

**CERTIFICATE IN DENTAL RADIOGRAPHY**

STEPHEN BRIGGS BDS BSC (HONS) RADIOGRAPHY

DAY 3  
SAT 18<sup>TH</sup> OCTOBER 2025

**RADIATION PHYSICS**

**AIM**

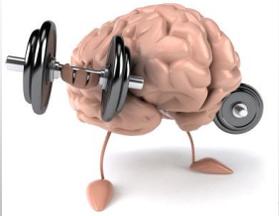
- TO PROVIDE DENTAL NURSES WITH A FOUNDATIONAL UNDERSTANDING OF THE PHYSICAL PRINCIPLES OF RADIATION AND ITS APPLICATION IN DENTAL RADIOGRAPHY, ENSURING SAFE AND EFFECTIVE USE OF IONISING RADIATION

**LEARNING OBJECTIVES**

- DESCRIBE THE ELECTROMAGNETIC SPECTRUM AND ATOMIC STRUCTURE
- EXPLAIN THE PRODUCTION AND PROPERTIES OF X-RAYS
- UNDERSTAND ATTENUATION, SCATTERING AND ABSORPTION OF RADIATION
- DISCUSS BIOLOGICAL EFFECTS AND RISKS/BENEFITS OF RADIATION EXPOSURE
- APPLY PRINCIPLES OF DOSE OPTIMISATION AND DOSIMETRY
- COMMUNICATE RADIATION RISK EFFECTIVELY TO PATIENTS

**"RADI-KNOWLEDGE-Y"**

- WARM UP YOUR



**QUESTIONS**

1. WHO DISCOVERED X-RAYS AND IN WHAT YEAR?
2. DO ELECTRONS PASS FROM CATHODE TO ANODE, OR ANODE TO CATHODE?
3. FROM WHAT MATERIAL ARE THE ANODE AND CATHODE NORMALLY MADE?
4. HOW MUCH OF THE ENERGY CREATED BY AN X-RAY TUBE ACTUALLY RESULTS IN X-RAYS?
5. HAVE THEY GOT A LONG OR SHORT WAVELENGTH?
6. HAVE THEY GOT A HIGH OR LOW ENERGY?
7. HOW IS THE HEAT DISSIPATED AWAY FROM THE TUBE?
8. WHAT DO THE RADIOGRAPHIC TERMS KV AND MA STAND FOR?
9. WHAT ARE THE 2 TYPES OF DIGITAL IMAGE RECEPTOR?
10. WHAT DOES AN X-RAY UNIT AND A BANANA HAVE IN COMMON?

### ANSWERS

1. WILHELM ROENTGEN 1895
2. CATHODE TO ANODE
3. TUNGSTEN
4. 1%
5. SHORT WAVELENGTH
6. HIGH ENERGY
7. COPPER BLOCK AND OIL
8. KILOVOLTAGE AND MILLIAMPERAGE
9. PSP (PHOSPHOSTIMULABLE PLATES) AND CCD (CHARGE COUPLED DEVICE)
10. BOTH GIVE YOU A RADIATION DOSE

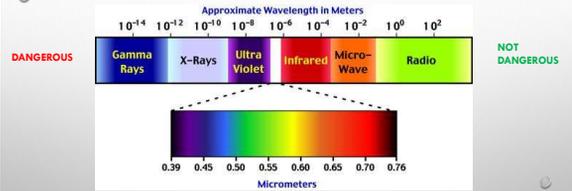
### INVENTION OF X-RAYS

- DISCOVERED BY WILHELM ROENTGEN 1895
- CALLED THEM X-RAYS BECAUSE THEIR NATURE WAS THEN UNKNOWN
- HIGH ENERGY ELECTROMAGNETIC RADIATION
- X-RAYS – MADE UP OF WAVE PACKETS
- EACH WAVE PACKET = PHOTON = ONE QUANTUM OF ENERGY
- X-RAY BEAM = MILLIONS OF INDIVIDUAL PHOTONS

