

Lectures & Handout *of*



By

Dr. Ahmad Mokhtar Abodahab

**Staff Member & Consultant of Radiology
Faculty of Medicine – Sohag University**

1ST EDITION

2025



وما أوتيتم من العلم إلا قليلا

صَدَقَ اللهُ الْعَظِيمُ

THIS HANDOUT

THIS IS A SIMPLE GUIDE TO THE BASICS OF THE DARK ROOM, WHICH I HOPE WILL BE HELPFUL. THE ONLINE LECTURES CAN EXPLAIN ANY HIDDEN TOPICS

**Good luck
The Author**



*Dr. Ahmad Mokhtar Abodahab
Sept 2025*



Contents:

TOPIC	Page
The Dark Room	<u>5</u>
X-Ray Production	<u>23</u>
THE FILM	<u>36</u>
INTENSIFYING SCREEN	<u>49</u>
PROCESSING CYCLE	<u>63</u>
AUTOMATIC PROCESSING	<u>95</u>
FILM PITFALLS	<u>105</u>

CHAPTER 1

THE DARK ROOM

- **Dark room :**

The place where we are **dealing with** sensitive radiographic films, as

- **Fill & remove** Films in Cassettes
 - **Film Processing**
- Dark or semi-dark during Processing works
 - As a Room = It has components.

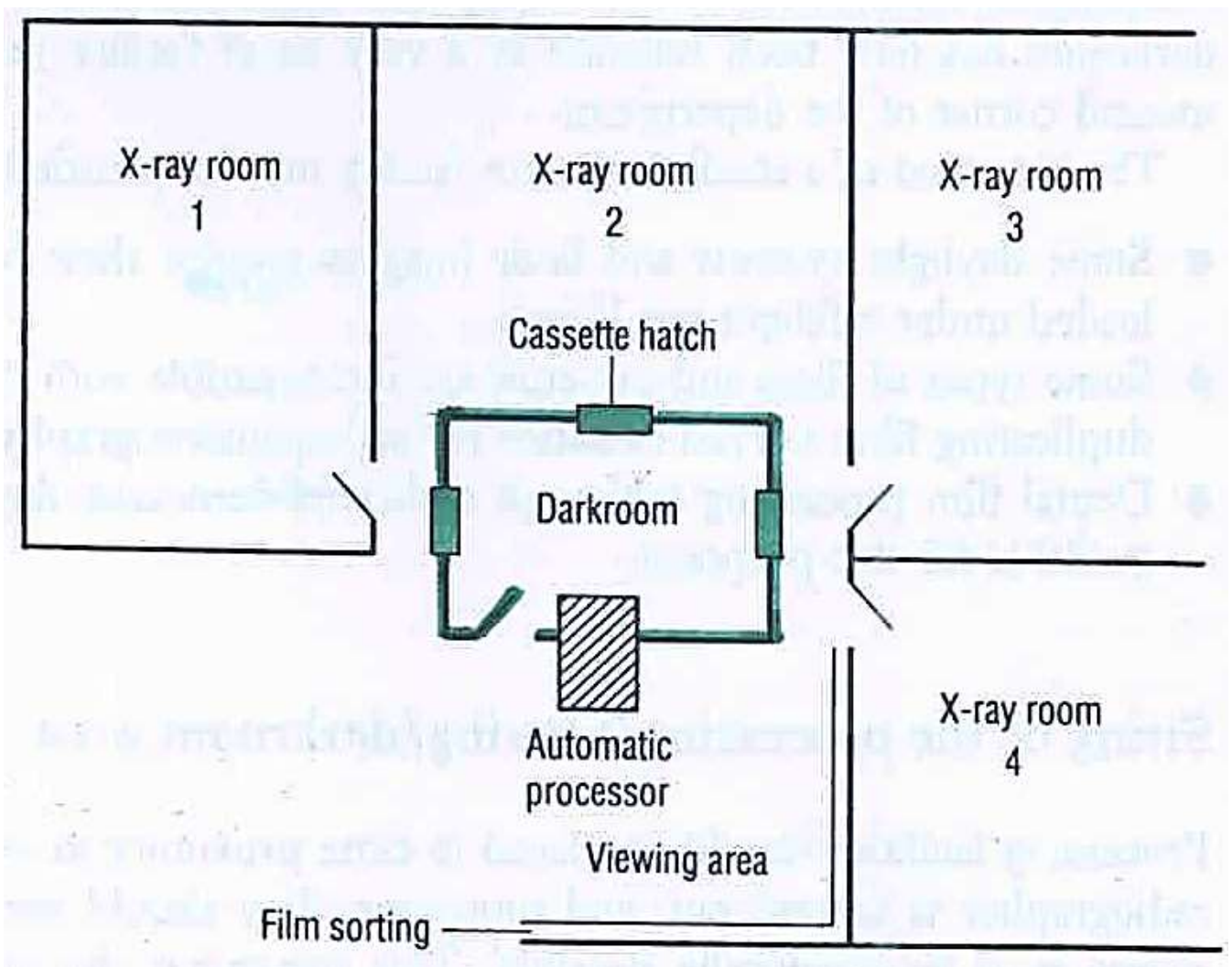
Such as:

safe light, ordinary light • Processing Tanks, Film holders

➔ **Criteria of Dark Room:**

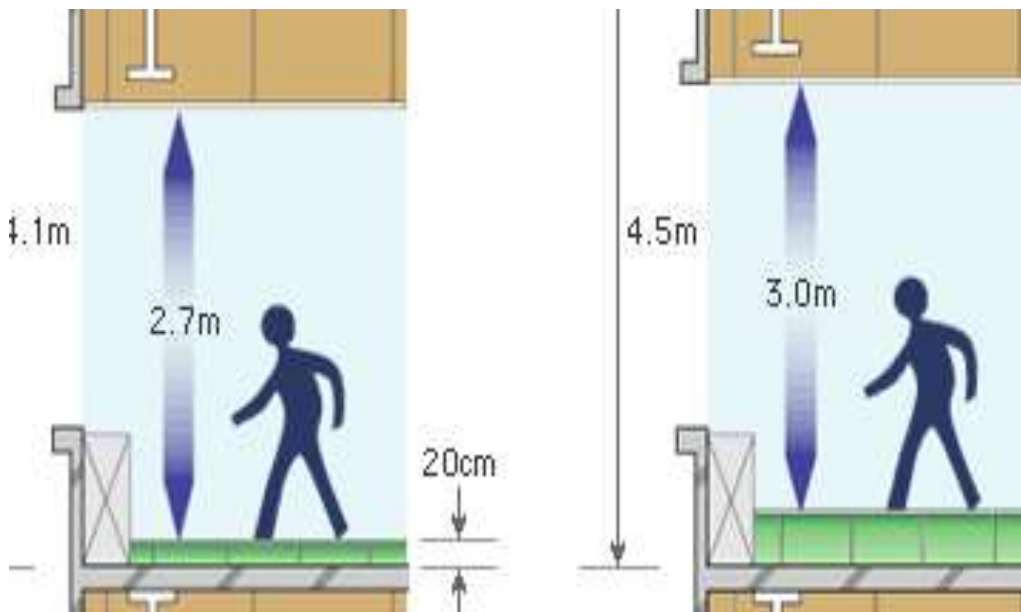
Like any room has components and criteria.

Location

Central

Area

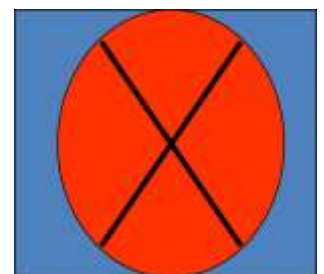
- ✓ Minimum **floor area** of **10 meter 2**
- ✓ **Ceiling height** of **2.5 - 3** meter
- ✓ Size may be reduced depending upon the department needs



SHAPE

Rectangular is better than square :

- Better use of walls
- Fewer moves of technicians



Components

1- WALLS

- Solid
- Non-dark Paints reflect light
- Easy Clean

2- CEILING

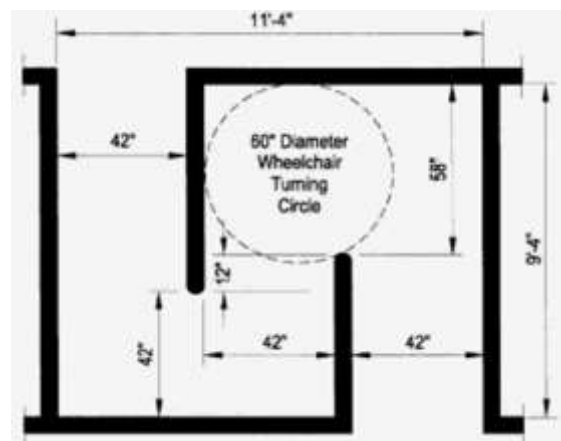
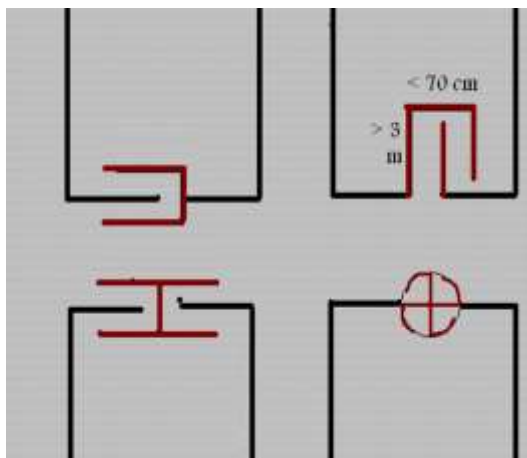
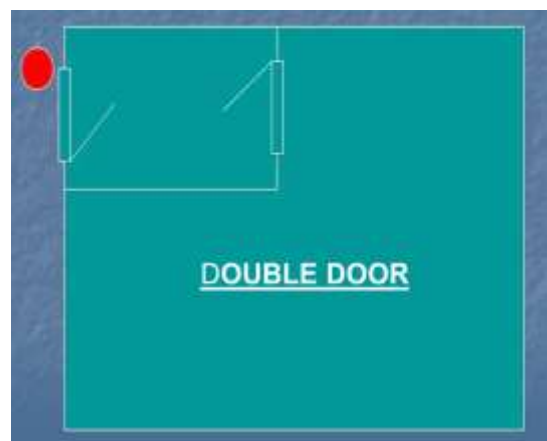
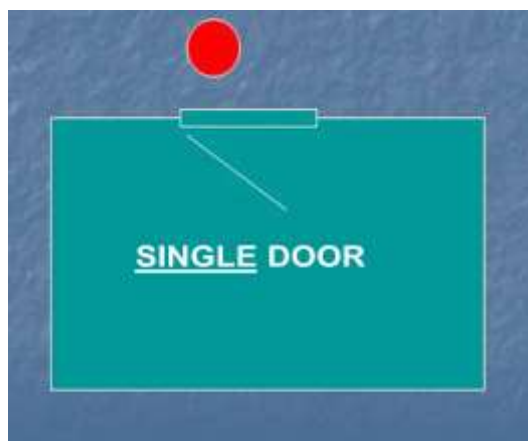
- Enough height , reflect light , no cracks

3- Floor

- not woody, not cement,
- Easy clean
- Not slibbery

ENTRANCE

- SINGLE DOOR SYSTEM
- DOUBLE DOOR SYSTEM
- MAZE TYPE ENTRANCE
- LABYRINTH
- ROTATING DOOR SYSTEM



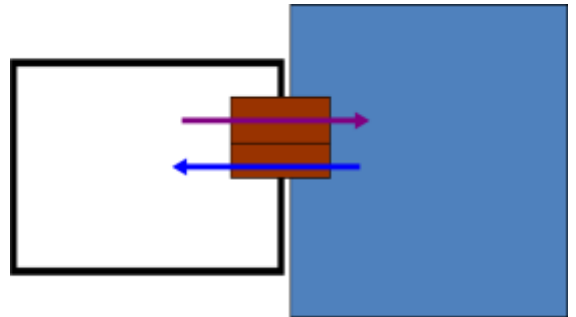
Role of these types of entrance ?

- Prevent light from entering the room all over the time

→ Avoid work failure due to the wrong light

Cassette Hatch

It is a cassette flow path from & to the Dark room, for easier transport



Water source

- ✓ Enough
- ✓ In & out
- ✓ Hot & cold
- ✓ For cleaning
& Processing works



Electricity sources

- **The dark room should include enough sources of electricity , For :**
 - Light
 - Aeration
 - Heating fluids
 - Automatic processing



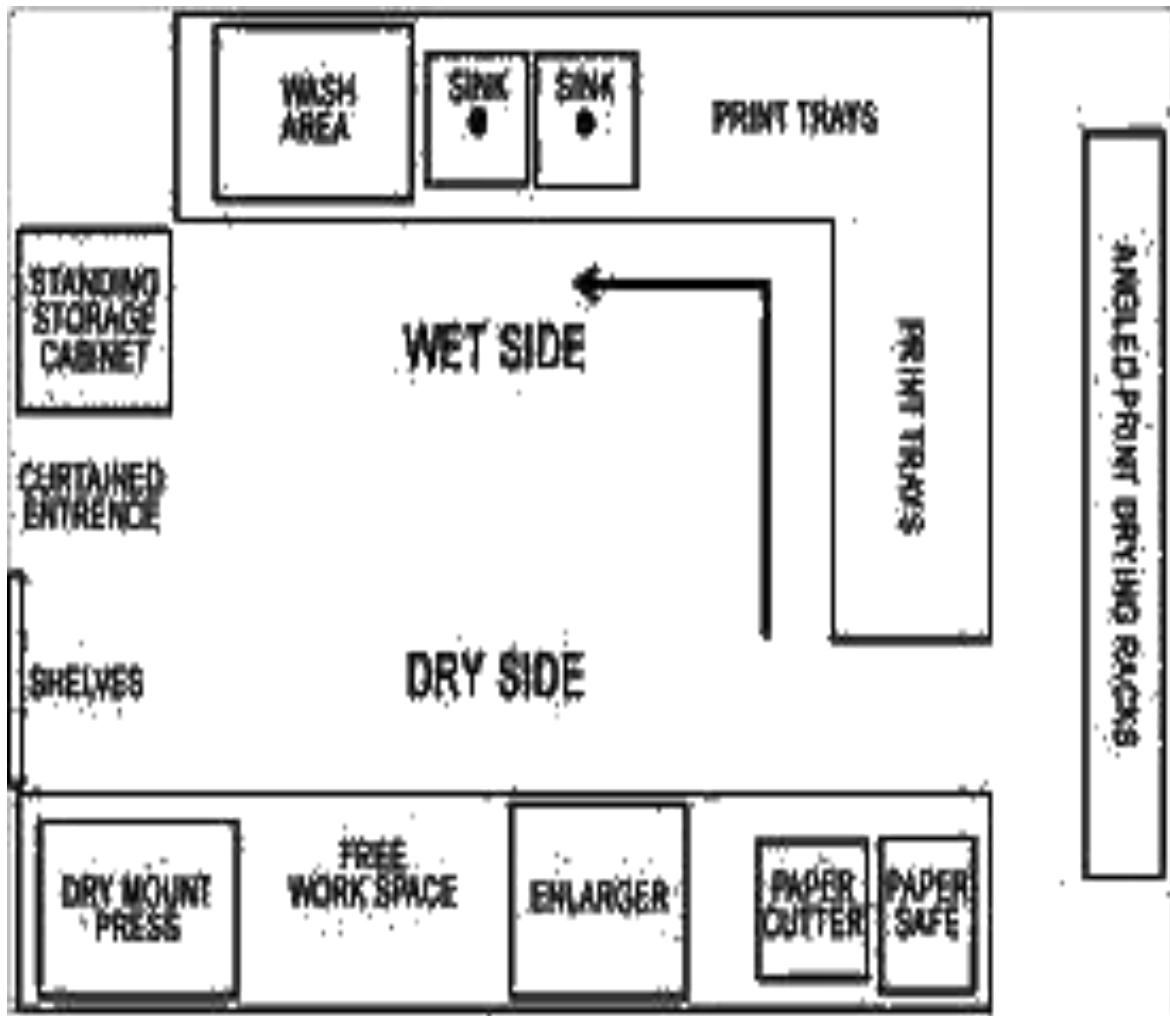
Temperature & Aeration

- Avoid **over heat** & **humidity**
- Temp 18 : 20 c
- Humidity 40 : 6- %

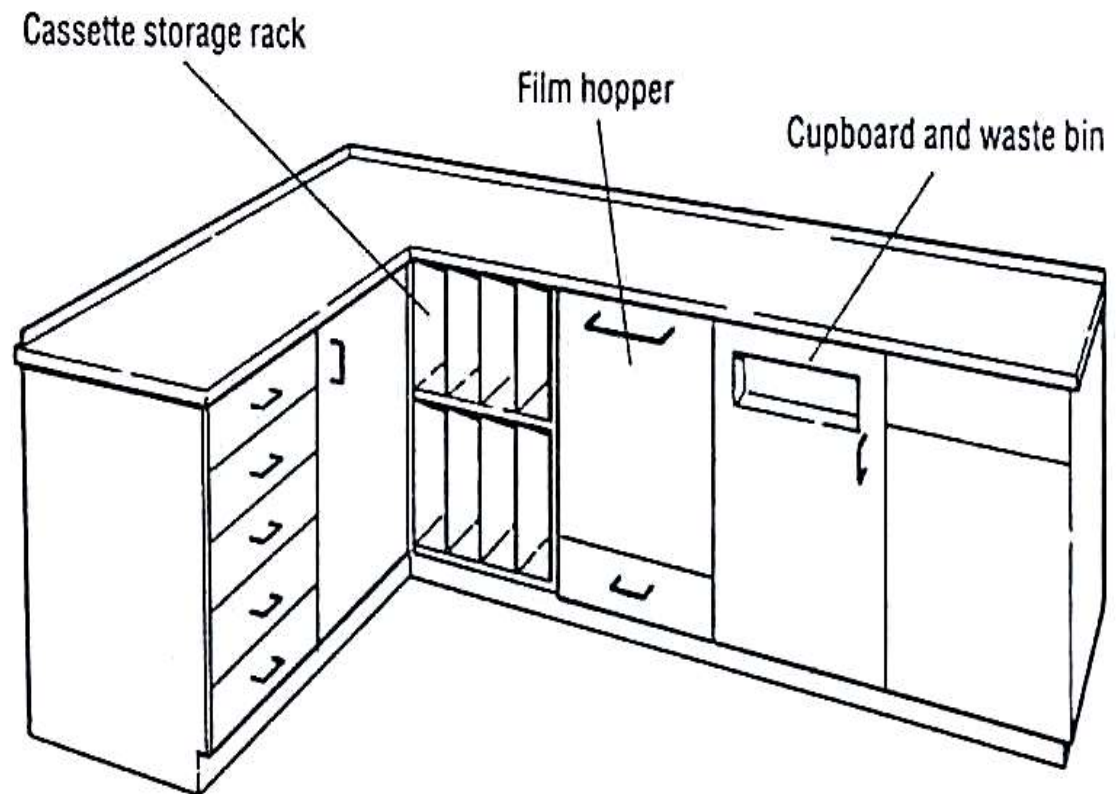


Dark room Design

- **Good separation** of Wet & Dry zone
- **Good arrangement** according to the steps of use
- Enough equipment.



