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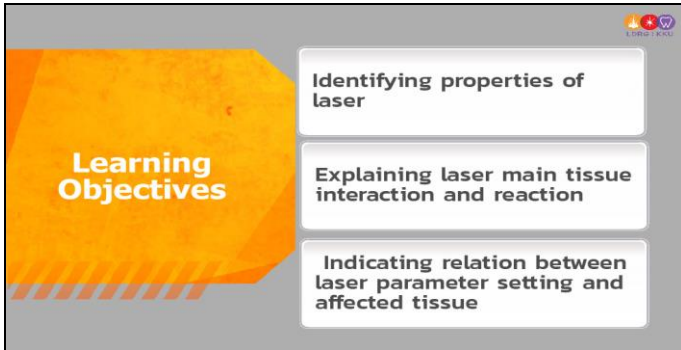
Slide 1 - START COURSE

Slide notes: Module one

Concept in laser dentistry.

This module overviews basic knowledge and application of laser dentistry.

Please click Begin Button to start the module.



Slide 2 - Learning Objectives

Identifying properties of laser

Explaining laser main tissue interaction and reaction

Indicating relation between laser parameter setting and affected tissue

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Slide 2 - objectives

Slide notes: After study this module, you will be able to  
identify the properties of laser which is different from other kinds of light,  
explain the relation between laser tissue interaction and reaction  
and indicate relation between laser parameter setting and affected tissue.



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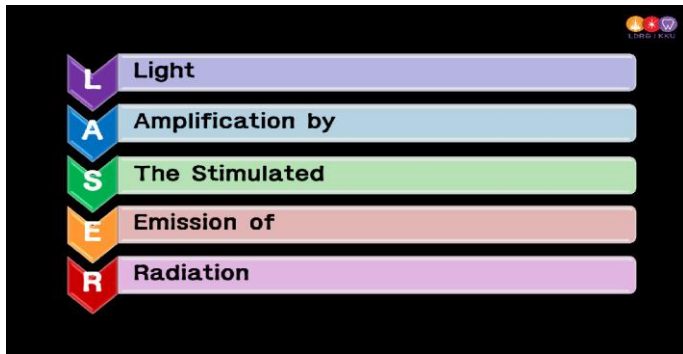
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Slide 3 - introduction related to laser education

Slide notes: Based on the laser education, laser physics and laser tissue interaction are two important basic subjects.

This module reviews these two subjects.



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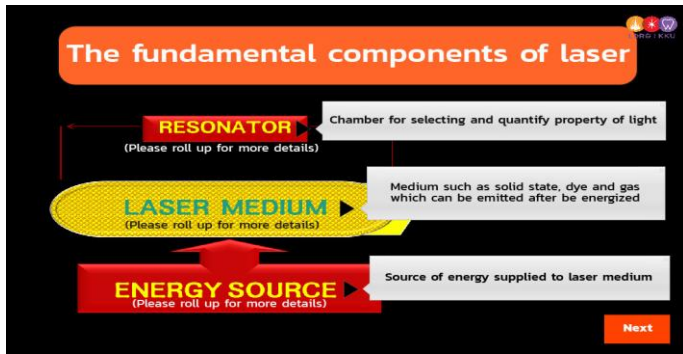
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Slide 4 - Acronym of laser

Slide notes: Laser is an acronym of light amplification by the stimulated emission of radiation.



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Slide 5 - the components of laser

Slide notes: The main components of producing laser as shown in the picture.

please click each component for reviewing.



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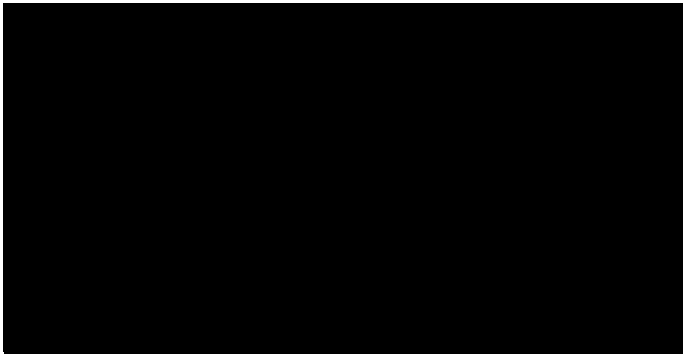
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Slide 6

Slide notes: Understanding the differences of spontaneous and stimulated emissions.

