Lec5: Processing Equipment & Dark Room د. هبة عزت بيرم

Dental X- ray film: Is a recording media on which image of the object was made by exposing this film to X- ray.

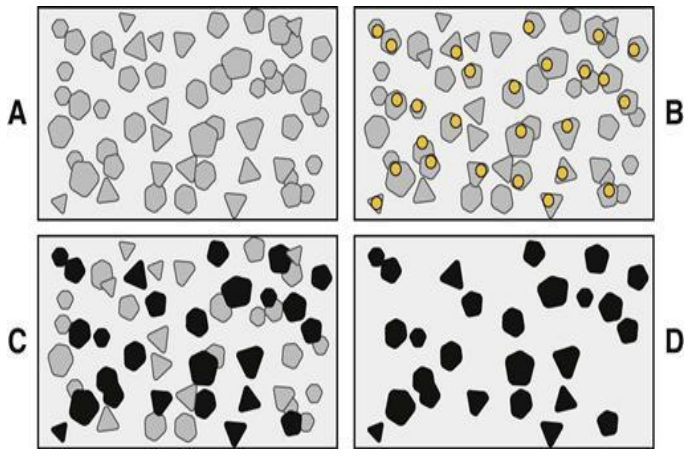
- ✓ To avoid film-related errors that result in increased patient exposure to x-radiation, the dental radiographer must understand the composition of the x-ray film and latent image formation.
- ✓ In addition, the dental radiographer must be familiar with the types of film used in dental radiography as well as film storage and protection.

- **What is happened during exposure of X- ray film to radiation?**

  Formation of the latent image when a beam of photons exits the patient and exposes an x-ray film, it chemically changes the photosensitive silver halide crystals in the film emulsion (sites in the crystals that are sensitive to radiation). These chemically altered silver bromide crystals constitute the latent (invisible) image on the film. Processing the exposed film in developer and fixer, convert the latent image into the visible radiographic image.

❖ Latent image formation:

The Ag-Br crystals in the film emulsion are changed when the absorb X- ray photons and store the energy from the radiation (exposure center), the result is precipitation specks of silver in each exposed crystals and collection of these specks produce invisible latent image and must be processed to convert it to visible image X- ray film.



Emulsion changes during film processing. **A,** Before exposure, many silver bromide crystals (gray) are present in the emulsion. **B,** After exposure, the exposed crystals containing neutral silver atoms at latent image sites (orange dots exposure center) constitute the latent image. **C,** The developer converts the exposed crystals containing neutral silver atoms at the latent image sites into solid grains of metallic silver (black). **D,** The fixer dissolves the unexposed, undeveloped silver bromide crystals, leaving only the solid silver grains that form the radiographic image.

Processing Equipment: Conversion of latent image in to visible permanent radiographic image that can be kept without deterioration for a number of years. This process done by using manual dark room or an automatic film processor.

❖ Processing technique include the following steps:

1. **Exposure** - Latent image created.
2. **Development** - Converts latent image to black metallic silver. X- ray film is placed in alkaline developer solution; the action of developing agents is on exposed Ag Br crystals to continue the process of precipitating the specks of silver until all silver is deposit at the site of crystal and the bromine is released into the developing solution causing softening of the X- ray film emulsion.
   a. Developer: or reducing agent convert the exposed silver halide crystals to black, metallic silver grains.
   b. Activator or accelerator: It softens and swells the emulsion so that the developing agent reach the crystals more effectively; it also provides the necessary alkaline environment for developing agents.
   c. Restrainer: Prevent the developer from developing unexposed crystal and keep the image from appearing fogged (dull, grey, lacking in contrast).
   d. Preservative: Prevent oxidation of the reducing agents in the developer in order prolong the effectiveness of chemicals.
3. **Rinsing** [stop bath] - Removes excess developer 30s to terminates the developer action and remove chemicals from emulsion.
4. **Fixing** - Dissolves out unexposed silver halide crystals.