Wet zone & Dry zone of the dark room



A darkroom dry bench system. (Courtesy of Wardray Products Ltd.)

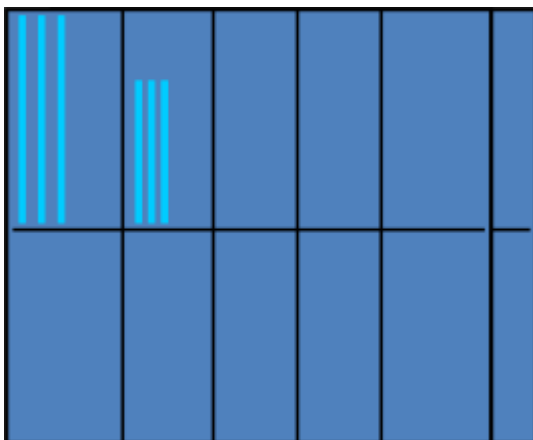
DARK ROOM Equipments



Film Hopper
دولاب تخزين الافلام



Cassettes racks according to size



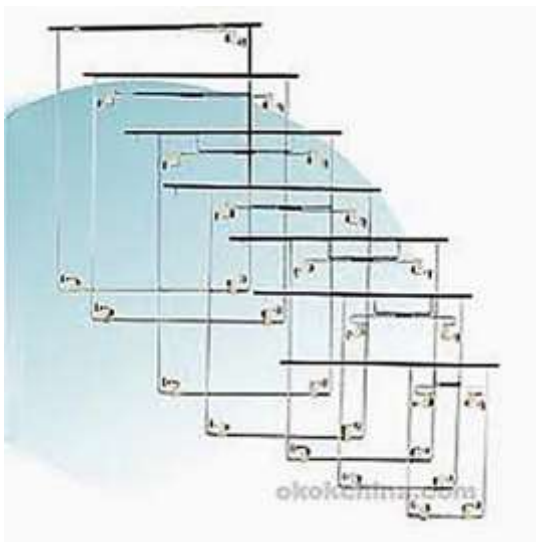
Wet Zone Components

Manual Processing Tanks



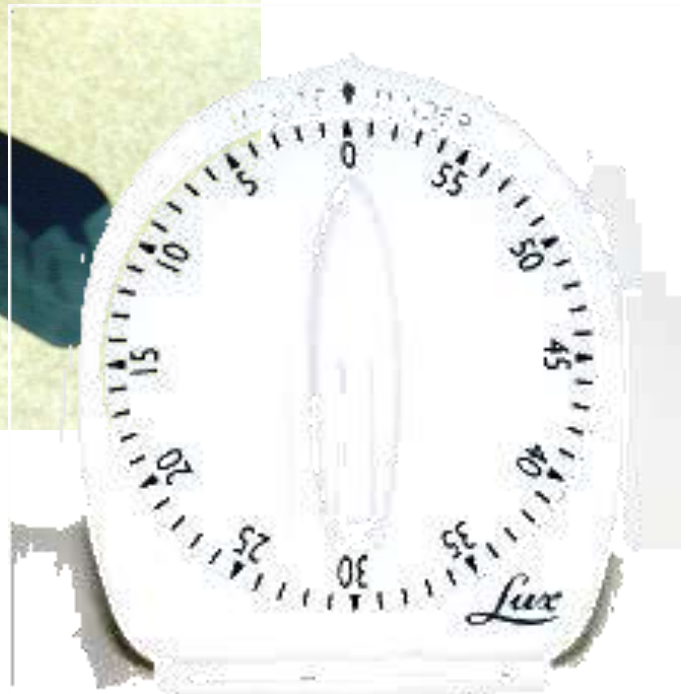
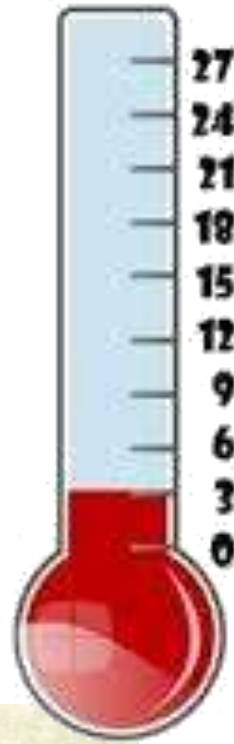
→ **Film Hangers or Holding frames:**

1- Channel hanger	2- Tension Hanger or Clips Fastener
U shape	Square with clips
<ul style="list-style-type: none"> -Difficuilt to clean -Film bowing during use -Fracture of moving part .=Loss function -Borders of it covering film edges → non processed edges 	<ul style="list-style-type: none"> -Need more experience -- Film injury by sharp clips



Other equipments:

- ➔ Dental film Holders
- ➔ Timer
- ➔ Thermometer
- ➔ Light system



Dark Room Light



1- Ordinary Light الضوء العادي

- *For works other than dealing with films.*
- *Enough for the area.*
- *Light On design,*

Must never be accidentally opened.



2- Safe Light

- ***2 Types :***

1- Direct 2- Indirect

- *No absolutely safe light*

- ***Red or orangebut not blue***



Direct Safe Light الضوء الامن المباشر

- On the wall or ceiling
- About 15 watt
- > 1 m distance from films



Indirect Safe Light الضوء الغير مباشر

- Up to 25 watt
- Directed upward & reflected
- Height 2.5, 3.5 m



*SAFE LIGHT NEEDS repeated
safety tests*

CHAPTER 2

X-RAY PRODUCTION

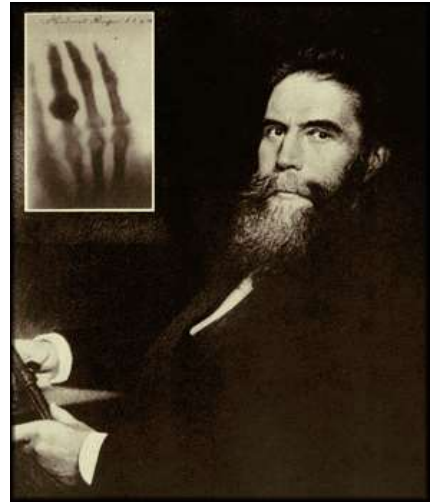
Wilhelm Roentgen,

Professor of Physics,

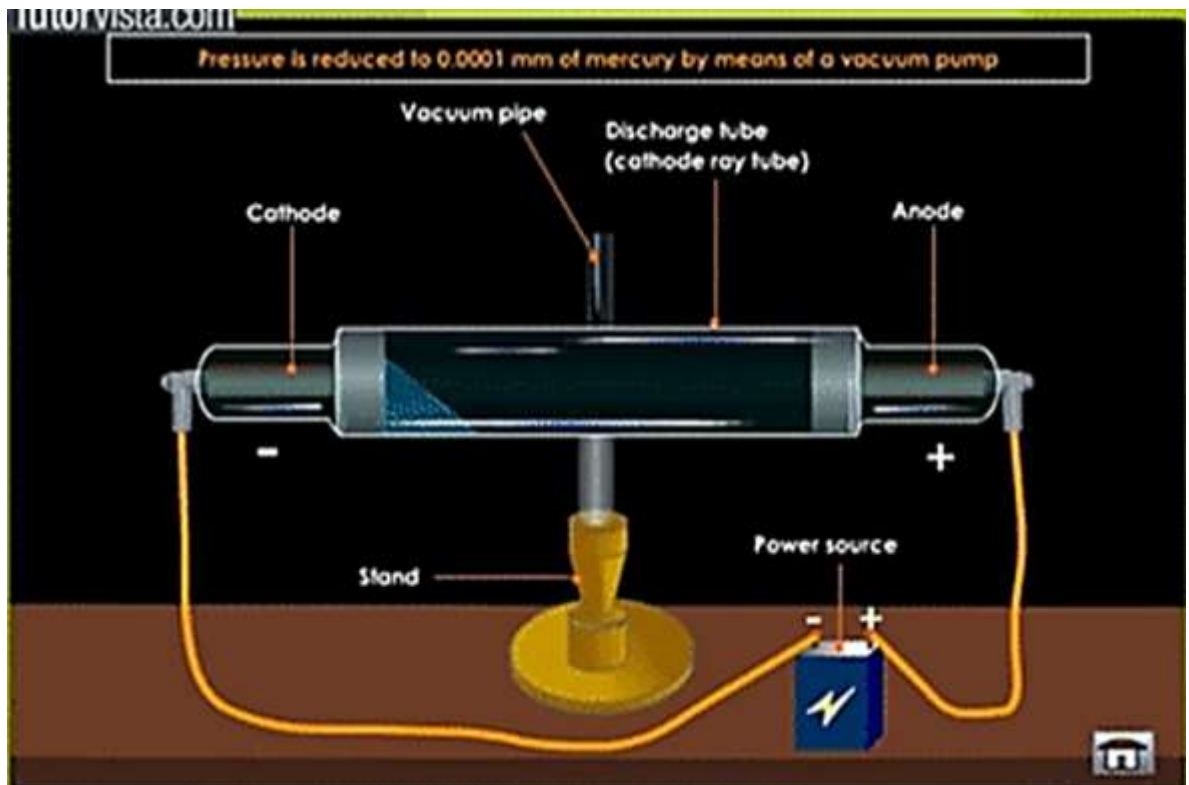
discovered X-rays

in 1895 —accidentally—

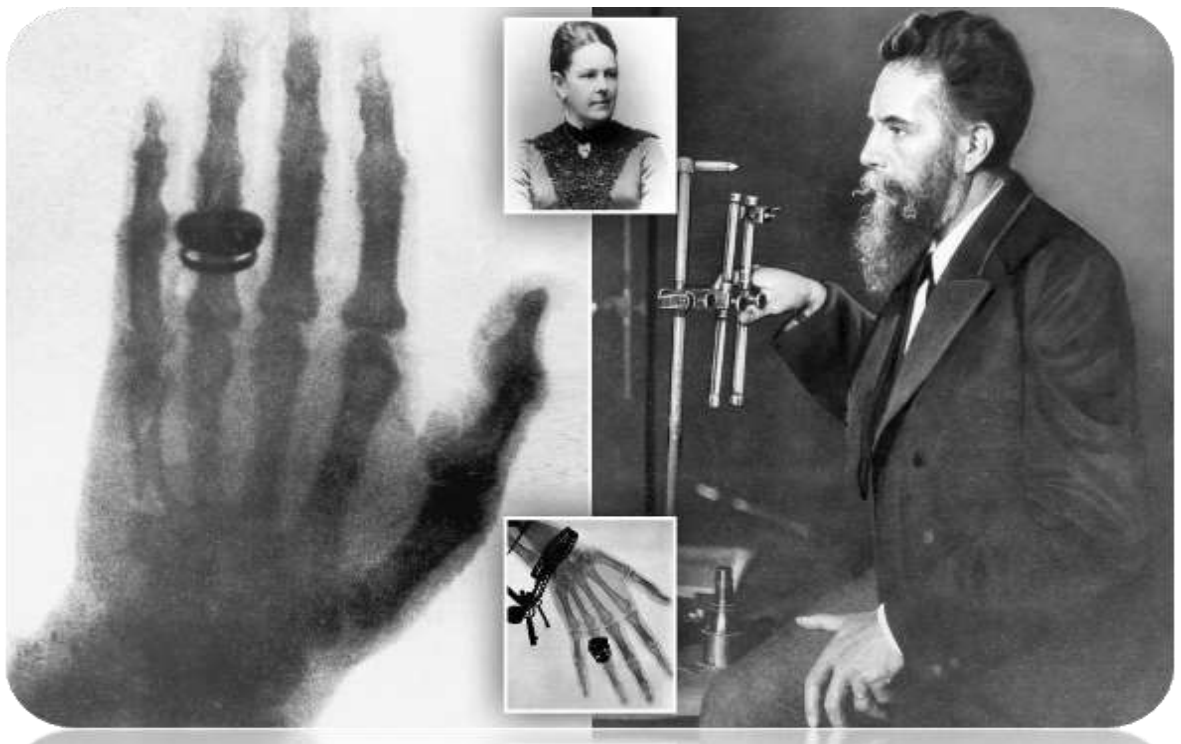
while testing cathode rays.



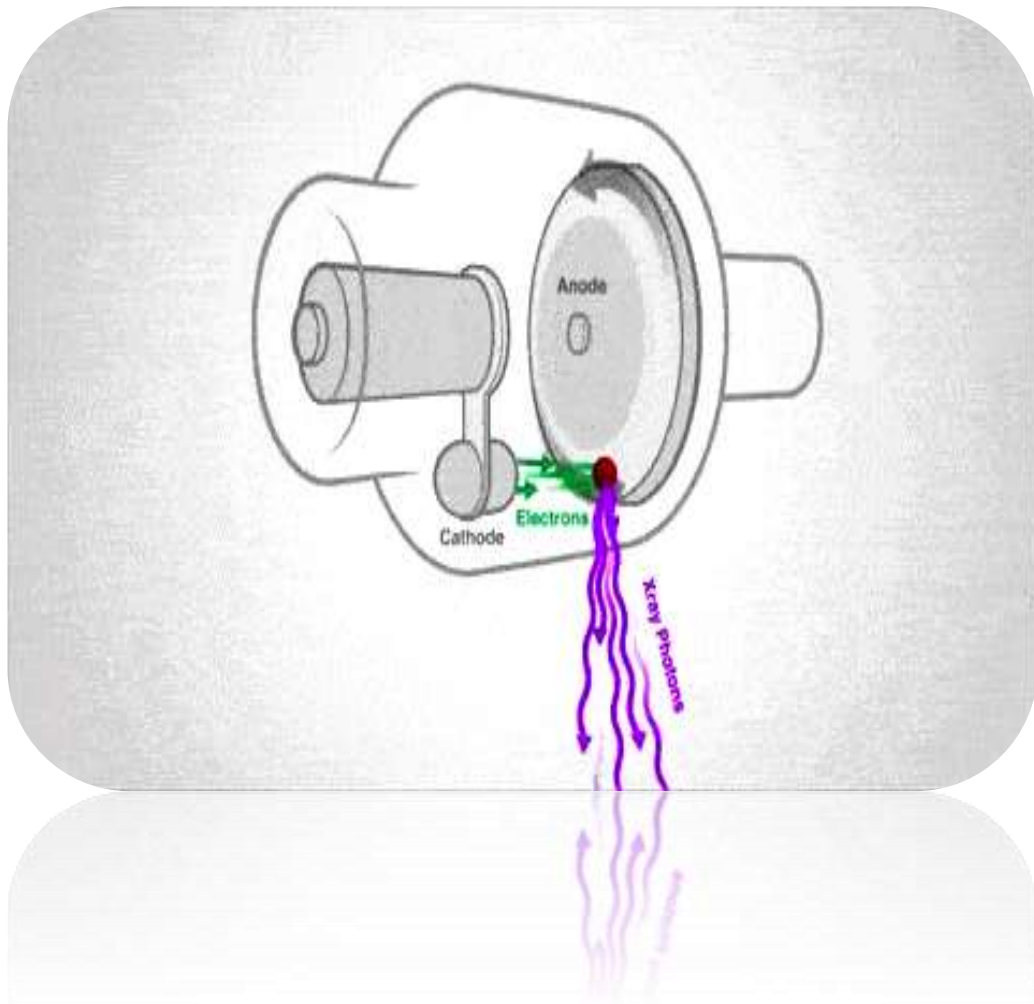
Cathode ray tube



Cathode Tube



The 1st Film : human X-ray of his wife's hand in 1895



X-RAY PRODUCTION



Adjust kV – mA - & Time mAs

kV = Kilo Volt

mA = mili Ampere

Time mAs = milli Ampere / Second

Abbr.	Prefix name	Decimal size	Size in thousands
K	kilo-	10^3	1,000
M	mega-	10^6	$1,000^2$
G	giga-	10^9	$1,000^3$
T	tera-	10^{12}	$1,000^4$

- **kV** is controlling **X-ray penetration**
- **mA** is controlling **X X-ray amount**
- **mAS = time of exposure**

عوامل التعرض Exposure Factors

هي العوامل التي يمكن من خلالها التحكم بالأشعة الخارجة من أنبوبة الأشعة وهي ثلاث عوامل:

1. الكيلوفولت KV: هو فرق الجهد بين الكاثود والأنود خلال إنتاج الأشعة. وهو يتحكم بطاقة الأشعة السينية فكلما زاد الكيلوفولت زادت طاقة الأشعة. وكلما زادت طاقة الأشعة السينية زادت قدرتها على اختراق الأجسام.
2. الميلي أمبير mA: كلما زاد الميلي أمبير زادت الإلكترونات المنبعثة من الكاثود إلى الأنود مما يؤدي إلى زيادة كمية الأشعة السينية.
3. مدة إنتاج الأشعة: فكلما زادت مدة إنتاج الأشعة زادت معها كمية الأشعة وهي تقاس بالثانية.