Please click start to study the video, then will have knowledge check review.



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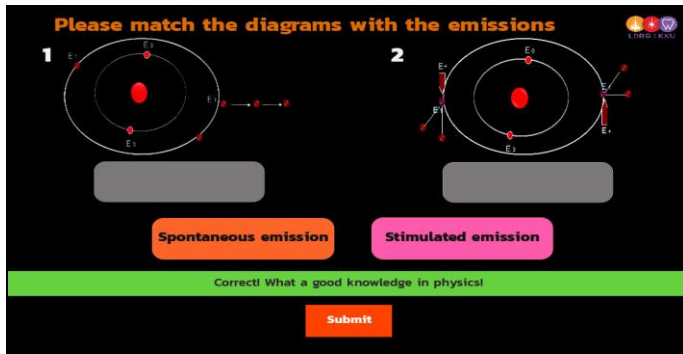
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Slide 7

The video for information about stimulated and spontaneous emissions.




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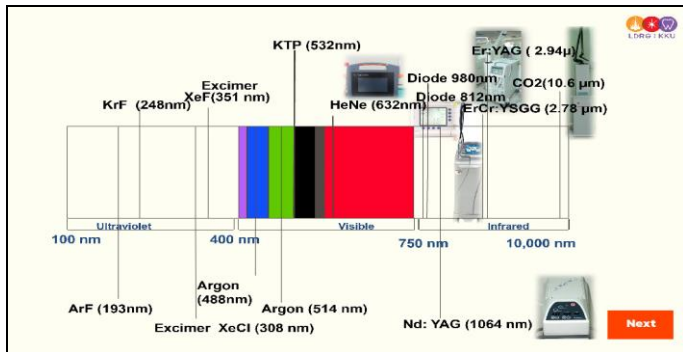
Slide 8 - knowledge check 1

Slide notes:

Knowledge check 1

Please drag the name of emission and drop to match diagram of atom and photon transmission.





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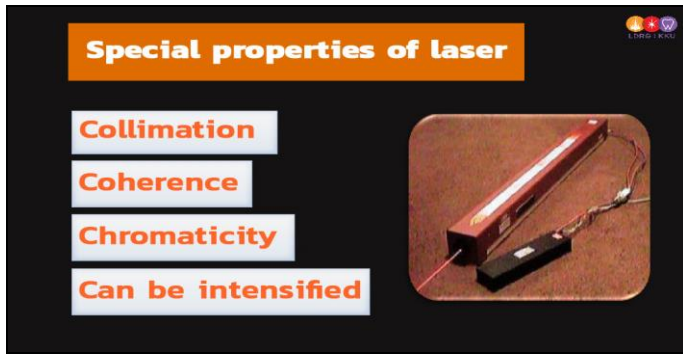
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Slide 9 - laser wavelength and laser machine

Slide notes: By the process of stimulated emission of the laser medium, there are a variety types of lasers as shown in this picture.

Please click next to move on the special properties of laser.



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Slide 10 - special properties of laser

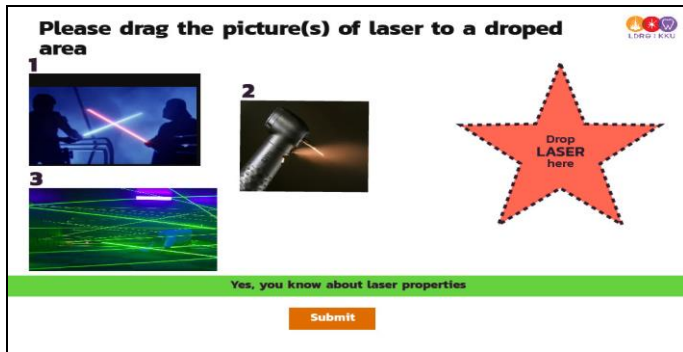
Slide notes: Laser has the special properties which are different from the other lights as followed:-

Collimation; the laser beam is less diversity that why it is precise

Coherence; the resonator can make the laser with same phase of wave form

Chromaticity; One medium produces one of laser with a single wavelength

Can be intensified; The laser is intense and focus that why it can transfer a large amount of energy to the tissue