By using a fixer solution, its action is: a. Re harden the film emulsion. b. Removed all the unexposed or undeveloped crystals.

   a. Fixing or clearing agent: It remove (by dissolving) unexposed, undeveloped silver halide crystals from the emulsion.
   b. Acidifier: Helps to terminate the developing process by neutralizing the alkaline developer. It also provides the necessary acid environment required by the fixing agent.
   c. Hardener: Shrink and hardens the emulsion after it has been softened by the activator in the developing solution.
   d. Preservative: Prevent chemical deterioration of fixing solution.
5. **Washing** - Removes products of processing.

6. **Dry** - Removes water.

Developer solution:

1. Developing agent: (**Hydroquinone**: Converts exposed silver halide crystals to black metallic silver. **Slowly** generates the black tones and contrast in the image and **Elon**: Converts exposed silver halide crystals to black metallic silver. **Quickly** generates the grey tones in the image).
2. Preservative (**Sodium sulphite**): Prevents rapid oxidation of the developing agents.
3. Accelerator (**Sodium carbonate**): Activates developer agents. Provides alkaline environment for developing agents. Softens gelatin of the film emulsion.
4. Restrainer (**Potassium bromide**): Prevents the developer from developing the unexposed silver halide crystals.
5. Hardener (**Glutaraldehyde**): Used in automatic processing, to prevent emulsion from softening and sticking to the rollers.
6. **Fungicide**, buffers: Prevents bacterial growth.
7. Solvent (**Water**): It dissolves chemicals.

Composition of fixer:

1. Fixing agent (**Sodium thiosulphate; ammonium thiosulphate**): Removes all unexposed and undeveloped silver halide crystals from the emulsion.
2. Preservative (**Sodium sulphite**): Prevents deterioration of fixing agent.
3. Hardening agent (**Potassium alum**): Shrinks and hardens the gelatin in the emulsion.
4. Acidifier (**Acetic acid; sulphuric acid**): Neutralizes the alkaline developer and stops further development.
5. Solvent (**Water**) It dissolves chemicals.

Dark Room:

The primary function of the dark room is to provide a completely darkened environment where the X-ray film can be handled and processed to produce a diagnostic image. Since the processing operations are carried out in near total darkness, every piece of equipment must be in a specific place.

One of the most important requirements is that the darkroom be **lightproof**. If it is not, stray light can cause **film fogging and loss of image contrast**. To make

the darkroom lightproof, a light-tight door and have a lock to prevent accidental opening.

The darkroom must also be **well ventilated** to provide a comfortable working environment and to exhaust moisture from drying films. In addition, a comfortable room temperature helps to maintain optimal conditions for developing, fixing, and washing solutions.

if one person works in the darkroom, 9x9 feet is recommended to process dental) radiograph, while 20x20 feet of floor space is recommended for more than one person.

➢ The size will vary depending upon:

✓ Volume of radiographs processed.
✓ Number of persons using the dark room.
✓ Type of processing equipment used. (processing tanks or automatic processor).
✓ The space required for the duplication of films and storage.

The dark room should have sufficient space to accommodate the processing tanks or automatic processors. The dark room work space must include an adequate counter area where films can be unwrapped prior to processing. This area should be absolutely clean, dry and free of processing chemicals, water, dust and debris. This should ideally be at least 4 feet away from the processing tank.

Construction and design

— Light tight room through the use of a maze or a light tight door.
— The surface of the room should be able to resist chemicals of processing.
— Floor should be waxed to be protect from chemicals and wall colors should be light enough to reflect the safe light.

Illumination:

As the term darkroom suggests the room must be completely dark and must exclude all visible light – Light Tight. By use of a light tight door or the door should have a lock to prevent accidental exposure of the film. Fluorescent lights should not be used in the dark room because there is often a short after glow that may **fog** the

first few films opened after the light is turned off. The processing room should have both white illumination and safelights.

