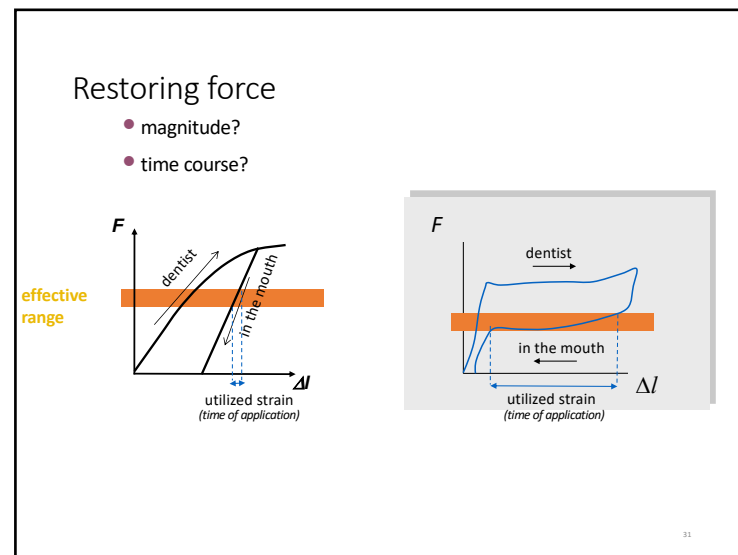
28



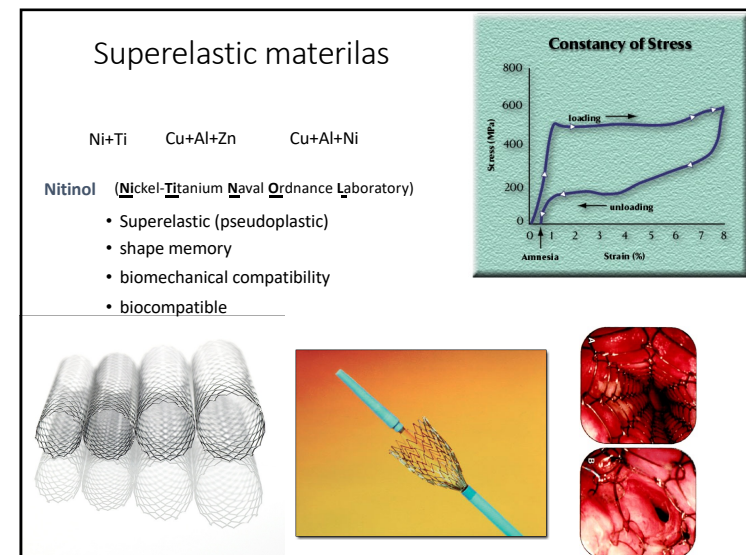
29



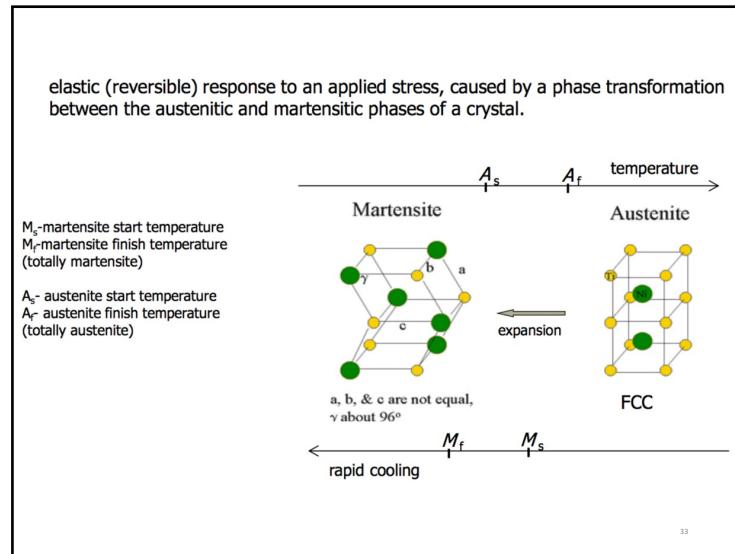
30



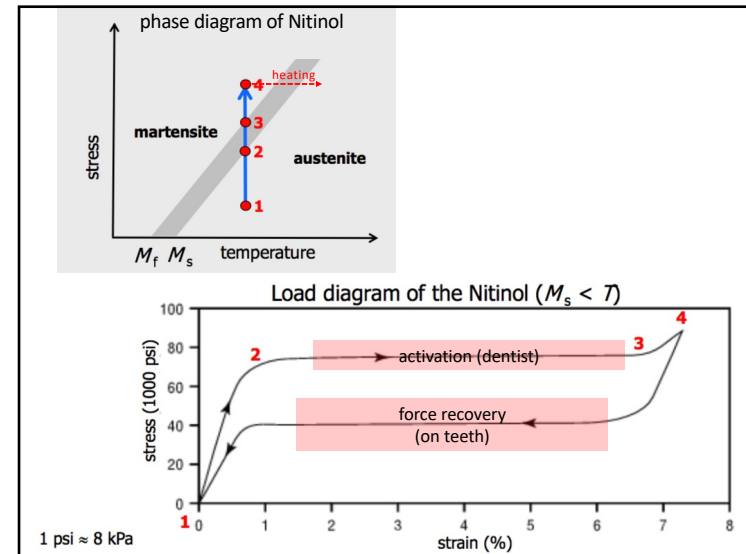
31



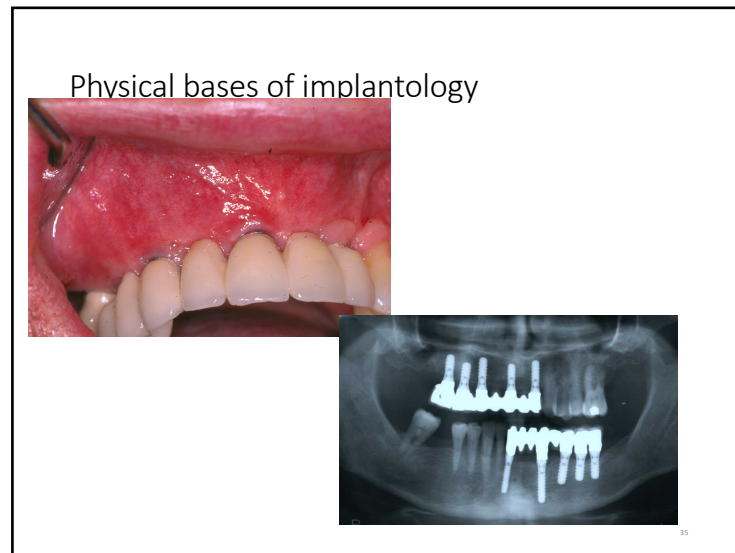
32



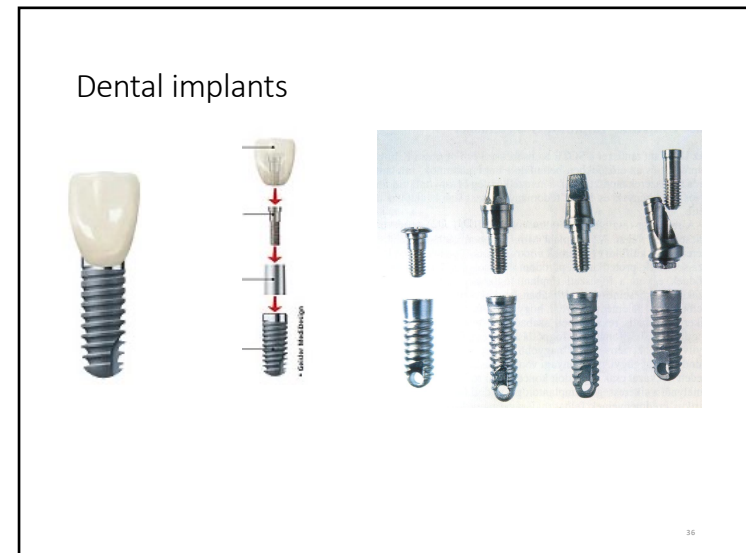
33



34



35

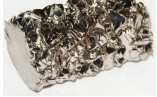


36

Implant materials

metals

- titanium (Ti)



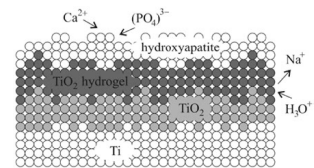
- titanium alloys (Ti-6Al-4V)
- kCobalt alloys (Co-Cr-Mo)

ceramics

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



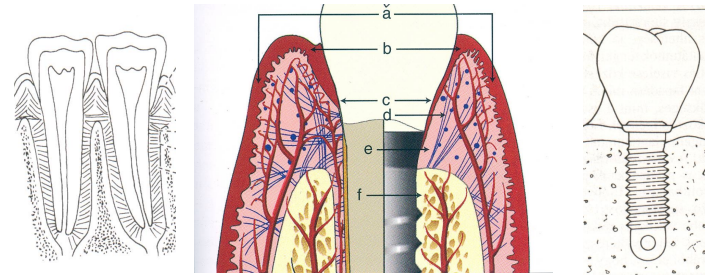
metals with ceramic coating



37

37

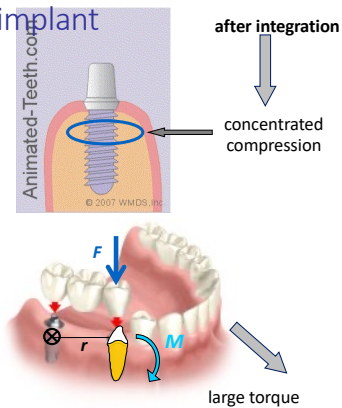
Tooth vs. implant



38

38

Force transition of implant

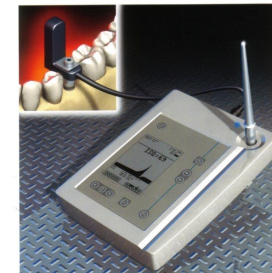


39

39

Methods for testing implant stability

- Resonant Frequency Analysis (RFA)



40

40

• Periotest

The diagram illustrates the Periotest principle. On the left, a probe is shown with a light cone indicating the measurement area. A graph in the center shows the 'Signale des Beschleunigungsgebers' (Acceleration sensor signals) with a 1 ms scale bar. To the right, a 'Micro-computer' processes the data, leading to an 'Optische Anzeige des PERIOTEST-Wertes' (Optical display of the PERIOTEST value) showing '+ 10' and an 'Akustische Ausgabe des PERIOTEST-Wertes' (Acoustic output of the PERIOTEST value) represented by a speaker icon.

Below the diagram are two photographs. The left photo shows the 'GULDEN Periotest' device on a blue surface with its probe and other components. The right photo shows the probe being used on a patient's teeth.

41

41