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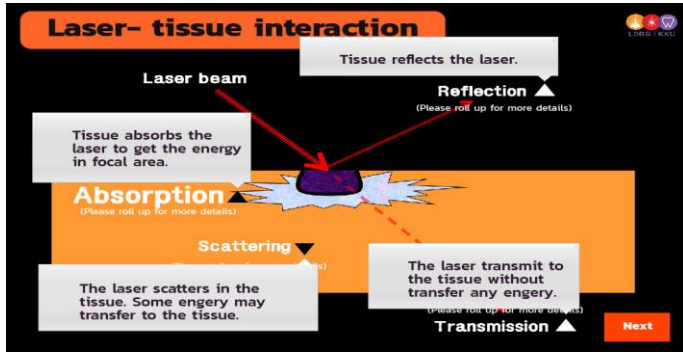
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Slide 11 knowledge check 2

Slide notes: Your knowledge check for identifying laser from laser properties.



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Slide 12 - laser tissue interaction

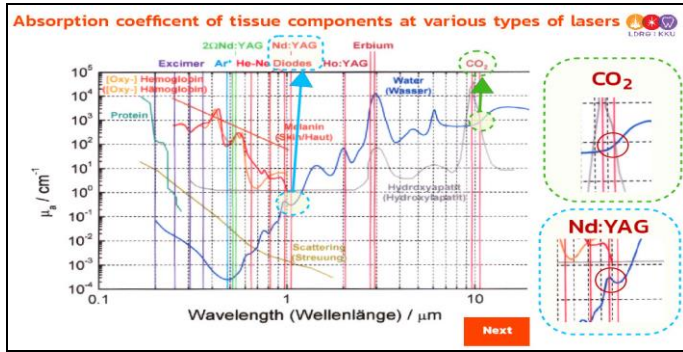
Slide notes:

Let move on from the laser physics to the phenomenon when the laser strike the tissue.

It is called laser tissue reaction as seen in the picture.

Please click to see the highlight of each interaction.

Four interactions occur in the tissue at the same time in a different proportion, This is based on composition of the tissue.



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Slide 13 - absorption coefficient


Slide notes: The laser can be absorbed by the compositions of the tissue with the differences in amount of energy.

This information can be generally found in the graph called absorption co-efficient of the laser

For example, the CO<sub>2</sub> laser can be more absorbed by the water than Nd: YAG laser.


Please click to study VDO comparing soft tissue ablation between CO<sub>2</sub> laser and Nd:YAG laser.

Please study the video of laser tissue ablation with the different lasers



Go to study The Nd: YAG

Nd:YAG Laser 3.15 Watt  
315 mJ/Pulse 10Hz



Go to study CO<sub>2</sub> laser

CO<sub>2</sub> Laser 3 Watt Continuous Wave

Go to Knowledge Check

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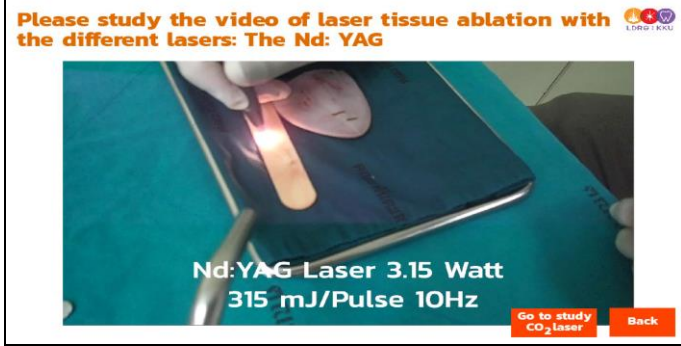
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Slide 14 - video samples of ablation

Slide notes: Please study the video of two different wavelengths of lasers ablating tissue samples. After this you will answer the questions.



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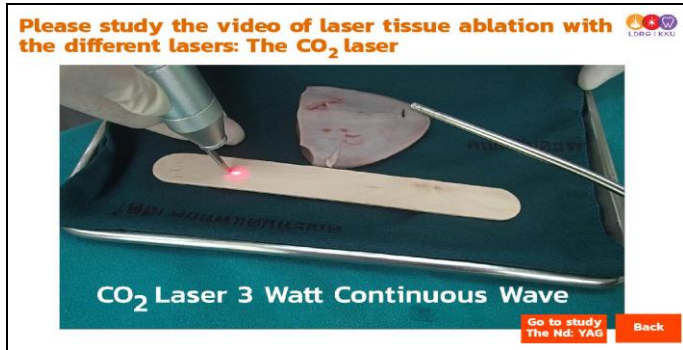
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Slide 15 - video samples of ablation: The Nd:YAG laser

Slide notes: Please study the video of two different wavelengths of lasers ablating tissue samples. After this you will answer the questions.