### ELECTROMAGNETIC SPECTRUM

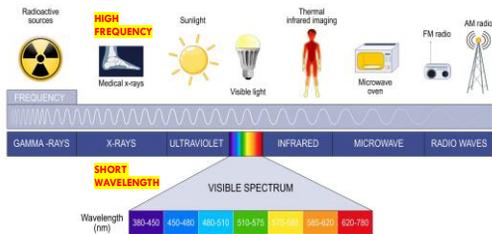
- FULL RANGE OF ELECTROMAGNETIC RADIATION
- ORGANISED BY FREQUENCY OR WAVELENGTH
- IS DIVIDED UP INTO DIFFERENT BANDS, WITH DIFFERENT NAMES FOR THE WAVES WITHIN EACH BAND (RADIO WAVES, X-RAYS ETC)
- THE ELECTROMAGNETIC WAVES IN EACH OF THE BANDS HAVE DIFFERENT CHARACTERISTICS
  - HOW THEY ARE PRODUCED
  - HOW THEY INTERACT WITH MATTER
  - PRACTICAL APPLICATIONS

### EM SPECTRUM



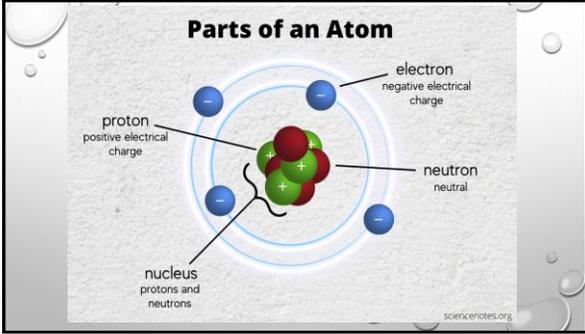
X-rays are "packets" of energy known as photons, which are short wavelength, high frequency radiation

### Electromagnetic spectrum



### ATOMIC STRUCTURE

- ATOMS = BUILDING BLOCKS OF MATTER
- MADE UP OF FUNDAMENTAL OR ELEMENTARY PARTICLES
- PARTICLES HELD TOGETHER BY ELECTRIC OR NUCLEAR FORCES
- CENTRAL DENSE NUCLEUS = PROTONS AND NEUTRONS
- SHELLS/ORBITS AROUND NUCLEUS = ELECTRONS



- ### DEFINITIONS
- **ATOMIC NUMBER (Z) = NUMBER OF PROTONS IN NUCLEUS**
  - **NEUTRON NUMBER (N) = NUMBER OF NEUTRONS IN NUCLEUS**
  - **ATOMIC MASS NUMBER (A) = SUM OF PROTONS + NEUTRONS (Z + N)**
  - **ISOTOPES = ATOMS WITH THE SAME ATOMIC NUMBER BUT DIFFERENT ATOMIC MASS NUMBER (THEREFORE DIFFERENT NUMBER OF NEUTRONS)**
  - **RADIOISOTOPES = ISOTOPES WITH UNSTABLE NUCLEI, WHICH UNDERGO RADIOACTIVE DISINTEGRATION**

### PERIODIC TABLE OF THE ELEMENTS

	LOCATION	MASS	CHARGE
PROTONS	NUCLEUS	$1.66 \times 10^{-27}$ kg	POSITIVE
NEUTRONS	NUCLEUS	$1.70 \times 10^{-27}$ kg	NEUTRAL (NIL)
ELECTRONS	ORBITING NUCLEUS	1/1840 MASS OF PROTON	NEGATIVE

- ### NEUTRONS
- CONTAINED WITHIN NUCLEUS
  - **"BINDING AGENTS"**
  - OTHERWISE PROTONS WOULD REPEL EACH OTHER
  - NUCLEUS WOULD NOT HOLD TOGETHER WITHOUT NEUTRONS