- White light illumination is required during cleaning tanks and preparing the solutions.
- A safelight is low-intensity illumination of relatively long wavelength (red) that does not rapidly affect open film but permits one to see well enough to work in the area. To minimize the fogging effect of prolonged exposure, the safelight should have a frosted 15-W bulb or a clear 7.5-W bulb and should be mounted at least 4 feet above the surface where opened films are handled.

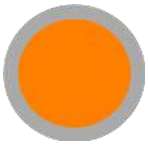
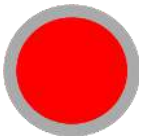
➢ Safelight:

Safelights are used in the darkroom to provide adequate light so that you can see what you are doing when you unwrap films for processing.

The safelights have special filters that produce light that does not expose the film.

There are two filters currently available: an **orange one:** Morlite and a **red on:** GBX-2.

The orange one can only be used for D-speed film. The red one can be used for all film types (D-speed, F-speed ,extraoral, and duplicating). Since most offices use both intraoral and extraoral film, it makes sense to always have a red filter.

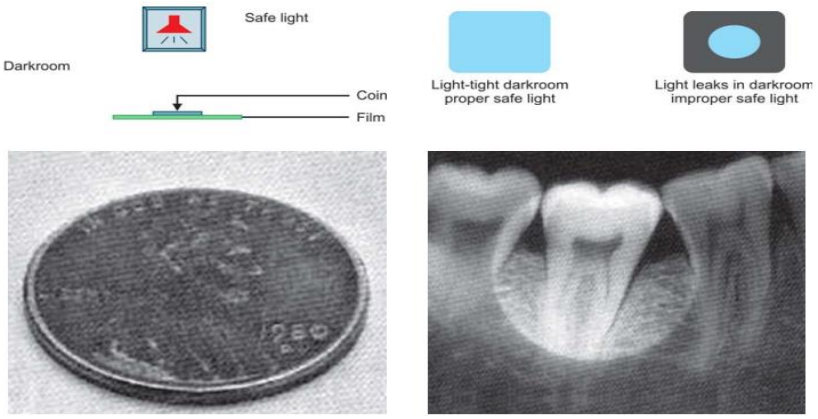
	
Morlite	***GBX-2***
D-speed	***D-speed, F-speed ,extraoral, and duplicating***

Tests for Checking Unsafe Illumination:

A. Coin test/penny is a test to evaluate for fogging caused by inappropriate safe lighting conditions:

1. Shut all lights and put on the safe lights.

2. Open film packet and place the base film in the area where films are usually unwrapped.
3. Place a coin on the film and leave it in this position for approximately 5 minutes.
4. Develop the test film as usual.
5. Inference: If the image of the coin can be seen on the resultant film, the room is not light safe for the particular film tested.



B. To check whether there is no light leak, shut the door and shut off all the lights in the dark room:

A few minutes after you become accustomed to the darkness, carefully view all the areas, like periphery of doors and windows to check whether any light from outside is been seen inside the dark room.

➢ Processing Equipment:

Dental X-ray film is processed in the darkroom using manual processing technique also known as Hand or Tank processing or an automatic film processor. Special equipment is required for both. This is the simplest and most efficient procedure for developing with accurate control.

➢ The processing tank contains two parts:

1- Master tank: (Size 8″ × 10″)