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Slide 16 - video samples of ablation: The CO<sub>2</sub> laser

Slide notes: Please study the video of two different wavelengths of lasers ablating tissue samples. After this you will answer the questions.



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Slide 17 - Knowledge check for ablation

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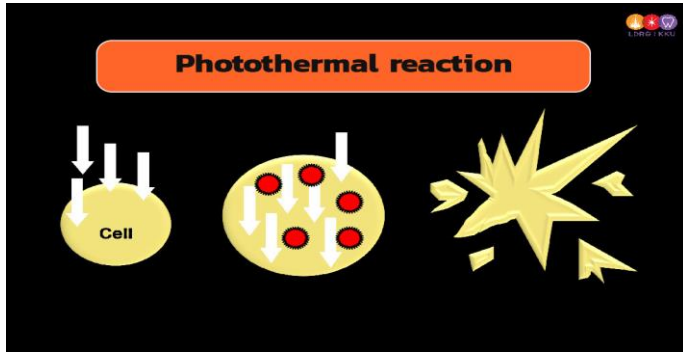
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Slide 18 Knowledge check for tissue ablation



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Slide 19 - photothermal reaction diagram

Slide notes:

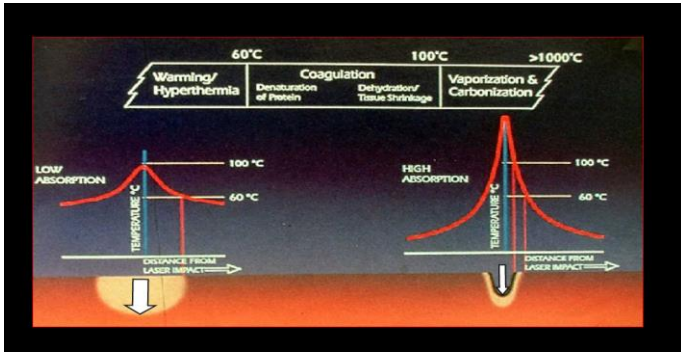
The example of soft tissue laser surgery by using laser as you have seen is mainly an interaction of laser-energy absorption into the tissue turning to heat.

Therefore, the photothermal reaction occurs.

The effect on the tissue is depended on the amount of increasing temperature.

For instance, temperature rising from 100 C, the water is vaporized, the ablative effect occurs,

Clinically, you will see the soft tissue is cut.



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Slide 20 - diagram of temperature and soft tissue affect

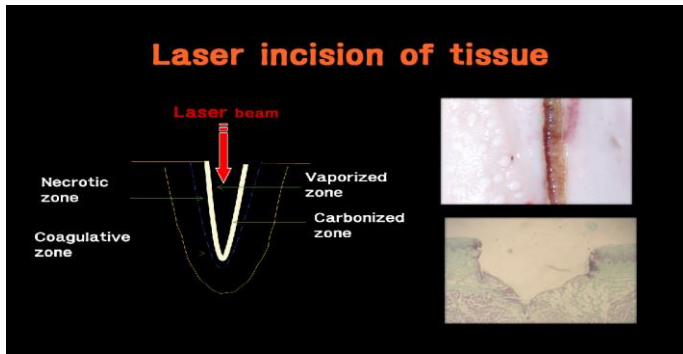
Slide notes: This diagram shows you the effect of temperature on soft tissue.

And the differences of effects on soft tissue irradiated by laser which low absorption versus high absorption into tissue.

In low absorption laser to the tissue, the affected area of tissue energized by laser, is wider and deeper than the high absorption tissue, when setting with the same power and energy density.

With the small amount of energy absorbed, sometimes, it is not enough to produce much structure change such as only gaining tissue hyperthermia or coagulation without ablation

For the high absorption laser to the tissue, the small area of tissue suddenly obtained full energy from the laser. Thus, it produces a distinctive change of tissue structure such as ablative or cutting effect on the soft tissue precisely.



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Slide 21 - laser incision of tissue; gross and histology

Slide notes: The tissue is changed after absorbs laser energy.

Ablative zone or vaporized zone is the area that tissue is evaporated, clinically you will see as the incision.

The surfaces of ablative tissue are covered with carbon. This is called carbonized zone.