تقاس بالثانية.

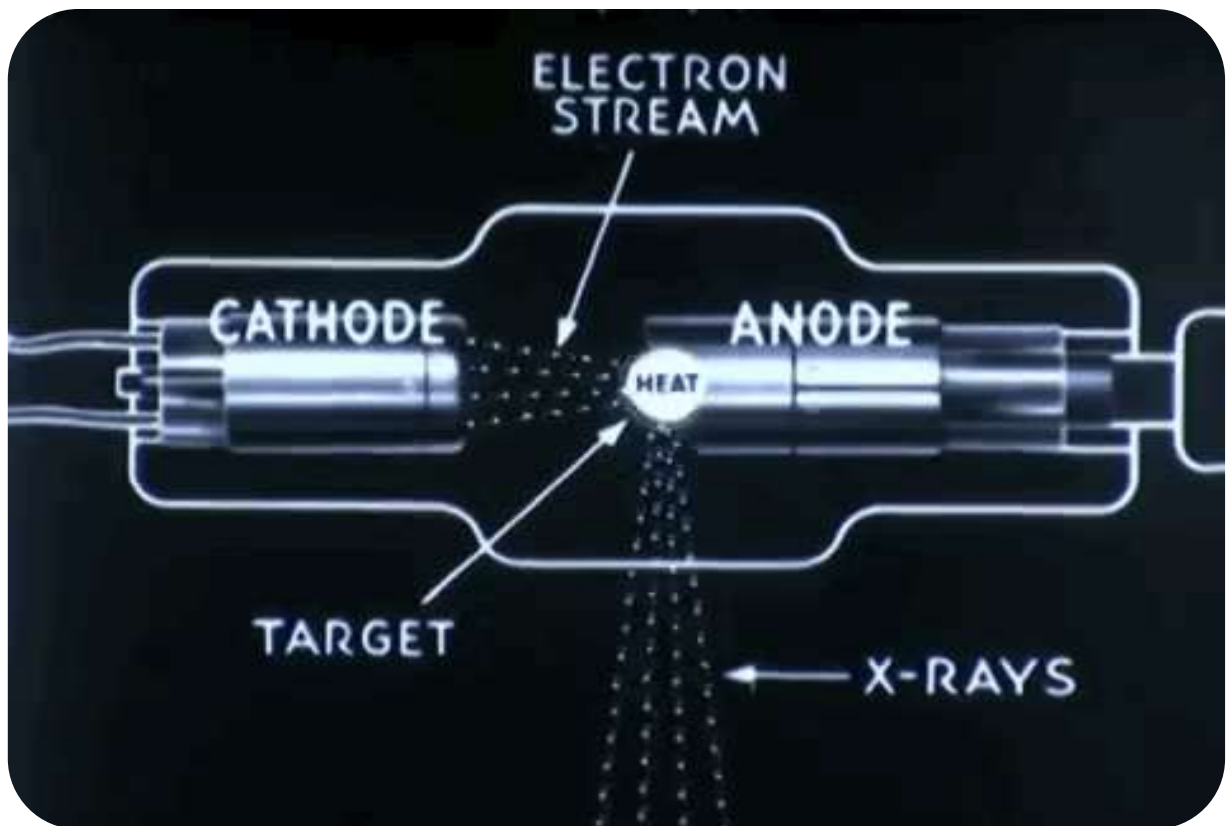
3. مدة إنتاج الأشعة: فكلما زادت مدة إنتاج الأشعة زادت معها كمية الأشعة وهي تقاس بالثانية.

X-Ray Click ON

- **1st Click – Preparation →**
 - Cathode filament: heat
 - Anode disc: rotate
- **2nd Click : X-ray Production**



Cathode Filament is strongly Heated

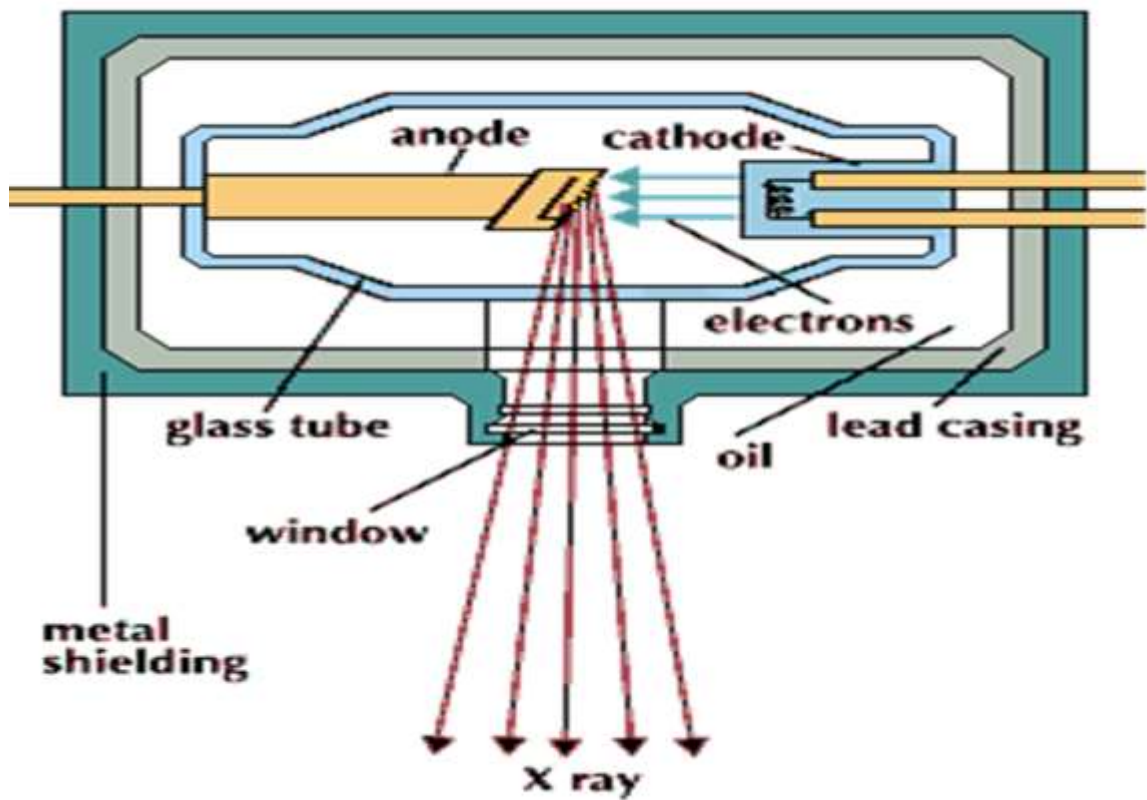


X-ray Production

X-RAY TUBE

- **X-rays are produced when :**
fast-moving electrons → suddenly hit the Anode, → converted into **X-rays**
(1% of electrons give X-ray) and (99% to heat).

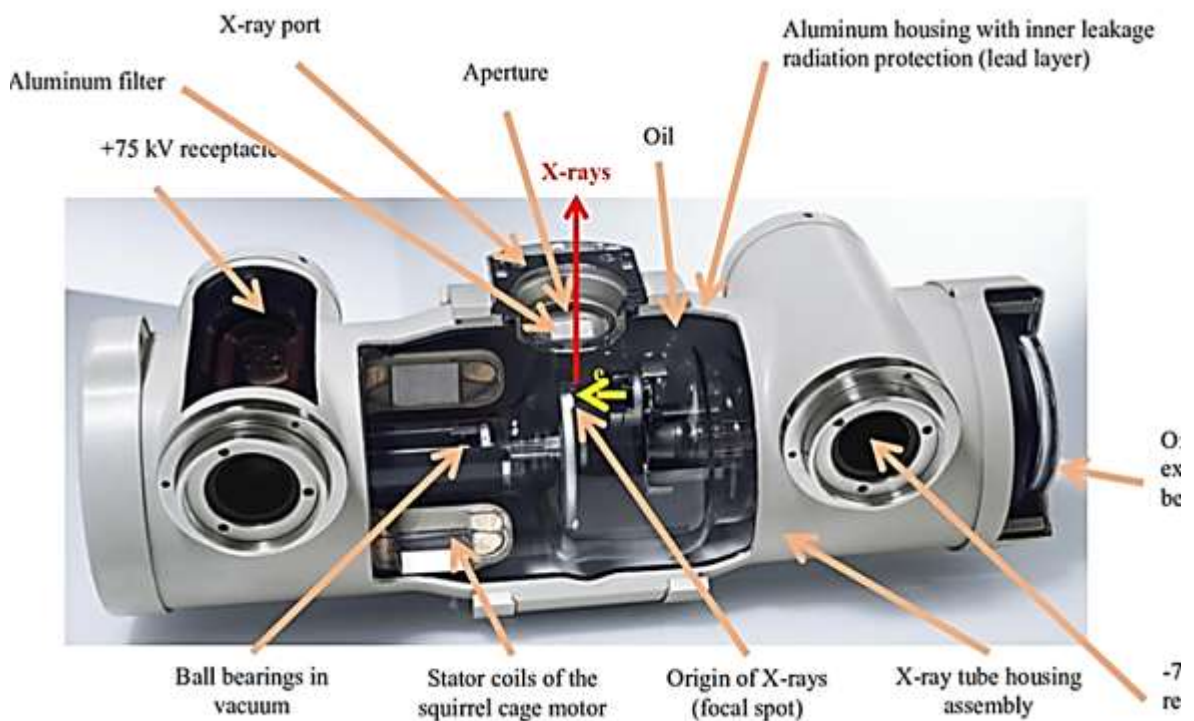
- **X-ray tube** consists of :
 - **Evacuated glass envelope**
 - two electrodes :
 - **(cathode)** negative electrode
fine **tungsten coil** or **filament**
 - **(anode)** positive electrode
smooth flat metal target Disc,
usually of **tungsten**.
 - The filament (**Cathode / -Ve**) is heated by → passing an electrical current → that emits electrons.
 - The free **negative** electrons → leave -ve **cathode** → attracted by the **positive anode**.



X-ray Tube

Why X-Ray Tube is Vacuumed ?

- **Vacuum**, → Electrons not hindered in any way, → hit the target with a velocity about half the speed of light.



مفرغ = Vacuumed

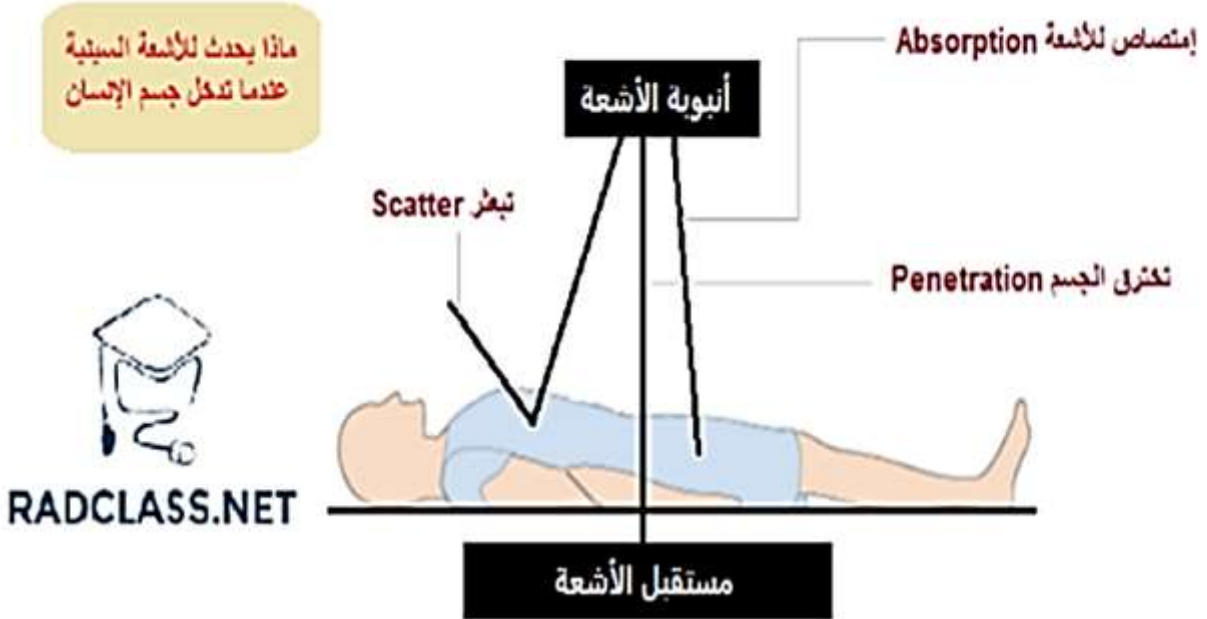
Hinder يعوق

Structure & Why ?

Why vacuum ?	No O ₂ , avoid more heat & cathode oxidation of
Why Pyrex glass envelop ?	To resist over heat
Why lead envelop ?	to avoid X ray scattering in all direction
Why Oil around ?	For good cooling
Why Steel envelop ?	For good protection
Why Aluminum filter ?	For Filtering of low energy rays

❑ X-ray Properties :

- ✓ Electromagnetic waves
- ✓ Light velocity
- ✓ Pass straight
- ✓ Non visible, Non charged
- ✓ Highly penetrating
- ✓ Blacking radiographic film



يعتمد تفاعل الأشعة السينية مع جسم الإنسان على عدة عوامل منها:
طاقة الأشعة السينية - السماكة - العدد الذري - الكتلة.