- ### ELECTRONS
- MOVE IN CIRCULAR OR ELLIPTICAL ORBITS/SHELLS AROUND NUCLEUS
  - ELECTRONS CAN MOVE BETWEEN SHELLS
  - CANNOT EXIST OUTSIDE SHELLS = **FORBIDDEN ZONE**
  - SHELLS HAVE DIFFERENT ENERGY LEVELS (K, L, M, N, O)
  - OUTER SHELLS HAVE MORE ENERGY
  - EACH SHELL CAN HAVE A MAX NUMBER OF ELECTRONS (IN BRACKETS)
  - MOVING OUT FROM THE NUCLEUS
    - K (MAX 2)
    - L (MAX 8)
    - M (MAX 18)
    - N (MAX 32)
    - O (MAX 50)
  - TO REMOVE AN ELECTRON FROM THE ATOM, **ADDITIONAL ENERGY** REQUIRED TO OVERCOME **BINDING ENERGY** OF ATTRACTION (KEEPS THEM IN THEIR SHELLS)

## SUMMARY OF ATOMIC STRUCTURE

- **PROTONS = ELECTRONS** (NEUTRAL ATOM)
- GENERALLY ATOMS ARE THEREFORE **NEUTRAL** (POSITIVE PROTONS CANCEL OUT NEGATIVE ELECTRONS) = **GROUND STATE**
- NUMBER OF ELECTRONS (SAME AS ATOMIC NUMBER Z) → DETERMINES CHEMICAL BEHAVIOUR
- PERIODIC TABLE
  - EACH ELEMENT HAS A DIFFERENT ATOMIC NUMBER
  - EACH ELEMENT THEREFORE HAS DIFFERENT CHEMICAL PROPERTIES

## PROCESSES

- **IONISATION**
  - REMOVAL OF AN ELECTRON
  - ATOM BECOMES POSITIVELY CHARGED (POSITIVE ION)
- **EXCITATION**
  - ELECTRON DISPLACED FROM INNER SHELL TO AN OUTER ONE (HIGHER ENERGY)
  - ATOM REMAINS NEUTRAL
  - BUT **EXCITED STATE**

Unit of energy in atomic system = **electron volt** ( $1\text{eV} = 1.6 \times 10^{-19}$  joules)

**X-RAY PRODUCTION**

- HIGH SPEED ELECTRONS BOMBARD A TARGET MATERIAL
- ELECTRONS BROUGHT SUDDENLY TO **REST**
- HAPPENS WITHIN A SMALL EVACUATED GLASS ENVELOPE = X-RAY TUBE

**FAST MOVING ELECTRONS**

## ELECTRONS SUDDENLY BROUGHT TO REST

**LOSES  
ALL ITS  
ENERGY**

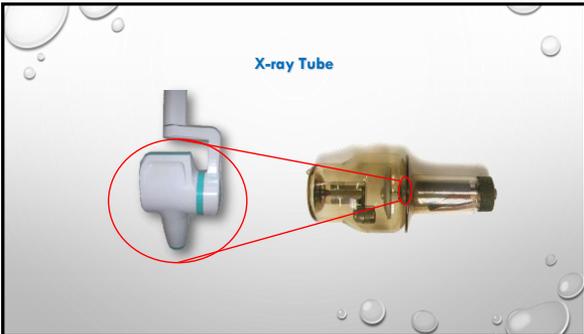
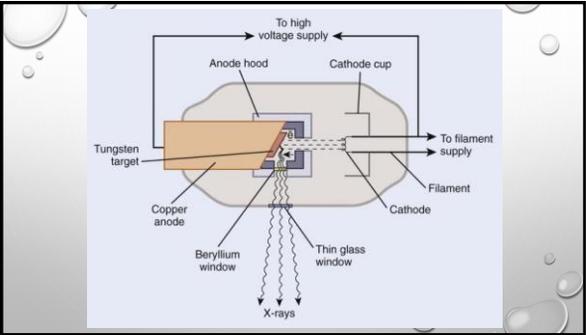
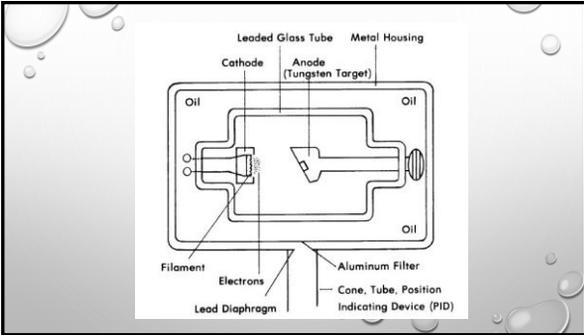
**LAW OF CONSERVATION OF ENERGY**