The next from this zone is necrotic zone of irreversible tissue damage.

And the outer area which can be observed by microscope. It is a reversible tissue damage which is called coagulative zone.

Normally, the high absorption laser into the tissue has less coagulative zone.

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Slide 22 - knowledge check for differentiating the cutting effects of lasers

Slide notes:

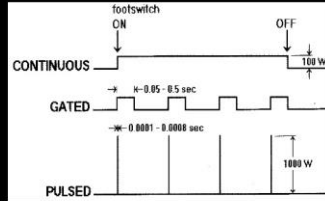
Please drag the name of laser and drop to the box under the corresponding ablative outcome.

### Other related factors to the affected zone of photothermal reaction

-Energy density ( $J/cm^2$ ) and power density ( $W/cm^2$ )

-Rate and duration of exposure; pulse or continuous (frequency)

-Mode of delivery and manipulation; focus or non-focus, contact or non-contact



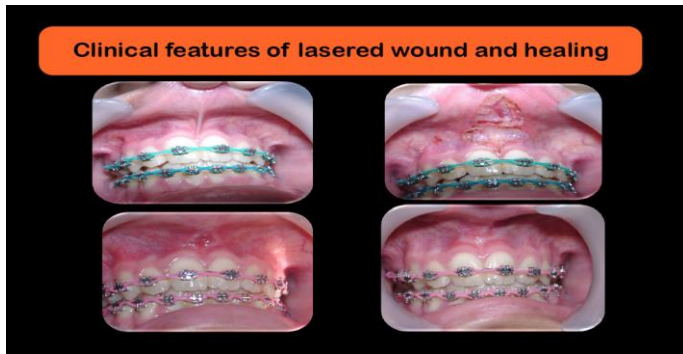
Slide 23 - other related factors

Slide notes: Although, the tissue absorption of the laser into the tissue plays an important parts in photothermal reaction, there are other related factors to transfer the energy from laser to the tissue as follows:-

The energy density and power density

The rate and duration of exposure

And mode of delivery and manipulation



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Slide 24

Slide notes: For the soft tissue healing of the lasered wound, it is very distinct from using the other instruments, please find the references as assigned in the google classroom for self- studying.



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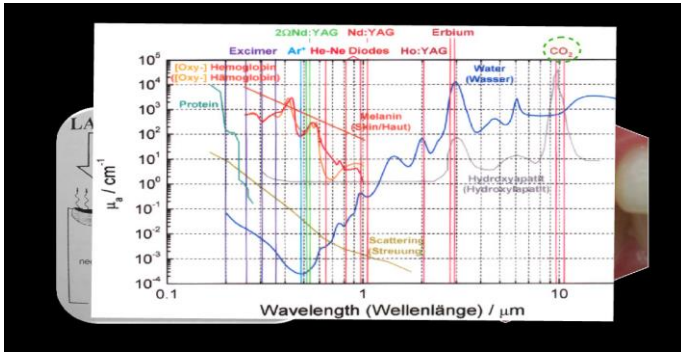
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Slide 25 - knowledge check for hard tissue laser properties

Slide notes: Let challenge your knowledge on laser tissue interaction  
by asking you to pick you the properties of laser for hard tissue ablation  
such as tooth preparation



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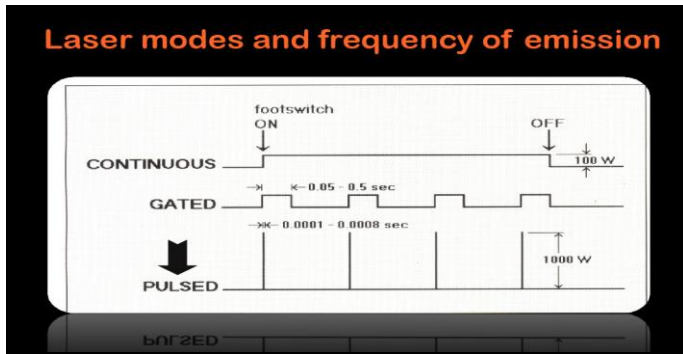
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Slide 26 - Photothermal reaction and hard tissue

Slide notes: From the graph of absorption coefficient, you can see clearly that CO<sub>2</sub> laser can be absorbed by hydroxyapatite even higher than by water.

As mentioned earlier, using CO<sub>2</sub> laser for tooth preparation can produce heat from photothermal reaction.