CHAPTER 3

RADIOGRAPHIC FILM

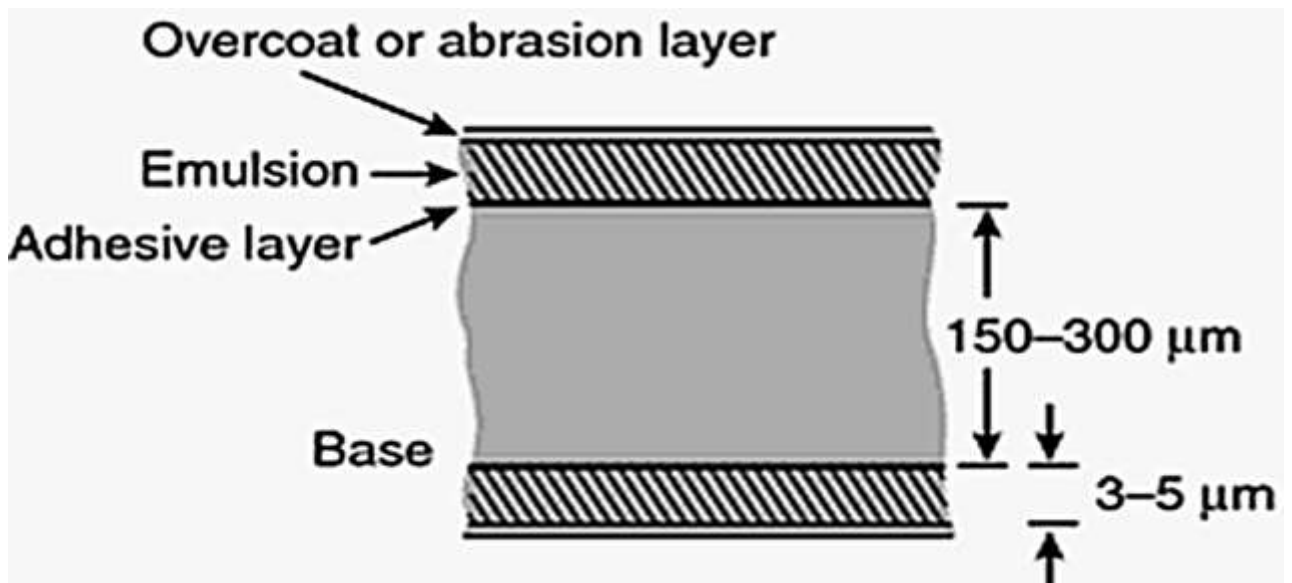
Historical View

- 1889, William Röntgen discovered X-rays
- Glass was the main material of films till **W.W.I**
- Then **cellulose nitrate**
- Until it becomes of current shape

X-ray Film Layers

- 7 Layers
- 2 main components :
 - **Base** "قاعدة" المادة الأساسية
 - **Emulsion** المادة الحساسة
- & **2 other components** :
 - *Adhesive material*
 - Super coating layer

X-ray film 7 Layers :



1- Base

- *Transparent*
- *Light blue* ← مريح للعين
- *Flexible*
- *Fixed Dimensions*
- *non inflammable*
- *Water proof* “

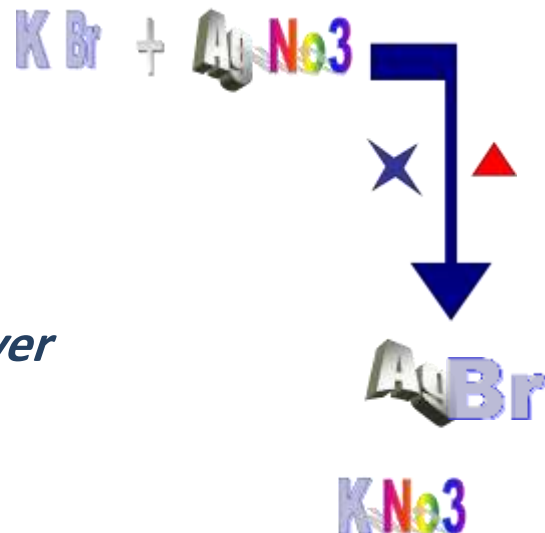


2- Sensitive emulsion

Silver Iodide - Silver bromide

*Sensitive material , when exposed to light
& Xray → Form image .*

- *On both sides of Film*
- *Fixed by adherent layer*
- *Protected by protective layer*



Sensitive material Grains (2 Types)

- ▶ Fine grains حبيبات رقيقة
 - ▶ Larger grains حبيبات سمكة
 - ▶ According to temperature & mix velocity
 - Rapid mixing & low temp. → Fine grains
 - Slow mixing & high temp. → Larger grains.
 - ***Sensitive material is composed of***
 - ▶ AgBr 90 : 99 %
 - ▶ AgI 10 : 1 %
- ➔ **WHY ?**
- ▶ This Mix is more sensitive .

Difference between Fine & coarse Grains?

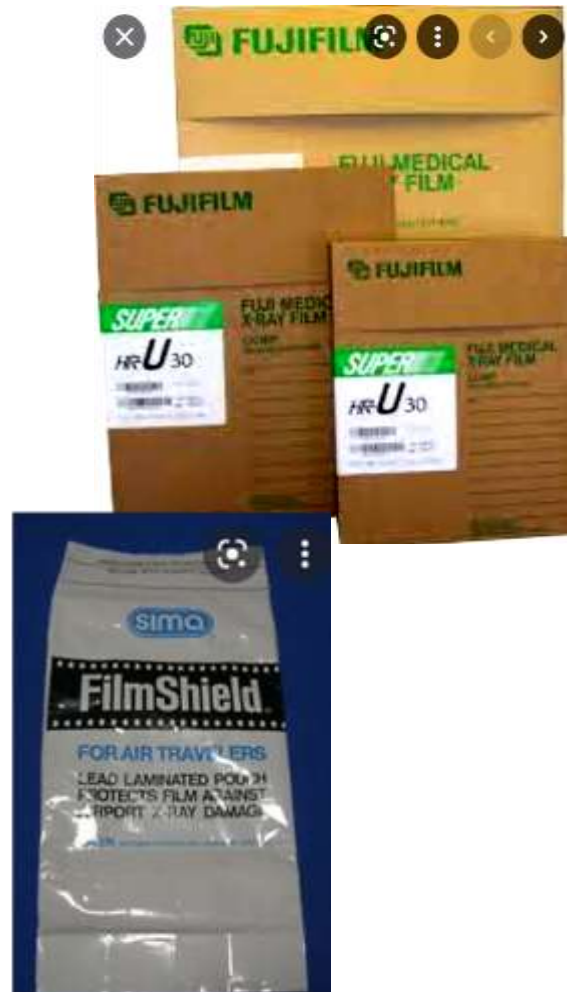
More mix → **More film sensitivity.**

Use of one type → less sensitivity .

How to deal with X ray Films ?

- **Film boxes**

- ▶ Films inside **plastic bags**
- water proof
- Light proof



- **Film Storing :**

- Film sensitivity is lost over time
- but Good storing = **longer life**
- Avoid harmful factors, which are :

Avoid exposing stored films to :

- **Light**
- **Radiation**
- **Temperature**
- **Weight**

Ideal Storage Factors :

- ✓ **Temp < 20 c**
- ✓ **Humidity 50 : 60 , cool & dry**
- ✓ **Away from any source of radiation**
- ✓ **Boxes in vertical manner**
- ✓ **Clear visualized expire date**

Size of The Films



You can simply Memorize it as :

→ In cm :

13 x 18 x 24 x 30 x 40 cm
35 35 X 35 X 43

→ In inches :

8 x 10 x 12 x 15
14 X 14 x 17

Data must be on any X-ray Film

1. Name of Dr of Hospital
2. Patient name & number
3. Examination date
4. Site & type of exam
5. Timing of sequence scan eg, IVU

Types of Films

According to Sensitivity :

- Blue Sensitive Films
- Green Sensitive Films
- Panchromatic Films

According to Screens Used :

-Non-Screen Films

(Direct Exposure ..as dental)

- Screen Films :

- Single Screen
- Double Screen

According to Coating :

- Single Emulsion
- Double Emulsion

Non screen Films أفلام تستخدم بدون اللوحات المقوية

- Sensitive for **X-ray only**
- Manual & Automatic Processing
- **More Thick** sensitive layer
- Need **more fixation** time
- More detailed image → used in **mammography & bone imaging**

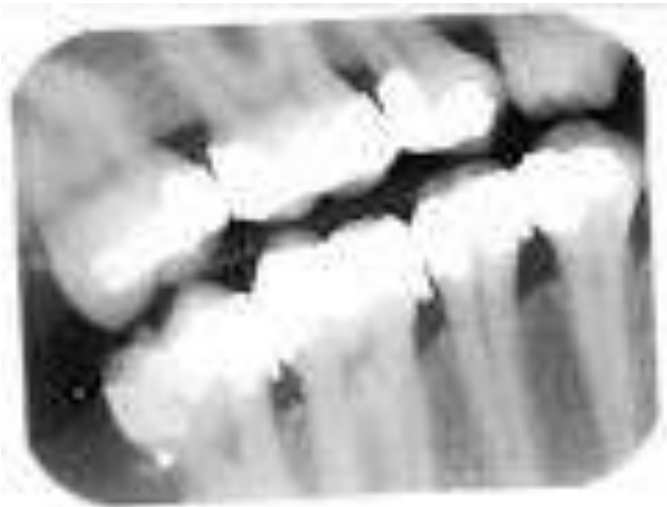
Mammography Films

- For breast imaging
- One side covered by a sensitive layer.
- Very fine grains → , More detailed image
- Without intensifying Screens
- 18x24 & 24x30 cm
- Manual or automatic processing



Dental Films افلام الاسنان

- Very small sized
- Used with its cover



New Types of Dental Films

- Processing Fluids are located with in a separate bucket with the film.
- After exposure , **squeezed** → mix with film → image processing



But



Laser Prints Films

**Is the main & dominant
now !!!**

CHAPTER 4

INTENSIFYING SCREENS

Intensifying screens

- are devices used in the **x-ray cassette** to **intensify the effect of the x-ray photon** → by producing a larger number of light photons.

Principle of work

- Fluorescence :**
material absorbs energy from X ray and re -emits it as a visible light

Importance

X ray is **non visible**, **but the** Screens convert it to **light**

- X ray films are **more sensitive to light** many time > X ray
so let us know

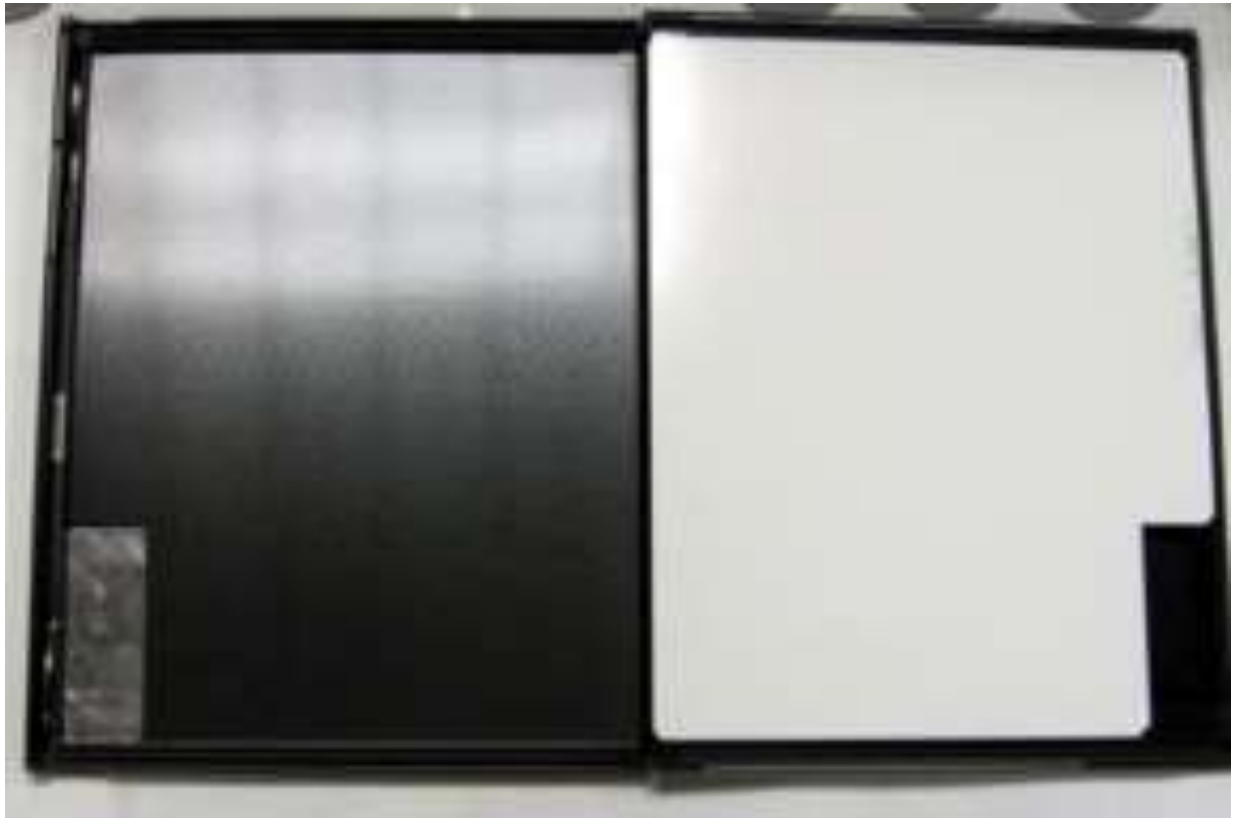
INTENSIFYING SCREEN .



That it intensify X ray action → **better image** & **less dose**

- 2 screens are present, one on both sides of the cassette
 - Some films used with a one side screen
- eg. Mammography or without screens.

■



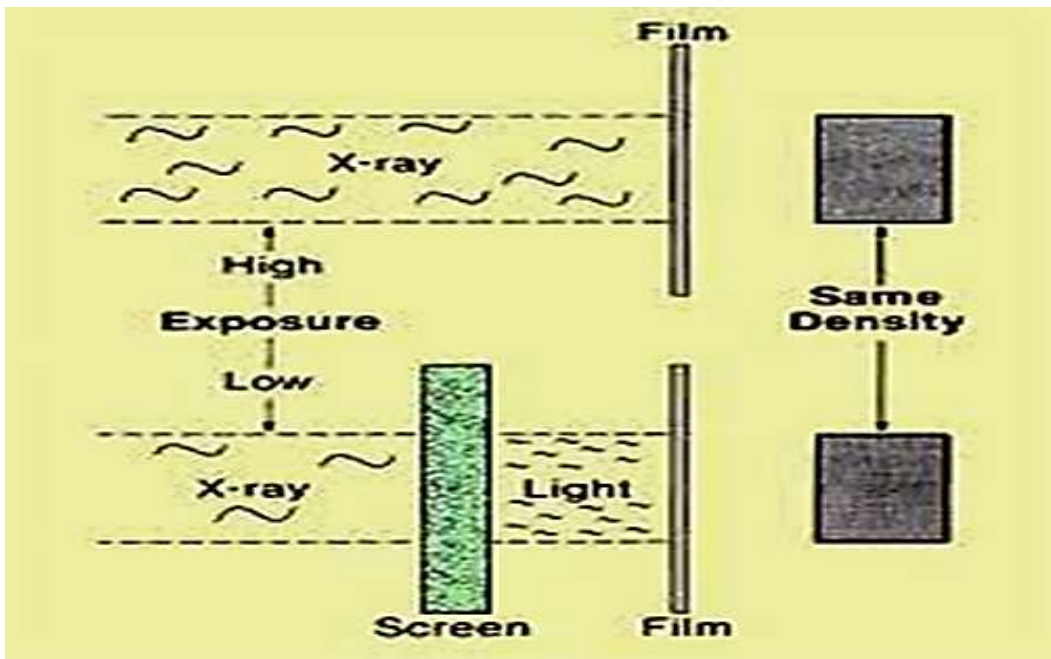
Fluorescence in Qouran



- Olive oil has the criteria of fluorescence, i.e. it has the ability to absorb light & re-emit it.

Formation of X ray Image

- 95 % of the **light** emitted from the screen
- 5% only from the **direct** X-ray effect.