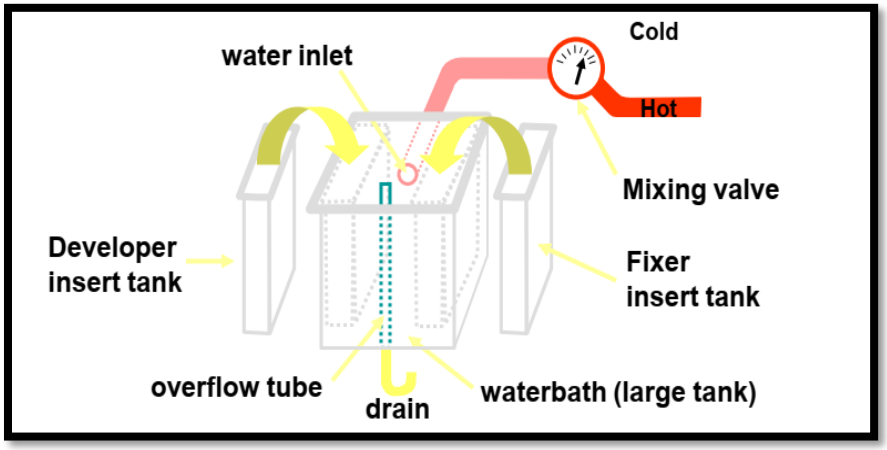
This serves as a heater jacket to hold the insert tanks and is large enough to provide space between the two insert tanks for rinsing and washing of the films

when necessary. It also helps to maintain the temperature of the developer and the fixer in the insert tanks. Master tank should have a cover:

- To reduce oxidation of the processing solution.
- To protect the developing film from accidental exposure to light.
- To minimize evaporation of processing solution.
- To prevent contamination with dust.
- There should be running cold and hot water facility and minimize evaporation of the processing solutions. The ideal temperature is recommended to be 70°F.

2- Insert tanks:

Are removable containers for individual processing solutions. In most darkrooms the developer will be in the **left-hand** tank as you face the tank, the water bath in the center and the fixing solution in the **right-hand** tank, the developer can be identified by its soapy feel, (alkali) the fixer by its **vinegary** odor when fresh and **acid taste**. All three tanks must be made of stainless steel, which does not react with the processing solutions and is easy to clean.



A. Visual Method:

1. Manual Processing Procedures:

The visual method of manual processing is carried out in a darkroom with safe lighting conditions. In this method, an exposed x-ray film is immersed in the developing solution and periodically viewed under the safelight for the emergence

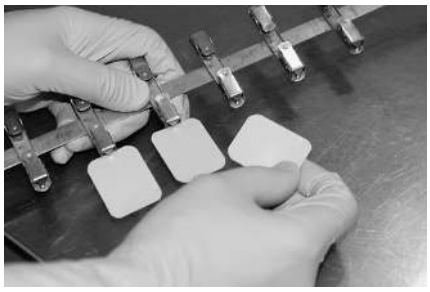
of a clear image. When the image appears, the film is washed and immersed in the fixing solution.

Manual processing of film requires the following steps:

1. Lock the darkroom door from the inside, and label the film hanger.
2. Stir the solutions to equalize the temperature and the chemical distribution of the processing solutions. Use a different utensil for stirring each solution to prevent cross-contamination of the solutions. Check the levels of solutions and replenish if necessary.
3. Check the temperature of the developing solution and set the timer. Refer to the time-temperature chart, which should be accessible when processing, and set the time for the desired interval.

Solution temperature	Developing time	Rinsing time	Fixing time	Washing time
65^0 F (18.5^0 C)	6	0.5	10-12	10
68^0 F (20^0C)	5	0.5	10	10
70^0 F (21^0C)	4.5	0.5	9-10	10
72^0 F (22^0C)	4.0	0.5	8-9	10
75^0 F (24^0C)	3.0	0.5	6-7	10
80^0 F (26.5^0 C)	2.5	0.5	5-6	10

4. Turn off the white light, and turn on the safelight.
5. Open the film packets while dropping the films on a clean working surface. When applicable, discard contaminated film packets and/or barrier wraps, and load the film on film hangers. Work carefully, avoiding finger marks or film scratches. Be sure that the film is securely fastened to film hanger clips.