This results damaged tooth structure.



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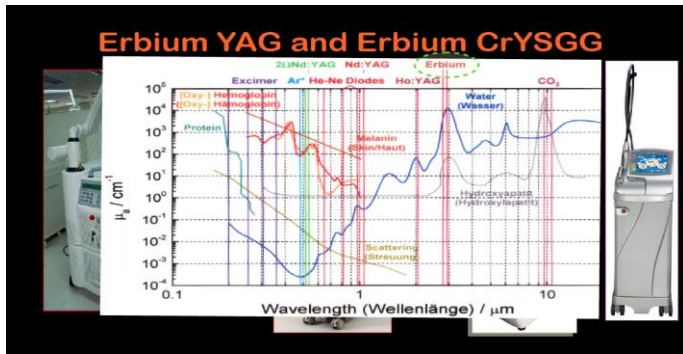
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Slide 27 - modes of emission

Slide notes: In order to transfer the large amount of energy from laser to the hard tissue with less photothermal reaction, the modes of laser emission play a crucial part. Using non-continuous frequency of laser emission will allow thermal relaxing time to avoid over heat the tissue.

Free-running pulse mode is the way to transfer a larger amount of energy from laser to tiissue with less photothermal reaction.



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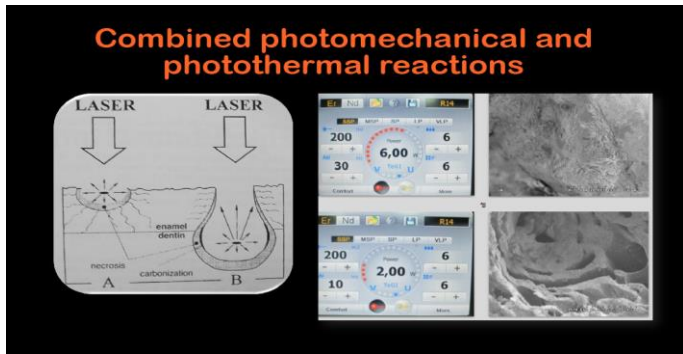
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Slide 28 - erbium and hard tissue

Slide notes: The erbium lasers are well absorbed by water and hydroxyapatite. With the setting mode of free running pulse and water coolant, these lasers can be used for hard tissue ablation without significant damaging the tissue structure



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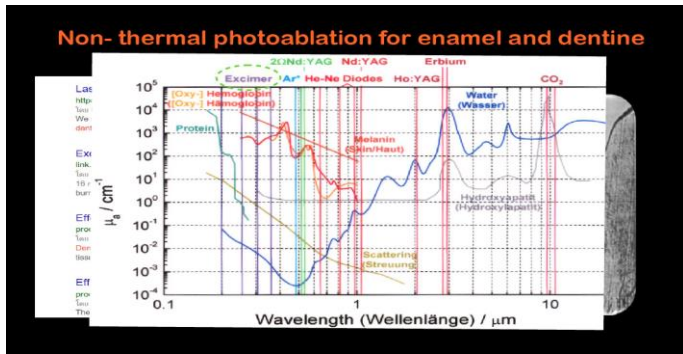
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## Slide 29

Slide notes: The reaction is the combination between photomechanical reaction and photothermal reaction. Apart of setting up of laser parameter, the coolant; air and water flow, is also needed.



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Slide 30 - excimer laser non thermal ablation

Slide notes: There is another type of laser of which high absorption into hydroxyapatite.

It is an excimer laser. The wavelength is in the ultraviolet region.

The excimer laser in free running pulse mode; the very high power and very short pulse width can perform hard tissue cutting without photothermal effect.



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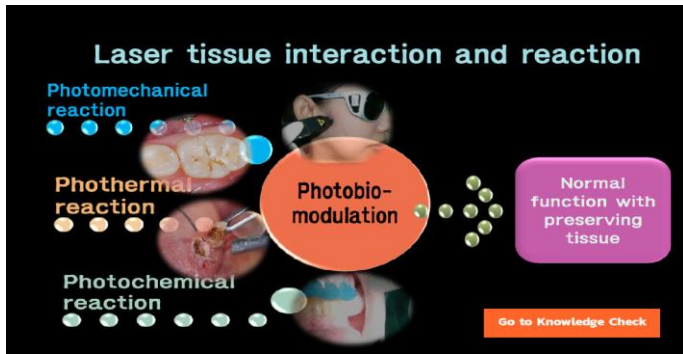
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Slide 31

Slide notes: Due to the size of machine and the laser delivery, using of excimer laser for tooth and bone ablation is still limited in laboratory research.