Advantages of Use

- . **Magnify** the effect of X-ray on Film →
 - **L**ess dose of X-ray & shorter time
 - **L**ess harm for the patient
 - **L**onger life of X-ray Tube
 - Use of portable apparatuses with its smaller (**L**ower) tubes

Structure

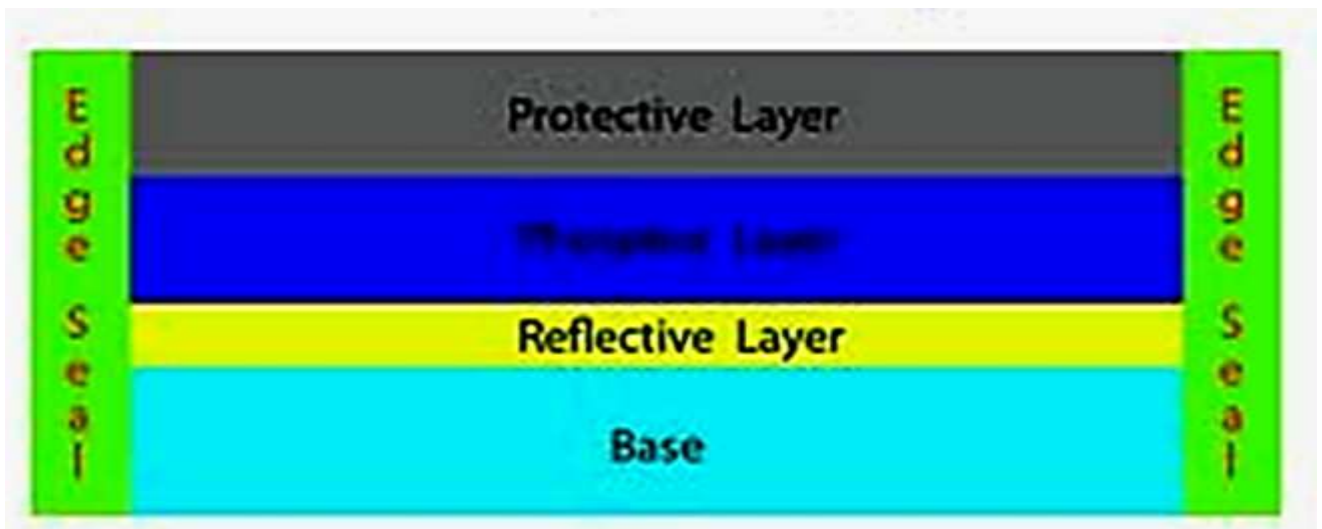
- **Shape** : white board
- **Thickness** : (About **0.4 mm**)
- **Dimensions** : As cassette
- **Component** : **4 Layers**

Base قاعدة ١ -

Reflecting layer الطبقة العاكسة ٢ -

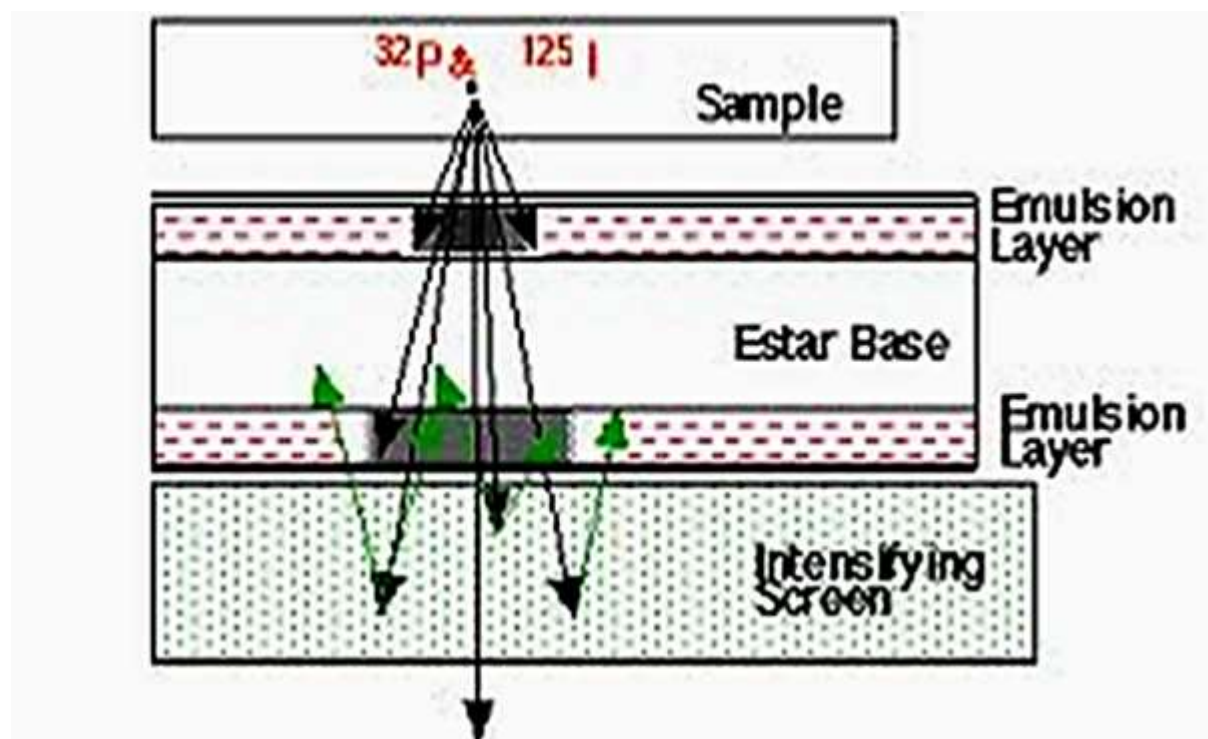
Phosphorus layer الطبقة الفسفورية ٣ -

Protective plastic layer طبقة الحماية ٤ -



The common used film size are:

In inch	in centimeter
6 x 12	13 x 18
8 x 10	18 x 24
10 x 12	24 x 30
12 x 15	30 x 40
14 x 14	35 x 35
14 x 17	35 x 43



1- BASE

- *Plastic Board*
- *thickness 1 mm*
- *Carrier of sensitive material*



➔ Criteria of Base Material :

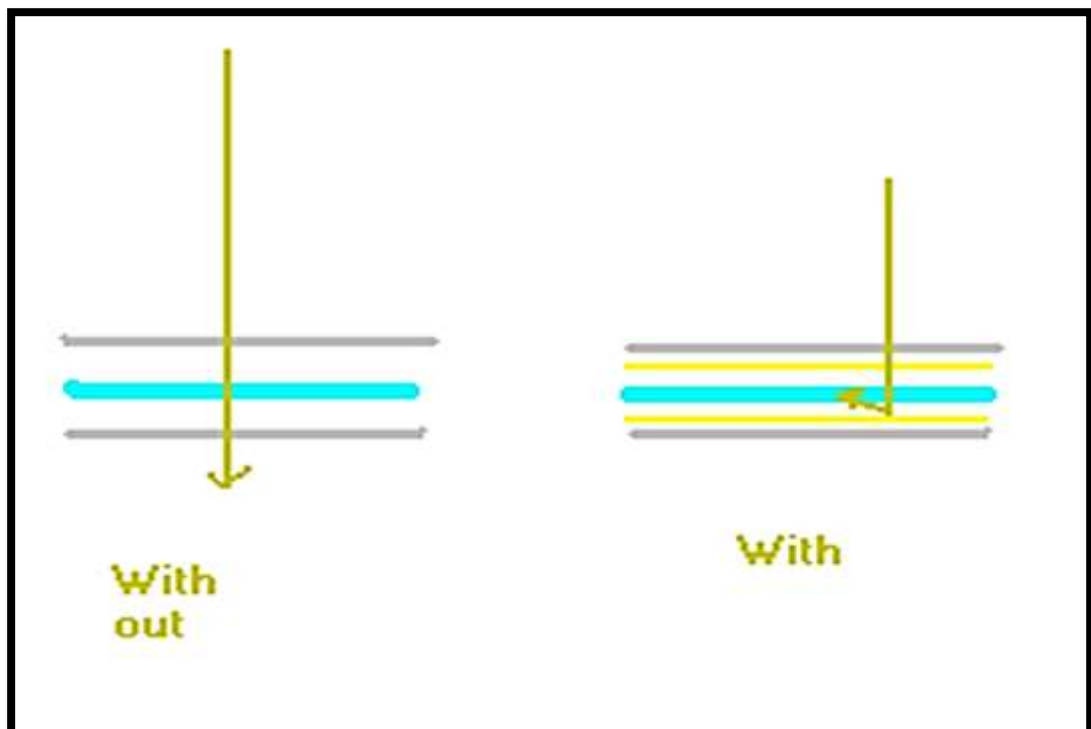
- **Inert**
- **Radio resistive**
- **Radio transparent**
- **Humidity resistive**
- **Flexible & smooth**

٢-الطبقة العاكسة Reflecting Layer

- Very Thin
- Light reflecting
- .Magnisium Oxide or Titanium dioxide

اكسيد المغنسيوم او ثانى اكسيد التيتانيوم

Reflect light photons to film & improve image



٣-الطبقة الفوسفورية 3-Phosphorus Layer

- Active layer
- Convert X ray to light
- 3 substances are used :
- **Ca tungstate** : *Ideal & Most used* تتجستات الكالسيوم كبريتيد الزنك
 - سلفات الباريوم و Barium sulfate & lead sulfate الرصاص

- **Calcium tungstate (CaWO₄):**
blue light
- **Lanthanum oxybromide (LaOBr):**
blue light
- **Gadolinium oxysulfide (Gd₂O₂S):**
green light

NB. Posterior screen is **more thick** → less X ray reach it → to compensate photons on both side → **homogenous images** on both sides of the film

1-Ca Tungstate	2-Barium lead sulphate	3-Zinc sulphide
*Most common		
•*→3500:5200 A	*→3000:4700A	*→3900:5500 A
i.e. ultraviolet, violet & blue (to <i>which film is most sensitive</i>)	* intensifying>Ca Tungstate .	i.e. v. b.& green *were used e low kv
• <u>SO</u> •* IT IS <u>Ideal</u>		*→ afterglow *large grains so Not used

Film Types & Sensitivity

✓ conventional films:

sensitive to **ultraviolet** and **blue lights**

✓ Polychromatic films:

sensitive to **ultraviolet**, **blue** and **green** lights

٤-الطبقة الواقية Protective Layer

- Plastic protective layer
- Very thin
- Transparent & water proof

Screens Care

Avoid

- Direct touch , Remove fonger prints by peace of cotton
- Processing Fluids → Destroy screens
- Electrostatic charges → remove by opening cassettes or using special spray .

SCREEN SPEED

- Relative number represent **screen activity** .
- Classified as :

<i>Slow speed</i> بطيئة	<i>Medium speed</i> متوسطة	<i>High speed</i> سريعة
0.5	1 (it is the base of comparison)	2 : 2.5
Smallest crystals	Average	Largest crystals
Thinnest	Average	Thickest

* *screen speed is related to*

1- Size of crystals of phosphorus layer

2- Thickness of phosphorus layer

عامل التقوية

INTENSIFICATION FACTOR

$$\text{■} = \frac{\text{Time of exposure with out screen}}{\text{Time of exposure with screen}}$$

- بما ان الالواح المقوية ، تقلل كمية الاشعة وقت التعرض
- اذا فان عدم استخدامها = زيادة كمية الاشعة . و وقت التعرض
- النسبة بين وقت التعرض بدون الواح / وقت التعرض باستخدام الالواح = **عامل التقوية**

بدون الالواح المقوية

٣ ثانية



باستخدام الالواح المقوية

١ ثانية

$$\text{■} \quad \text{عامل التقوية} = 1 / 3 = 3$$

- بمعنى ان الالواح المقوية ، قامت بتقوية تاثير الاشعة على الفيلم ٣ اضعاف

CHAPTER 5

PROCESSING CYCLE

Latent Image صورة خفية



Permanent Image

صورة ثابتة



Processing Steps :

1- Preparation التحضير

2- Development الاظهار

3- Rinsing النقع

4- Fixing التثبيت

5- Washing الغسيل

6- Draying التجفيف

1- Film preparation

- Remove Film from Cassette to Hanger
- Must be with :
 - Dry hands
 - No folding
 - Not exposed for safe light for long time

2- Developing : Convert image from **latent** to **manifest** .

3- Rinsing:

- ▶ Film rinsing in **water** to remove excess developer
- ▶ ➔ rinsing may be a **stop path**

Stop Path:

قد يحتوى هذا التانك على مادة حمضية ضعيفة ، يكون دورها
 ١- ايقاف مفعول المظهر "لانه قلوى"
 ٢- الحفاظ على حمضية المثبت "لانه حمضى"

4- Fixing: Remove **non exposed silver halides**

& Fixing those Exposed

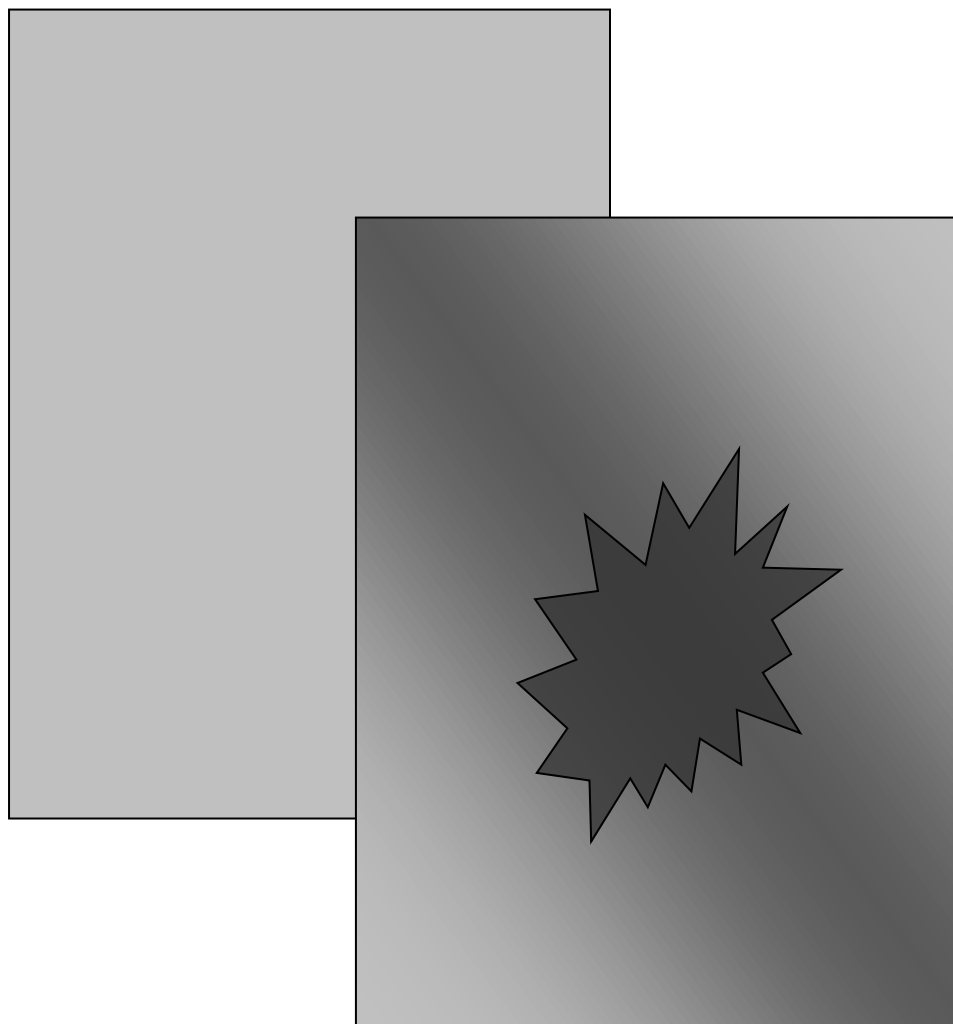
5-Washing :

Remove **excess Fixer** on film

6- Drying

Developer

المُظهِر



Developer Components

- **Weak Alkaline**
- **Reducing agent**

- 1- Reducing Agent
- 2- Restrainer
- 3- Preservative.
- 4- Buffer
- 5- Activator
- 6- Anti Swelling
- 7- Sequestering agent
- 8- Solvent

FUNCTION OF DEVELOPER

- *Source of **electrons** → **reduced** exposed silver halids → convert it to **black ions***
- *The more sensitive for exposed halides only , the better developer*
- *Really , it affect both exposed & non exposedbut **much more rapid on exposed** → so avoid to leave film for longer time in developer.*

Types of Reducing agents in Developer

انواع المواد المختزلة المستخدمة في المظهر

1- **High energy Agents** (as METOL or Phenidone

. Work on superficial layer & rapid

2- **LOW energy:** → eg. Hyperquinone

Work deep & slow , So equal **mix** is used

Activator “Accelerator”

المنشط او المحفز

→ Developer PH = 9.5 : 11Not > 12

- Alkaline مادة قلوية
- Open pores in gelatinous material

تساعد على فتح مسام في المادة الجيلاتينية على سطح الفيلم

- مما يحفز او ينشط تفاعل المظهر مع المادة الحساسة .
- يجب ان الا يزيد المظهر عن ١٢ PH
- PH >12 →

تفاعل زائد للمحفز مع المادة الجيلاتينية ، و انتفاخ جزيئاتها و تلف الفيلم

•

مانع الضباب

Restrainer "Antifog Agent"

- مادة تمنع حدوث الضباب الكيميائي..... إذا ما هو الضباب الكيميائي ؟
- = هو ضباب يحدث في صورة الفيلم نتيجة لتفاعل المظهر مع الاجزاء الغير متعرضة للاشعة .
- اذا تقوم هذه المادة بتأخير اختزال الهاليدات الغير متعرضة للاشعة .
- مثال : بروميد البوتاسيوم

E.g. Potassium bromide - •

Benzotrizol

Developing Tank
Stainless Steel & PVC Model



Solvents المذيبات

- **WATER** Is the usual Solvent & Diluents.
- Advantages :
 - Cheap
 - Available
- **Disadvantages :**
 - Excess Fe, Cu, → Fogging.

Forms of Developer

- 1- Powder مسحوق
- 2- Conc. Liquid سائل مركز



Preparation of Developer

1- Powder

- يتم فى غرفة منعزلة لتجنب تلوث مكونات الغرفة المظلمة
- يجب ان تكون التتكات نظيفة
- تتم اضافة الماء في درجة حرارة ٤٠ م ، و بكمية = كمية المسحوق $\frac{3}{4}$
- اصف العبوة رقم ١ ببطء "bag 1" developer ، ثم قلبها حتى الذوبان التام
- اصف العبوة ٢ "bag 2" ، ثم قلب الخليط حتى تمام الامتزاج
- لا يستخدم قبل ١٢ ساعة من التحضير

2- Concentrated Fluid

- Mix with water of ammount as described on the bottele



Time of Developing

should be enough for developing image .

- **Factors affecting time of developing :**
 - PH of developer
 - Film agitation → more reaction → less
 - Temperature . of Developer



Temperature of The Developer

- Ideal 20 , Not < 16 c
- Practically 5 min at 20 c → best image with less fog
- More temp. → Less time of developing

18 c	6-5 min
20	5-4
22	4-3
24	3-2

Agitation = Shaking Film

- Role :
 - Remove bubbles on film surface
 - Mix developer components
- If no agitation :
 - **Bubbles** on film , prevent contact of developer → “**Air Bell Marks**”



Developer Expire

- ▶ Developer New is clear, while expires is turbid.