6. Immerse the film hanger in the developer solution and activate the timer. After immersing the film, immediately raise and lower the hanger slowly a few times so that the film surfaces are covered totally by solution.
7. Remove the film rack from the developer when the timer sounds (under safelight conditions).
8. Rinse thoroughly for 20 seconds in the water bath (under safelight conditions).
9. Place the film rack in the fixer solution. Gently agitate the rack up and down immediately after the initial placement. Films should remain in the fixer for a minimum of 10 minutes (approximately twice the developer time) for permanent fixation but may be removed after 3 or 4 minutes for use as a wet reading. After fixing, with the tank lids firmly in place, normal lighting can be resumed in the darkroom. Safe-lighting is not needed. After the timer signals that fixation is complete, films are moved from the fixer to the water bath.
10. Place the films in the running water bath for 20 minutes.
11. Dry the films. Remove the films from the water bath and suspend them from rack holders or place them in a film dryer to dry.

2. Rapid-Processing Chemicals, Time-temperature method:

- Rapid-processing solutions is a type of manual processing and typically develop films in 15 seconds and fix them in 15 seconds at room temperature. They have the same general formulation as conventional processing solutions but often contain a higher concentration of hydroquinone. They also have a more alkaline pH than conventional solutions, which causes the emulsion to swell more, thus providing greater access to developer.
- It is advantageous in endodontics and in emergency situations, when short processing time is essential.
- Although the resultant images do not achieve the same degree of contrast and they may discolor over time if not fully washed.
- After viewing, rapidly processed films are placed in conventional fixing solution for 4 minutes and washed for 10 minutes; this improves the contrast and helps to keep them stable in storage.

3. Self-developing Film:

These have also been referred to as rapid autodeveloping films. It is essentially a one-piece soft plastic (polyvinyl chloride) pouch designed such that the film is located at the end and a monobath of developer and fixer is locate at the other end. Both the ends are connected via a narrow corridor that helps in carrying the processing solutions to the film.



B. Automatic Method:

Automatic Film Processing that automates all processing steps is available, the most important is the time saved. Depending on the equipment and the temperature of operation, an automatic processor requires only 4 to 6 minutes to develop, fix, wash, and dry a film. Many dental automatic processors have a light-shielded (daylight loading) compartment in which the operator can unwrap films and feed them into the machine without working in a darkroom. However, special care must be taken to maintain infection control.

In automatic processing, the step of rinsing in water after developing is avoided. As the roller system has a squeezing action, the developing solution absorbed by the gelatin of the emulsion will be less as it is transported from the developer to the fixer.

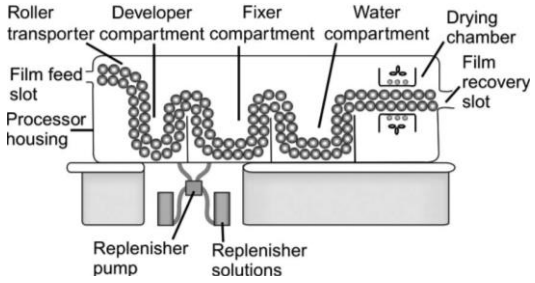
The automatic processing machines make use of belt-driven roller system for the transport of film. The film comes out through the other end of the processor, processed, dry, and ready for viewing.

Advantages:

- Rapidity of the operation, the entire process may take less than 4-7 minutes.
- Uniformity of results.
- Less floor space required and have daylight loading capability.
- No wet films to be handled, no film hangers, and film dryer.
- No wet reading of films. A dry film is more useful diagnostically than a wet film.
- Density and contrast of the resultant radiograph are consistent.

Disadvantages:

- Quality is not as high as that of a manually developed radiograph. More grain is evident in the final image.
- High cost of equipment and maintenance





➢ **Some differences between manual and automatic processing:**

1. No stop bath between developer and fixer as rollers remove the chemicals.
2. Higher temperatures for automatic processors. Therefore different chemicals required.
3. Hardener placed in developer in automatic processors.
4. Additional hardener is added to the fixer solution.
5. Because of the daylight-loader a darkroom is not required.
6. Because of the heater in the automatic processor, the process is a "dry to dry" process.