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Slide 32 - laser tissue interaction and reaction

Slide notes: Photoreactions of the laser are the effects after laser absorbed into the tissue.

Photothermal reaction is the light turned to heat. This needs a power more than one watt with longer period of absorption at normal from 1 sec. This is normal use for soft tissue surgery.

Photomechanical reaction is the method of transferring high amount of laser energy into the tissue to change the molecular structure with minimal heat effect.

This can happen when using laser in a free running pulse mode; very high energy or power with very short period of time.

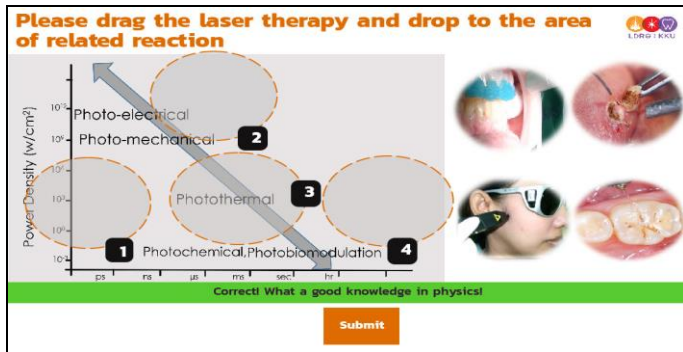
This can be applied for hard tissue cutting.

In case, no need for changing the structure, photochemical reaction is the way of using the laser at a power less than one watt with longer period of time in several seconds. This can be used for initiating chemical agent such as bleaching gel.

All of type of laser has the photobiomodulation for modulating living tissue into a normal function. In case aiming for photobiomodulation only, the setting is low power less than one watt in several seconds is needed to avoid photothermal effect.

The photoreactions are the effects of the laser absorption into the tissues. They can be varied by the setting up of laser parameter.






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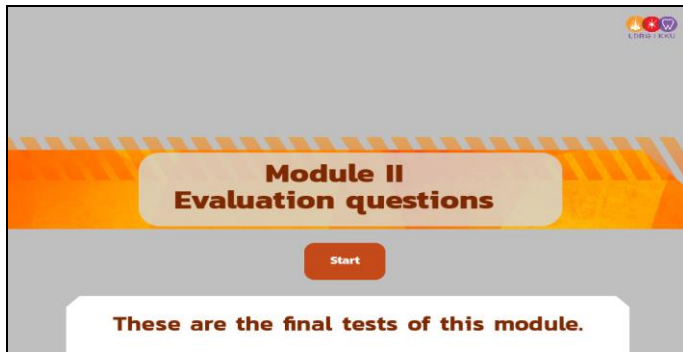
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Slide 33 - knowledge check for tissue reaction and laser parameter setting

Slide notes: This is for reviewing your knowledge of using the relation between photoreaction and laser setting parameter. Please drag the picture of laser therapy and drop to correct place for laser tissue reaction.

After this you will move on to the final part of this module.



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Slide 34 - evaluation

Slide notes: You reach the final session of this module: laser physics and tissue interaction.

Please click the start button to enter the knowledge evaluation.

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Slide 35 - question 1

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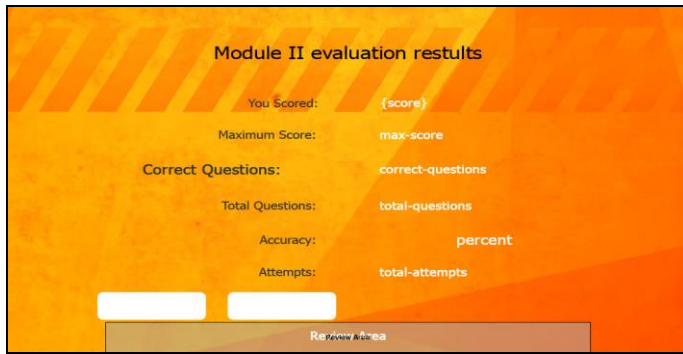
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Slide 36 Question 2




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Slide 37

Slide notes: Your reach the ending of this module please click exit from control panel or click rewind if you would like to restudy this module.