Causes :

- ▶ **Non cover** → air oxidation → expire
- ▶ **Lose of alkalinity**, due to
 1. H ions
 2. Bromide ions
- ▶ Preservative decrease concentration, due to :
 - Vaporization
 - **Biscuit & Tea physical loss**

Factors affecting Developer age :

1. **Temperature** → more temp = less age
2. Larger films → more exhaustion
3. Double face films → more exhaustion
4. Harder film → more developer .consumed

i.e. higher temp. , harder film , Larger film ,

**Less
Developer
Age**

ما عدا اثناء الاستخدام فقط
يجب ان تظل تنكات المظهر
مغطاة



REPLENISHERS مكدات الوظيفة

- هو سائل يضاف للمظهر لاعادة و تجديد وظيفته.
 - كل نوع مظهر و له نوع مكدد مناسب تبعا لتركيبه الكيمياءى.
- Eg . ORWO R 11 R → For ORWO T 11 •

Kodak D 19 R for Kodak D19 —

→ يختلف تركيب المكدد عن المظهر فيما يلى :

→ تركيز اعلى من المواد الفعالة .

- عدم احتواءه على بروميد (Restrainer)

****Forms : Powder or Conc Fluid**

Methods of Replenishing

1. Topping-up Method : اعادة المستوي

- By keeping developer level in tank
- Adding replenisher once or twice daily

2. Adding according to developed films area

- يضاف ١ جالون / ٤ فيلم او ما يوازي نفس المساحة من الافلام المختلفة
"الجالون = 3.5 : 4.5 L"

3. Adding Developer to resume same level .

- **DONOT ADD WATER AT ANY TIME.**



Developer Expiring Date **فترة صلاحية المظهر**

▶ فترة صلاحية اى مظهر بعد تجهيزة لا تزيد عن شهرين حتى

لو لم يتم استعماله !!!

▶ استخدام المظهر منتهى الصلاحية يؤدي الى عيوب فى الافلام

مثل : الصبغات ، و نقص كفاءة الصورة و الضباب الكيميائى .

”يتم شرحه بالتفصيل فى جزء عيوب الافلام“



Don't ForgetComposition Of Developer

- 1- Reducing Agent
- 2- Restrainer
- 3- Preservative.
- 4- Buffer
- 5- Activator
- 6- Anti Swelling
- 7- Sequestering agent
- 8- Solvent

ما عدا اثناء الاستخدام فقط
يجب ان تظل تنكات المظهر مغطاة



2- Rinsing or Stop Path



► Substance :

- **Water** or
- Water + 1-2% Acetic acid.
- 20% Na metasulphite.

► Role :

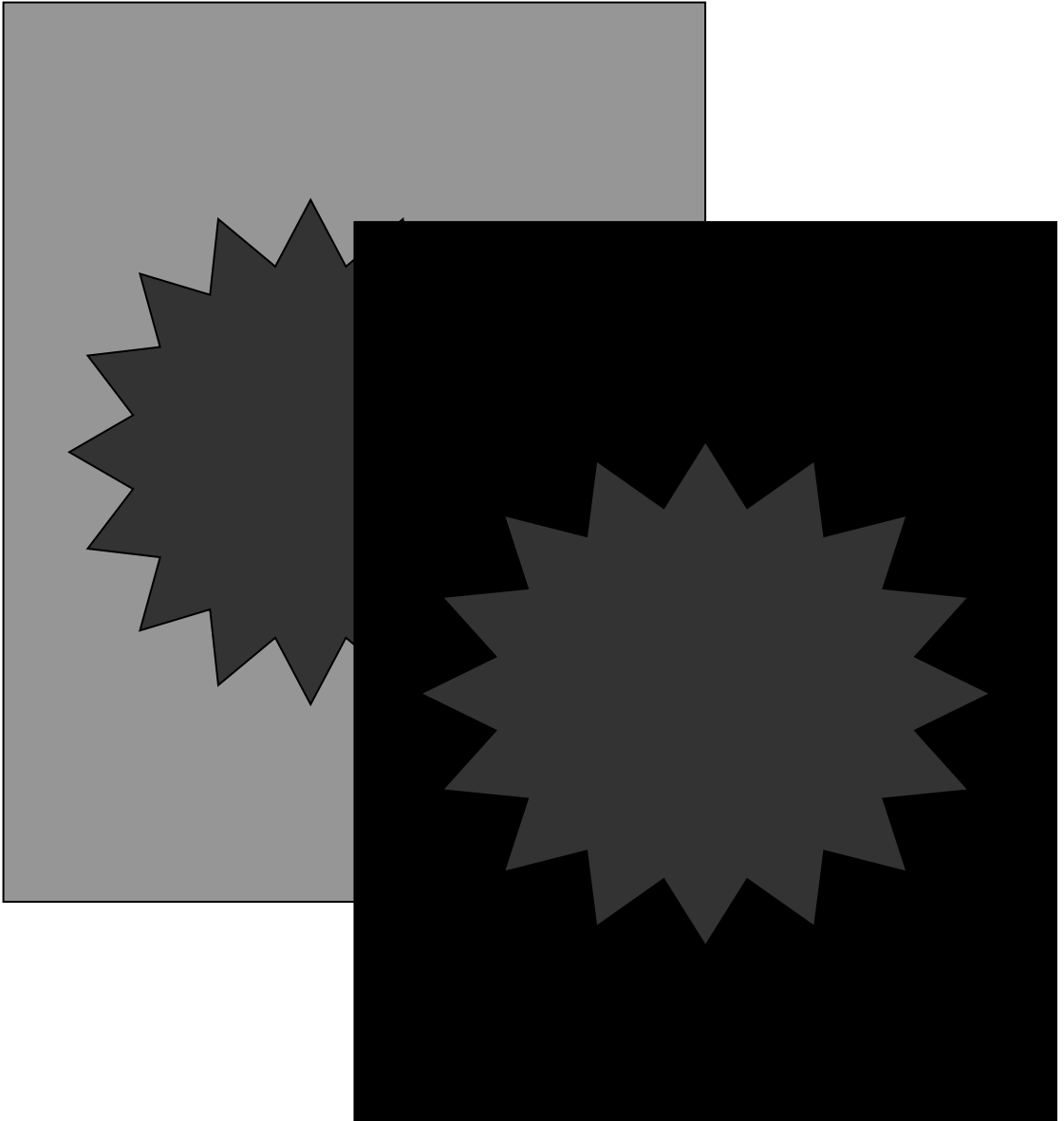
1- Stop Developing Process.

2- Prevent Fixer contamination by Developer.

➔ *In Rinse path, Film left for 15 – 30 sec. with Agitation.*

FIXING

التثبيت



دور المثبت

Role Of Fixing

1. *Prevent further Development.*

١ - إيقاف نشاط المظهر

2. *Remove Unexposed Crystals (Milky appearance → Transparent)*

٢ - إزالة اجزاء المادة الحساسة الغير متعرضة للاشعة

3. *Hardening Gelatinous layer.*

٣ - تقوية المادة الجيلاتينية

4. *Covert Image To Permanent.*

٤ - تحويل الصورة الى صورة ثابتة بشكل نهائى

Fixer Composition

1. Fixing "Cleaning" Agent. عامل تثبيت
2. Acidifier. مادة حمضية
3. Buffer. موازن
4. Preservative , Stabilizer مادة حافظة
5. Solvent مذيب
6. Hardening Agent. عامل تماسك او تصلب

1- FIXING "CLEANING" AGENT.

عامل التثبيت

- **Substance:**

– ثيو كبريتات الصوديوم Na thio-sulphate

– او ثيو كبريتات الامونيوم .

- **Role دوره**

– اذابة املاح بروميد الفضة الغير مختزله "الغير

متعرضه للاشعه" ، تحويله الى ملح ثنائى قابل للذوبان في

الماء ،

– و بازالة تلك الطبقة ، تتحول المناطق الغير متعرضه

للاشعة من اللون الابيض المعتم الى الشفافية .

– So Unexposed areas converted from **Milky** →
Transparent.

المادة الحمضية - 2- ACIDIFIER.

• **Role:**

- Neutralize alkalinity of Developer still on the film. & stop its action . معادلة قلوية المظهر و ايقاف عمله
- Keep Low PH. → Prevent "Dichroic Fog". حفظ حمضية المثبت

• **Substances: "Weak Acids"**

- *Glacial Acetic Acid* or حمض الخليك
- *Sodium or Potassium metasulphite* → *Dual action Acidifier & preservative.*

STRONG Acids not used as it destroy Fixer.

Dichroic Fog



→ Cause: *Developer work with in fixer*

- **Pink** stain ← الفيلم على الفانوس
- **Yellow Green** stain ← لما اشوف الفيلم على ضوء ساقط عليه

المادة الحافظة 3 PRESERVATIVE OR STABILIZER

- **Role:** Prevent decomposition of thiosulphate.
منع تحلل الثيوكبريتات .
- **Substance:** *Na or K metasulphite*
- تحللها يؤدي الى ترسيب الكبريت ، و تحول المثبت الى لون يشبه اللبن.
- Decomposition of thiosulphate → sulphur precipitation → Milky appearance of Fixer.

4- BUFFER الموازن

- **Substance:** Na Acetate + Acetic Acid.
حامض الخليك + خلات الرصاص
- **Role:**
 - Keep low PH ,
 - Neutralize Developer attaché to film.

5- HARDENER مادة زيادة الصلابة

- Alkalis → Softening emulsion.
- **Role:** Prevent further softening, avoid risk of damage.
- **Substance:** Chrome Alum , K Alum مادة الشبه
- **Advantages** Of use good Hardener:
 - 1- Decrease Drying Time.
 - 2- Increase gelatin melting point → increase Drying Temp.
 - * زيادة درجة الحرارة اللازمة لانصهار المادة الجيلاتينية = امكانية استخدام درجات اعلى فى التجفيف
 - 3- Decrease abrasion damage possibilities. * اقلال
امكانية الخدش

6. المذيب SOLVENT

Water is the solvent.

What are the advantages & Disadvantages of Using water as a solvent ?

DONOT FORGET

<i>Composition Of Developer</i>	<i>Composition Of FIXER</i>
1- <u>R</u> educing Agent 2- <u>R</u> estrainer 3- <u>B</u> uffer. 4- <u>P</u> reservative 5- <u>A</u> ctivator 6- <u>A</u> nti Swelling 7- <u>S</u> equestrating agent 8- <u>S</u> olvent	1. Fixing "Cleaning" Agent. 2. <u>A</u> cidifier. 3. <u>B</u> uffer. 4. <u>P</u> reservative , <u>S</u> tabilizer 5. <u>H</u> ardening Agent. 6. <u>S</u> olvent

FIXER PREPARATION

- Water Temp. **Not > 27 c.** → avoid speed Fixer destruction.
- Fixer in 2 forms :
 - *Powder Single Pack.*
 - *Conc. Liquid. "2 sections"*

FIXING TIME الوقت اللازم للتثبيت

Fixing Time is related to :

1. Composition: التركيب

ثيوكابريتات الامونيوم اسرع من ثيوكابريتات الصوديوم

2. Temperature: درجة الحرارة

كلما ارتفعت حرارته، قلت مدة التثبيت (٢٠ درجة / ١٥ دقيقة) -

- يجب الا يزيد فارق درجة حرارة المظهر عن ٥ درجات، لتجنب تدمير الطبقة الجيلاتينية

3. Mix of Fixer : تقليب المثبت

- اسراع ذوبان الاملاح الثنائية . ← تقليب الفيلم داخل المثبت

4. Concentration: درجة التركيز : مزيد من الاستخدام = زمن

اطول للتثبيت

2. افلام اكبر ، عوامل اكثر "او بدون الواح **Film Type نوع الفيلم** :
مقوية" = زمن تثبيت اكبر .

FIXER EXPIRE Date

Causes of Fixer Exhaustion :

More fixed films are lead to :

- 1- Decrease concentration of fixing agent
- 2- Topping up by added water from film after washing
- 3- Increase precipitated silver

IN HOT Climates

Fixer is changed double times changing of Developer

في الاجواء الحارة يتم تغيير المثبت ،

ضعف عدد مرات تغيير المظهر

FINAL WASHING

- Final Washing Tank , is double volume of Fixer Tank
- Should contain running water
- Water enter the tank from its lower aspect & passed out from its upper aspect
- Final washing should be for enough time to avoid salt precipitation **on the film.**

FILM DRYING



Types of Film Drying

- 1- Natural تجفيف طبيعي
- 2- Chemical تجفيف كيميائي
- 3- Hot Air الهواء الساخن
- 4- Roller Drying الملف الاسطوانى

1- Natural Drying التجفيف الطبيعي

- just hanging.
- Avoid Dust
- Avoid Sun
- Drying time Depend on :
 - Room Temp درجة حرارة الغرفة
 - Humidity الرطوبة
 - Air volume
 - use of hardener in fixer.



2- *Chemical* تجفيف كيميائي

- 2 minutes in 70% *ethyl alcohol*. Then electric or free air draying.
- Not Routinely used, as it may attack film base.
- Used in urgent need to rapid draying.



3- Hot Air or Electric Dryer الهواء الساخن



4- Roller Drying

- **Role :** Squeeze → remove excess water.
+ Strong air current 40 C.



CHAPTER 6

AUTOMATIC PROCESSING

Automatic Processing Steps

Developing – Fixing – Wash

No Rinsing

الفارق فى الخطوات عن التحميص اليدوى : لا يوجد نقع بعد المظهر.

Automatic Processing Machines

١- Frames Machine (old type)

2- Roller Machin

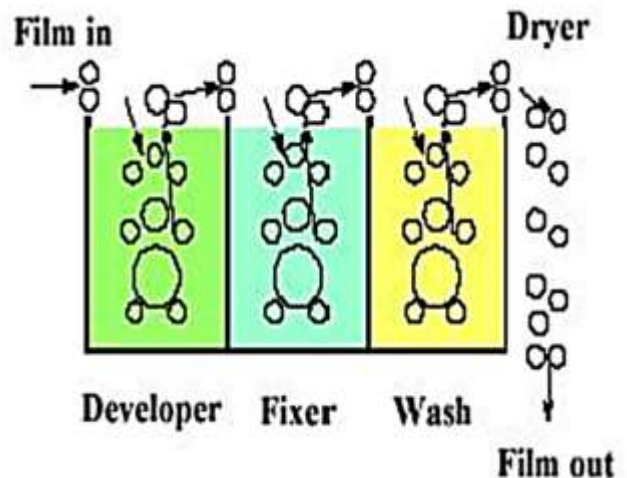
According to Machine size:

1- Large Machines :

- 1 cycle/ 90 sec
- 150 film / H

2- Small Machines

- 1 cycle/ 3-4 min
- 60 film / H



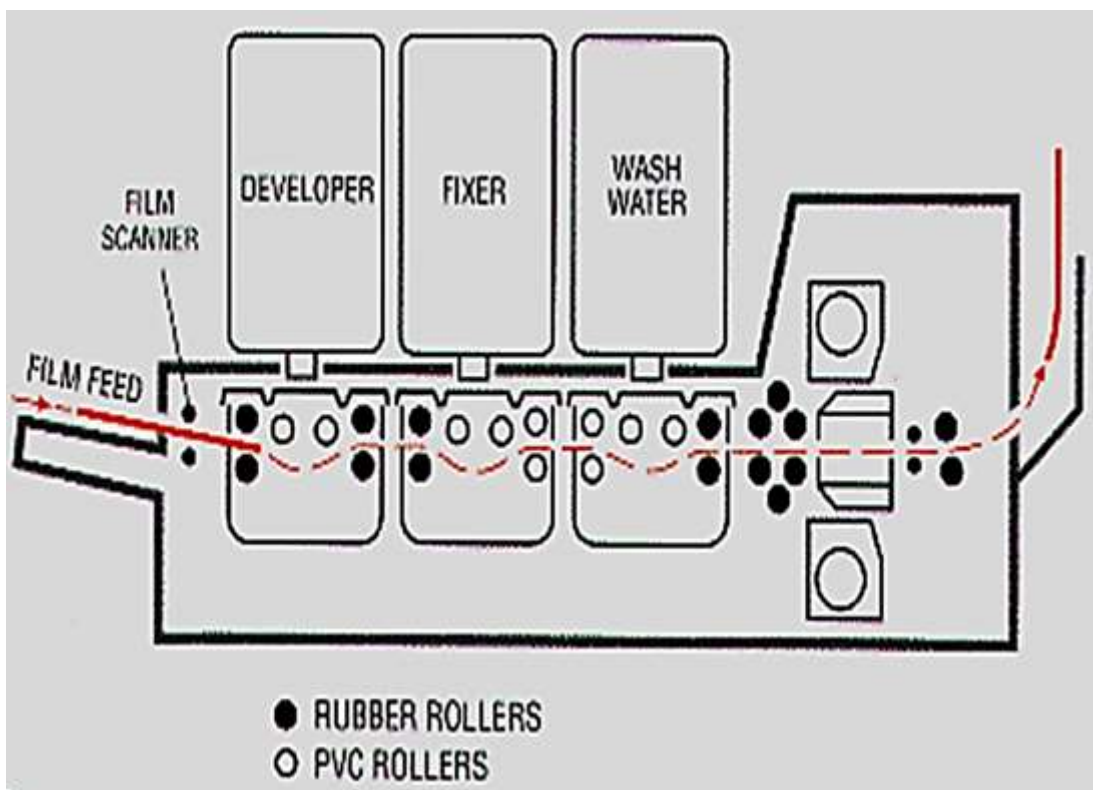
Film Rolling systems (3 Types)

- Slow 1 cycle/7 m
- Fast : 3-4 min
- Super fast : 60 : 90 sec

Automatic Processing Machine

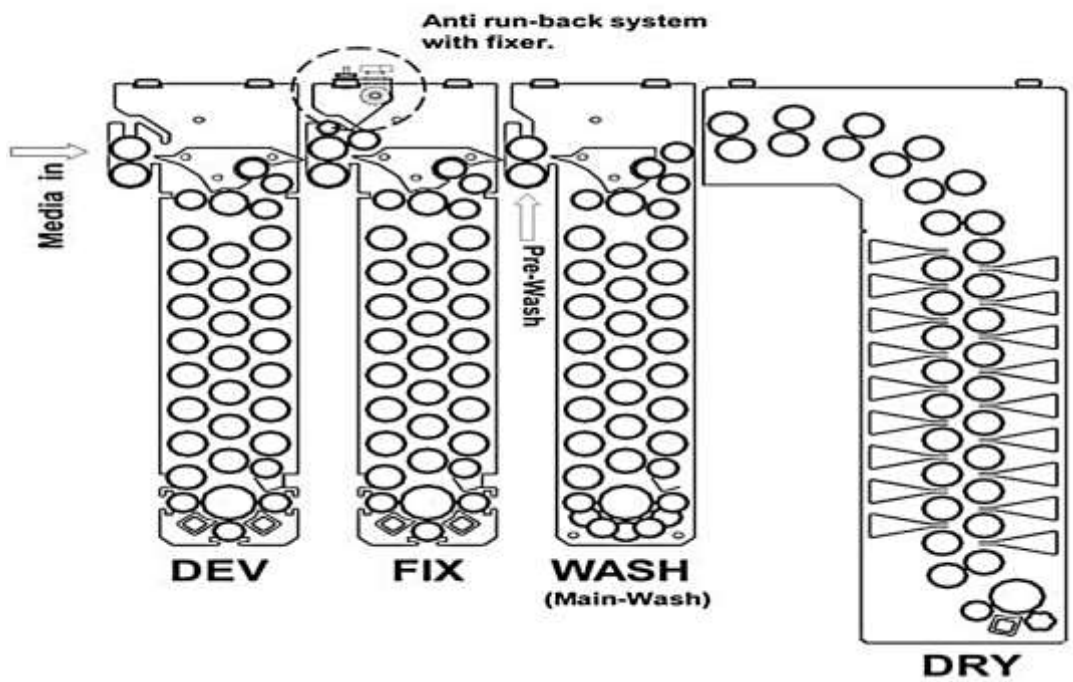
Main Components:

1. **نظام نقل** : لنقل الفيلم بين مراحل Transmission System
2. Thermostat
3. Replenishment System
4. **Water Cycle**
5. **Host air source**
6. **Tanks : Developer, Fixer & washing**





**TRANSPORT SYSTEM
COLENTA INDX 45/55**



Differences of Automatic Processing :

1- Developer :

- *Higher concentration than manual developer*
- *Replenishment by the same material*
- *Can be used in Higher temperature*

2- Fixer :

- *More hardener material*
- *Replenishment by the same material*
- *Fixer material is Amonia , Not Sodium Thiosulfate*

Advantages of Automatic Processing

1- Technical Advantages: مميزات تقنية

- Fixed processing factors for all films (But cannot correct factors variability).

2- Economical مميزات إقتصادية Advantages

- *Smaller Dark Room*
- *No need for manual processing equipment*
- *A smaller number of technicians.*
- *Less waiting time for patients.*
- *Avoid faults of manual processing → of less-repeated films → , More tube age*

Disadvantages of Automatic Processing

- *High Price*
- *More consuming Acids*
- *Manual Processing should be present beside it for emergencies.*
- *Cannot manage factors faults*

CHAPTER 7

SILVER RECOVERY

SILVER & Sensitive Films

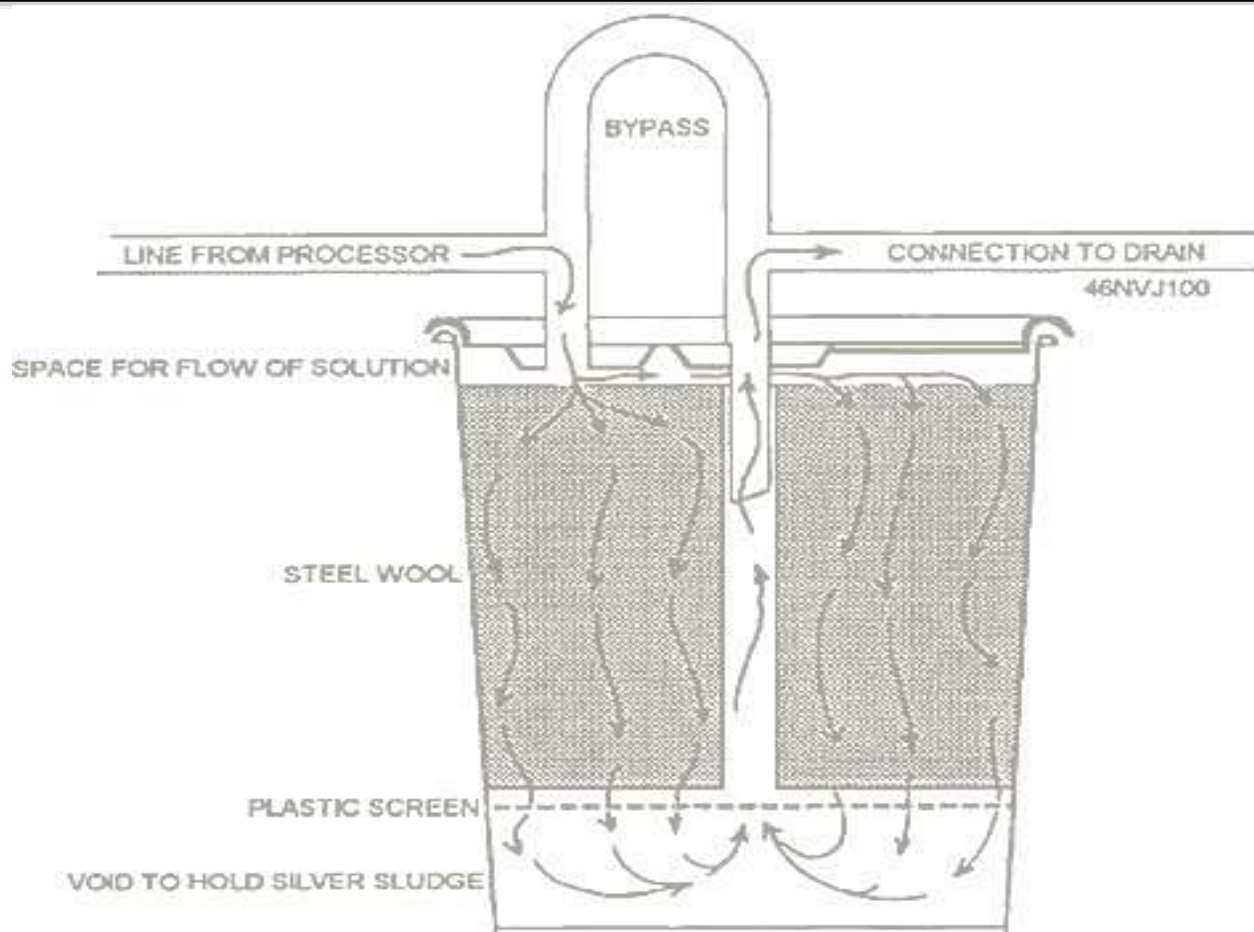
- Silver is a rare material
- 1/3 Silver in films are used in forming images.
- 2/3 solved in fixer
- 6-8 gm of silver can be extracted from fixer.

Advantages of Silver Recovery :

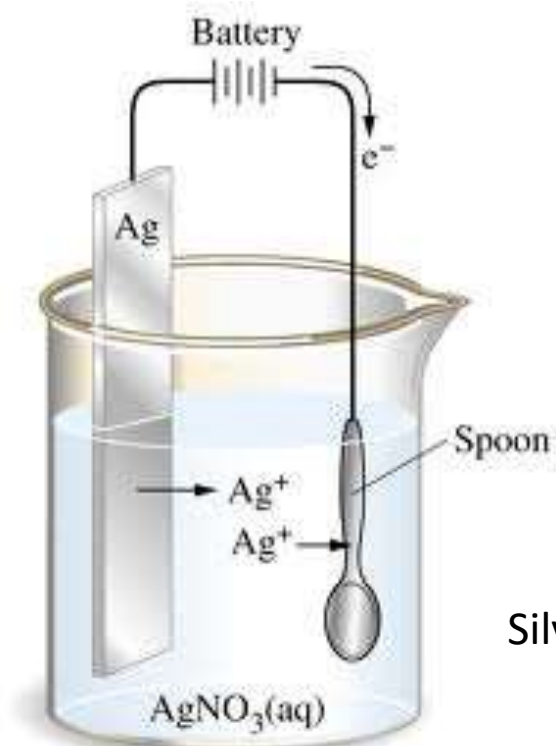
1. Keeping Silver
2. Decrease Pollution
3. Economic Value
4. Improve Fixer Functions : In Electrolytic Recovery

Methods of Silver Recovery :

1. الترسيب الكيميائي Chemical precipitation
2. الاحلال المعدني Metallic Replacement
3. التحليل الكهربائي Electrolytic Recovery



Silver Metallic Replacement



Silver Electrolytic Recovery

CHAPTER 8

DARK ROOM PITFALLS

Recognize common x- ray error
& How to solve it

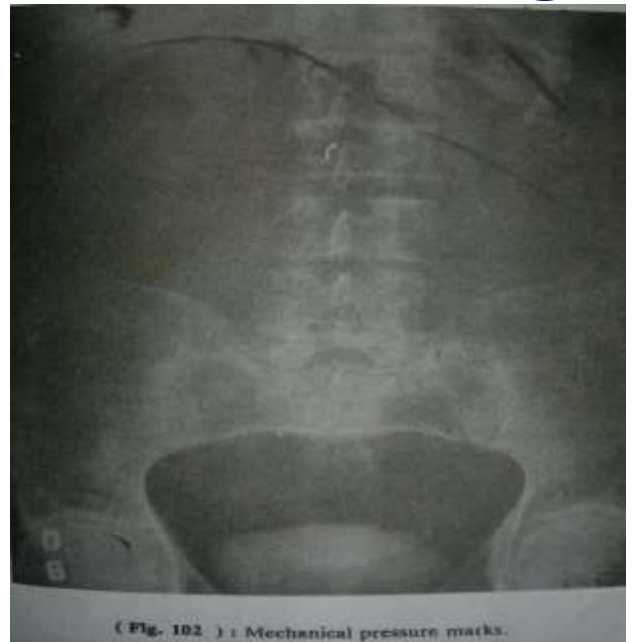
X-Ray Film Pitfalls

- 1- Before
- 2- During
- 3- After Processing “inadequate wash”

1. -Pitfalls Before Processing

• 1- Films Storage Pitfalls

Exposure to heat m radiation ,
light , boxes over each others



2- Cassettes & screens pitfalls

- Casette non complete closure → Black patches.
- Intens. screens contamination → Non exposure below it → white dots .



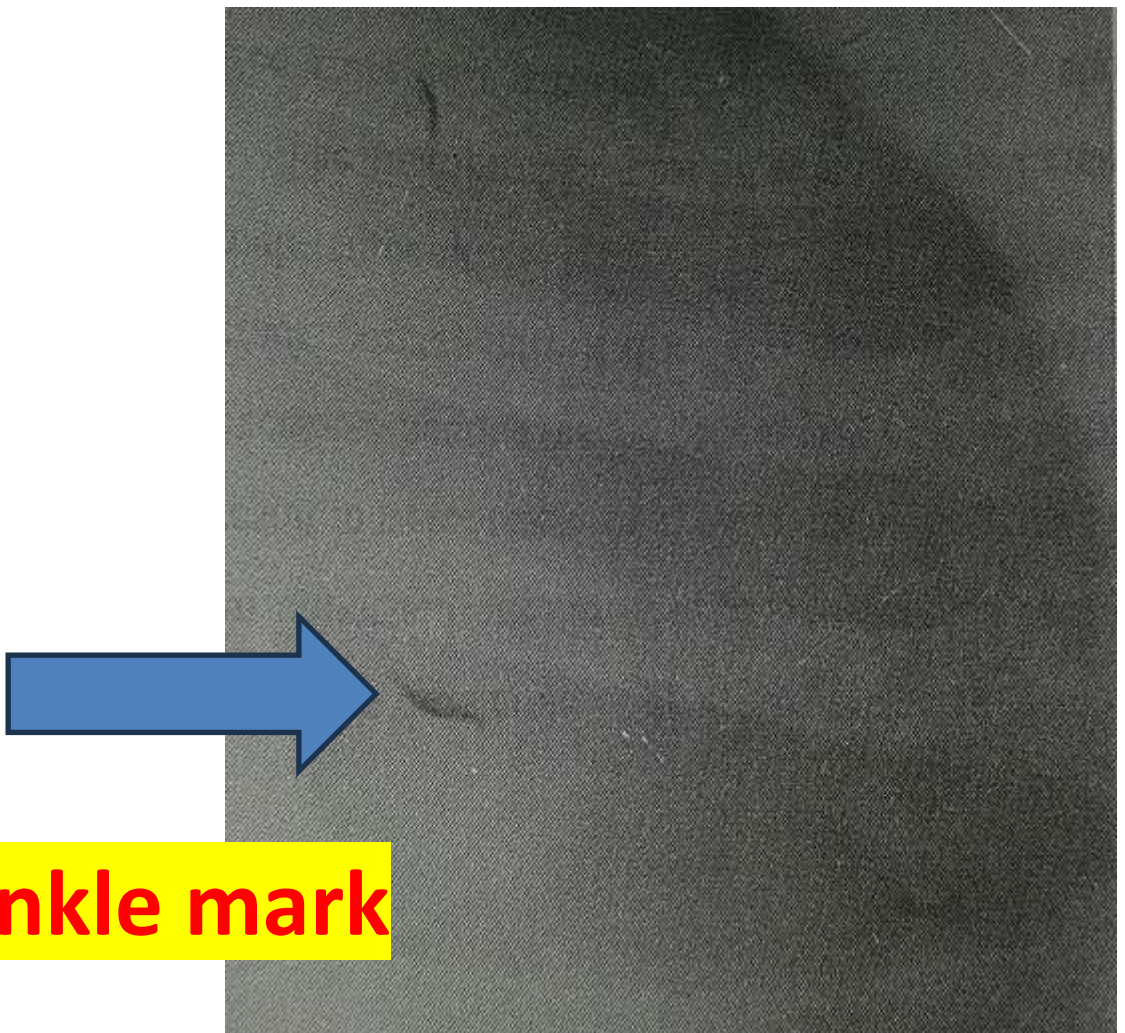
3- Film Handling Pitfalls

Crinkle Mark

ثنى الفيلم = تجعيده او ثنية

Importance of Crinkle mark ?

- Can be Misdiagnosed as fracture if occurred on a cortical bone



Electrostatic Marks

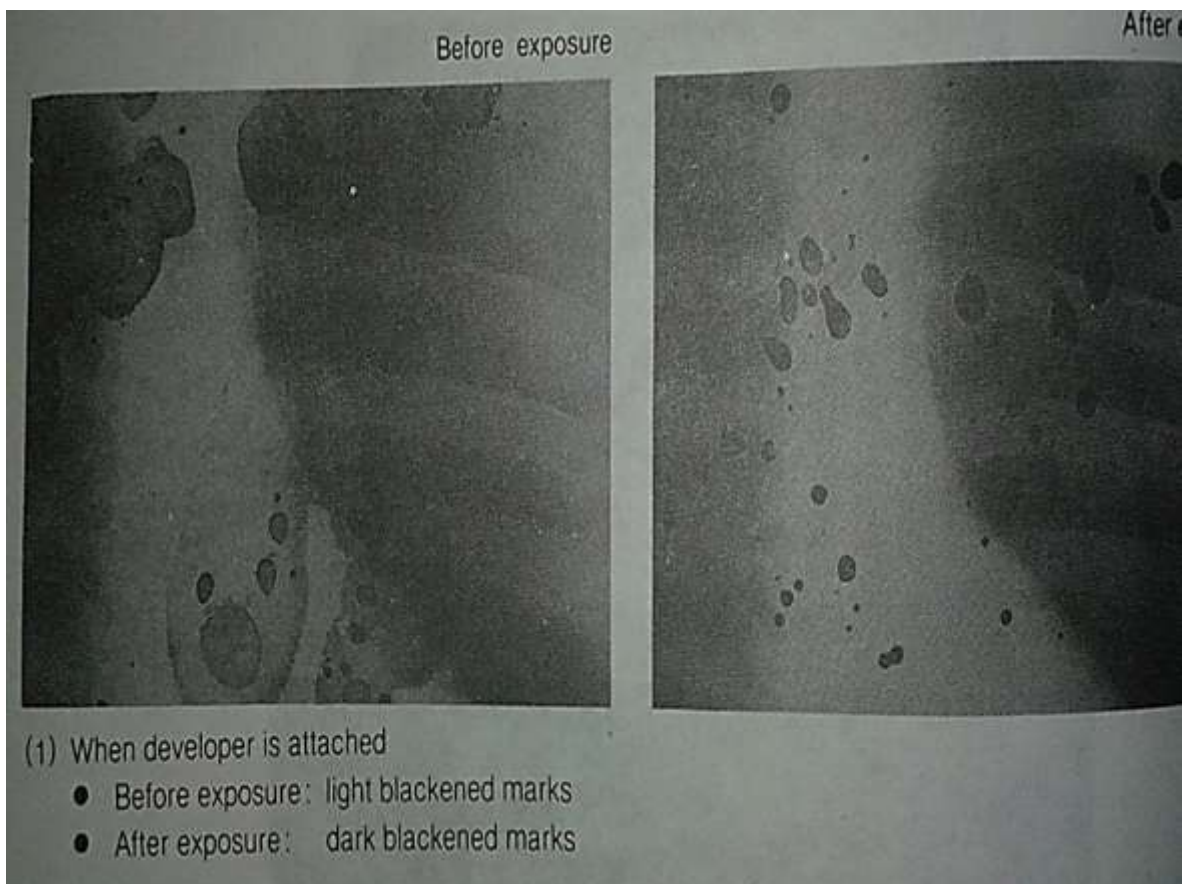
(Static Dot – Brush – Tree)

Due to rapid film handling



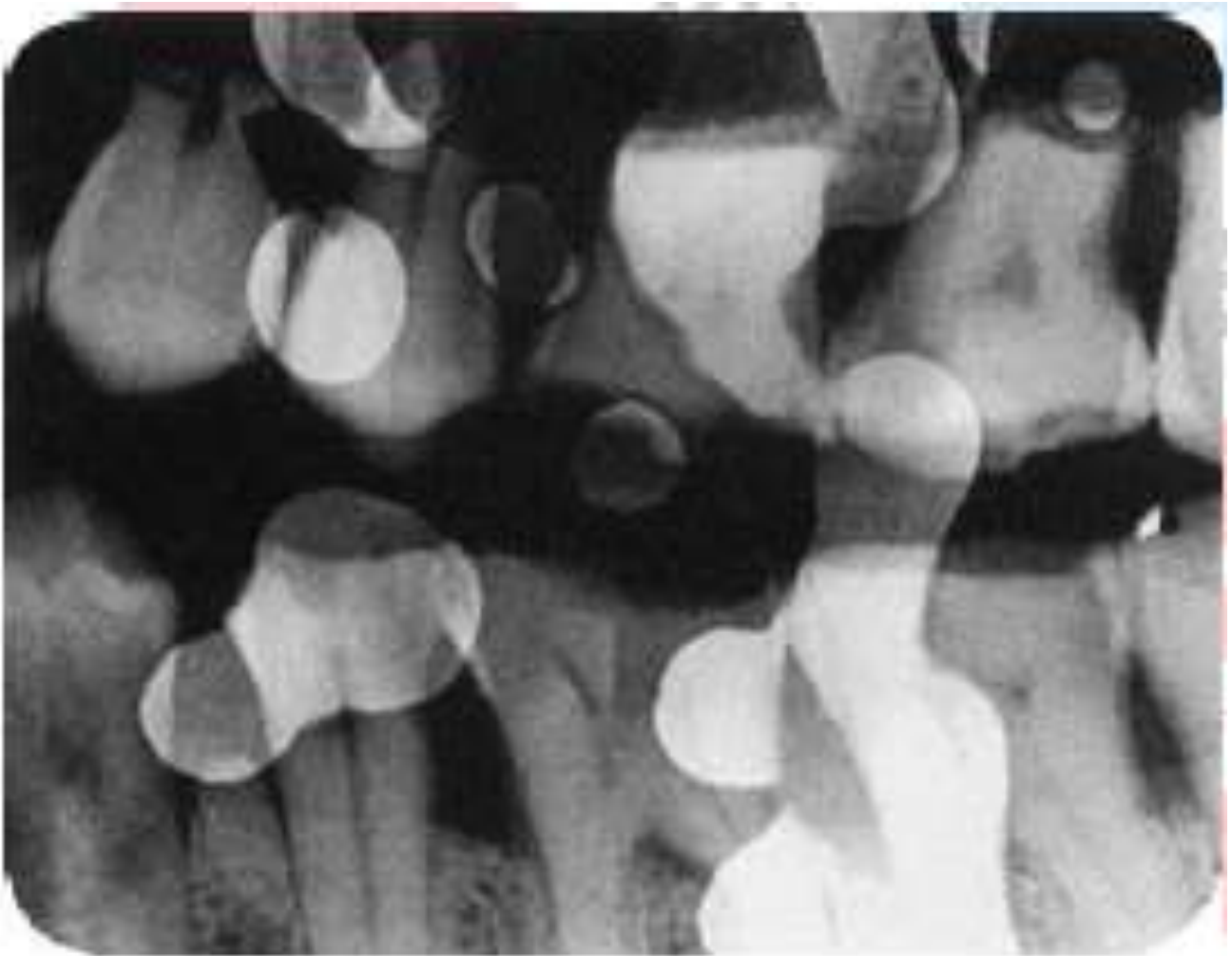
2 Pitfalls during Processing

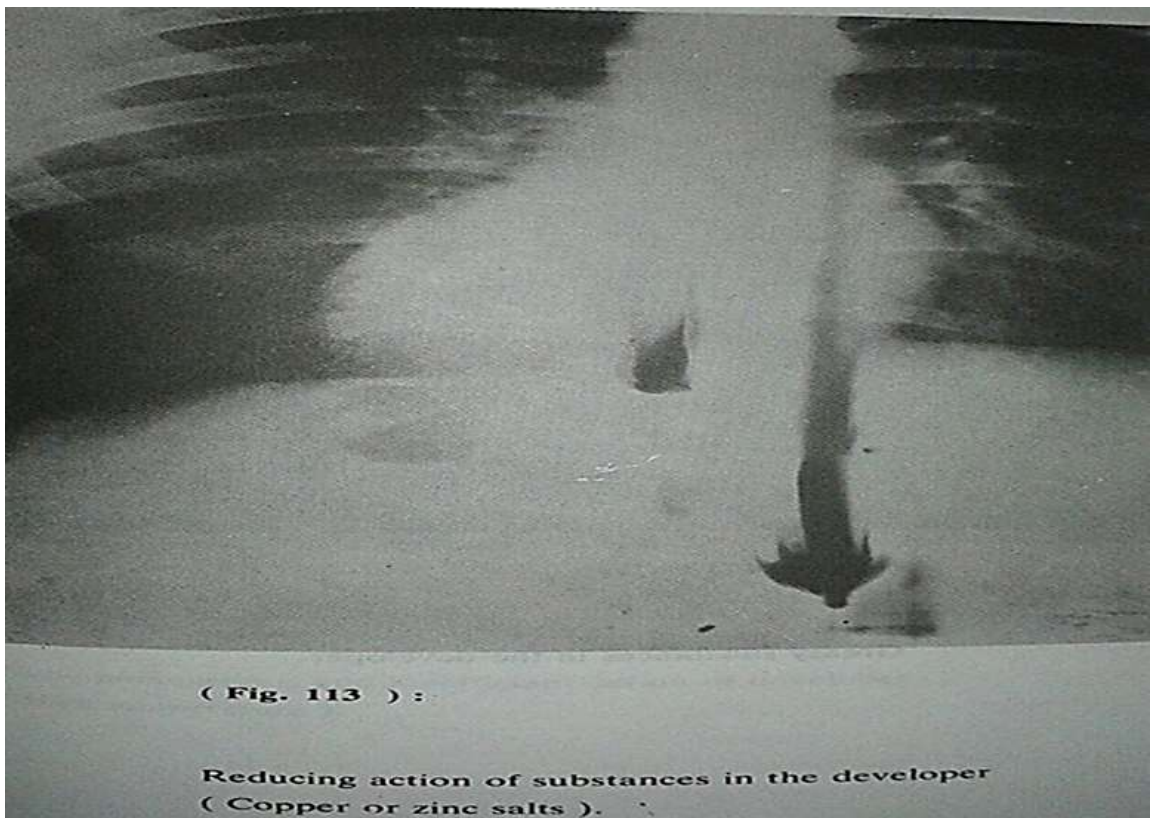
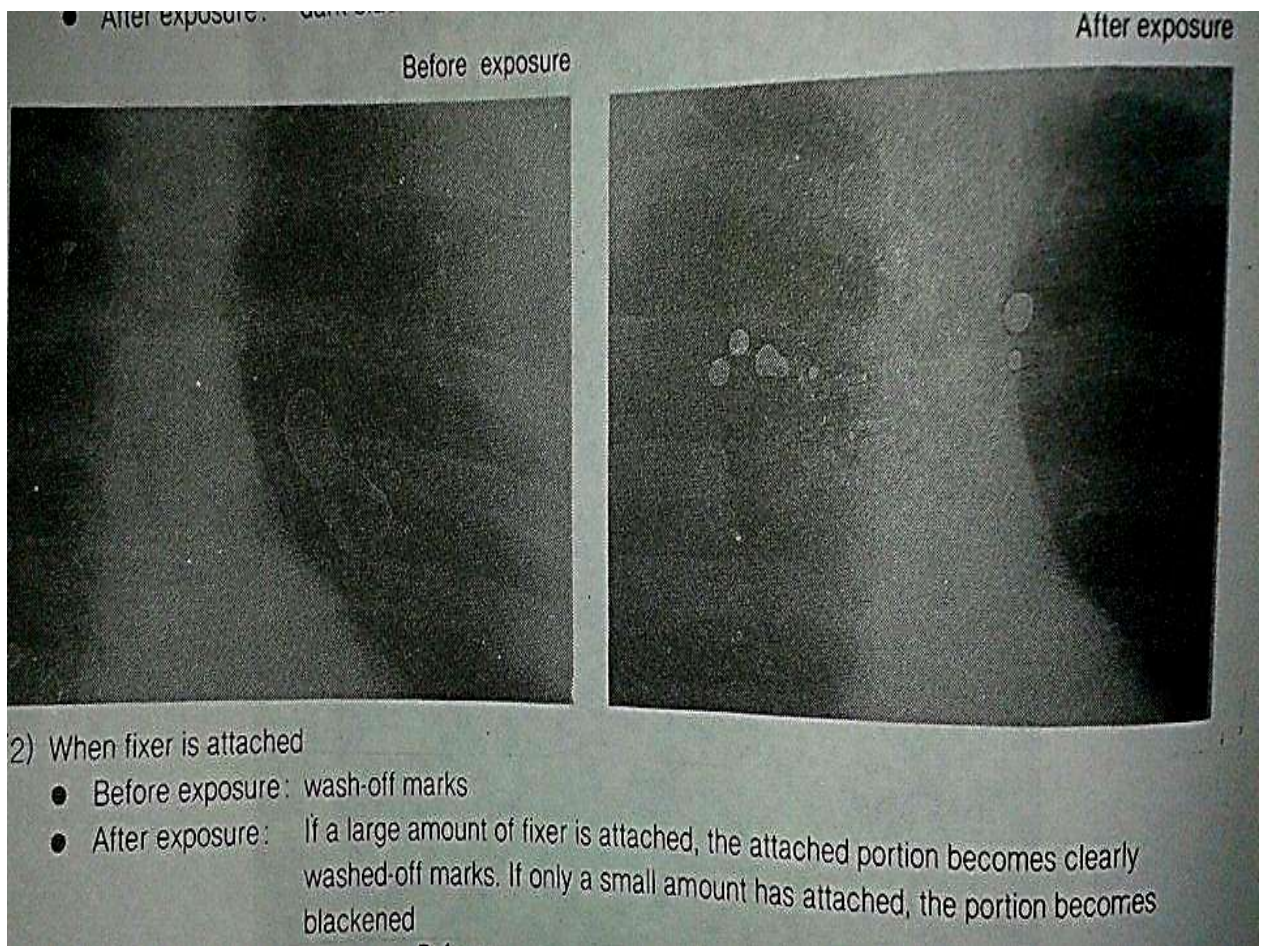
- 1- Non agitation **Air Bell Mark**)
- 2- Low temp. of Acids
- 3- Film Contamination (By Developer or Fixer)
- 3- High temperature



Contamination of film with Fixer

- The fall of a **lot of fixer** solution on the film before processing.





Dichroic Fog

Why?

Faults From Automatic Processing

- 1- Roller Marks
- 2- Jamming of Film
- 3- Insufficient Draying

1- Roller Marks :

- Fine dark lines parallel to rollers

This may due to :

- Roller surface irregularities
- Foreign matters

2- Jamming of Film

- When insert more than one film at same time
- or Film Twisting inside roller system

3- Insufficient Draying

- Low drying temperature
- Processing many large films after each others

CHAPTER 9

BASICS OF PACS & DIGITAL IMAGING

See Your Lectures



و اخيرا.....

تعليمات للعمل فى الغرفة المظلمة

HINTS FOR GOOD PRACTICE

الوصايا العشر "افعل و لا تفعل"

١. لا تستخدم يد مبلة في التعامل مع الكاستات و الافلام
٢. لا تنسى اغلاق علبة الافلام فور ا بعد الاستخدام
٣. لا تعادل اخطاء التصوير بالتحميض ، و لكن راجع عواملك
٤. لا تعلق افلام على الاطارات اكثر مما يستوعب المظهر
٥. لا تضع افلام اكثر مما يجب في التانك الواحد
٦. لا تترك الكاستات مفتوحة على طاولة التحميض
٧. لا تخزن علب الافلام في شكل افقى
٨. لا تطل فترة ابقاء الافلام في الاحماض اكثر مما ينبغي
٩. لا تنسى تعويض و تجديد الفاقد في الاحماض
١٠.(اضف ملاحظات) !!??? ...

SOURCES & FURTHER READING :

- **Dark Room** – Prof Dr. Nabeel Khattar
- **Dark Room** – MOH Institute –

PROFF. DR. AHMED FARID YOUSIF

- <https://radiopaedia.org/articles/x-ray-film>
- <https://www.nde-ed.org/NDETechniques/Radiography/EquipmentMaterials/isotopesources.xhtml>
- www.youtube.com/watch?v=npFqqH4gP7o&t=11s
- <https://www.radiation-physics.com/>
- Video Lecture – Dr. Ahmad Mokhtar Abodahab – 20216
- https://staffsites.sohag-univ.edu.eg/ahmed_abodahab

About The Author

Dr. Ahmad Mokhtar Abodahab



- **“MBBCH” Faculty of Medicine, Sohag University, Egypt (2004).**
- **Master’s “MSc” in Diagnostic Radiology - Sohag Faculty of Medicine (2011).**
- **Doctorate “MD, PhD” in Diagnostic Radiology - Sohag Faculty of Medicine (2021).**
- **Diploma of Total Quality Management – Sadat Academy of Management Sciences (2021).**
- **Diploma of Hospitals Management – Sadat Academy of Management Sciences (2024).**
- **Lecturer & Consultant of Diagnostic Radiology, Faculty of Medicine, Sohag University.**
- **Vice Manager of the New Sohag University Hospital (Emergency) for Information Systems (formerly).**
- **Certified trainer at the Supreme Council of Egyptian Universities.**
- **Trainer at Sohag University (for digital transformation and TOT).**
- **Supervisor of the University Clinics (Urban Center) (formerly).**
- **Lecturer at the Saudi Virtual Medical Academy, KSA (VMA).**
- **Worked in several medical centers and Hospitals inside and outside Egypt (as a Radiologist, Consultant, and Medical director).**
- **Trainer and Administrator of PACS & Teleradiology systems.**
- **Volunteer for several years with civil society organizations (73 Historians’) & (QELADA “Necklace”).**
- **More than 40 articles and stories about Egyptian and historical heroism.**
- **more than 150 lectures at teaching, conferences, seminars, and scientific meetings, and YouTube.** [Dr. AHMAD MOKHTAR ABODAHAB – YouTube](#)
 - **More than 33 published research papers in different scientific journals in the fields of *diagnostic radiology, teaching techniques, medical education, and management.***