- **ENERGY CANNOT BE CREATED OR DESTROYED**
- **IT CAN BE TRANSFORMED FROM ONE FORM INTO ANOTHER, BUT THE TOTAL AMOUNT OF ENERGY NEVER CHANGES**

### X-RAY TUBE FEATURES

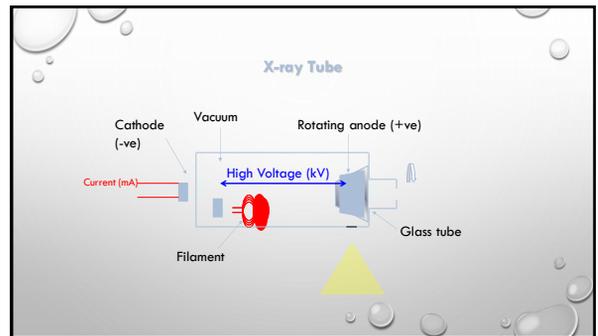
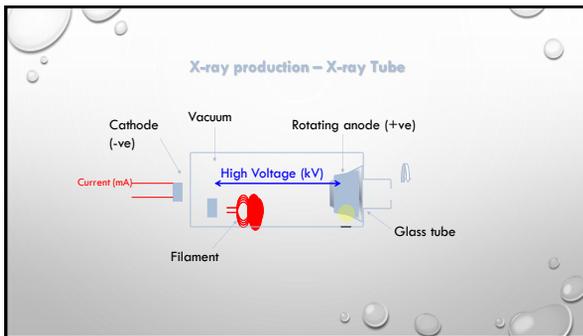
- **CATHODE (NEGATIVE)**
  - HEATED TUNGSTEN FILAMENT
  - SOURCE OF ELECTRONS
  
- **ANODE (+)**
  - SMALL TUNGSTEN TARGET
  - SET INTO THE ANGLED FACE OF A LARGE COPPER BLOCK (COPPER REMOVES HEAT)
  
- **FOCUSING DEVICE**
  - AIMS THE STREAM OF ELECTRONS AT THE FOCAL SPOT ON THE TARGET (ANODE)
  
- **HIGH VOLTAGE (KV)**
  - ACCELERATES THE ELECTRONS FROM THE NEGATIVE CATHODE TO THE POSITIVE ANODE

- **CURRENT (MA)**
  - CATHODE TO ANODE ALSO
  - MEASURES QUANTITY OF ELECTRONS BEING ACCELERATED
  
- **LEAD CASING**
  - ABSORBS UNWANTED X-RAYS
  - THEY ARE EMITTED IN ALL DIRECTIONS (BUT ONLY ONES HITTING ANODE ARE NEEDED)
  
- **OIL**
  - ABSORBS/DISSIPATES HEAT



### PRODUCTION OF X-RAYS

- (1) FILAMENT ELECTRICALLY HEATED = CLOUD OF ELECTRONS AROUND FILAMENT
- (2) HIGH KV ACROSS TUBE (- TO +) = ELECTRONS ACCELERATED TOWARDS ANODE
- (3) FOCUSING DEVICE = AIMS ELECTRONS AT TARGET
- (4) ELECTRONS BOMBARD TARGET → ELECTRONS BROUGHT SUDDENLY TO REST
- (5) ENERGY LOST BY ELECTRONS AS THEY ARE HALTED → 99% HEAT AND 1% X-RAYS
- (6) COPPER BLOCK AND OIL = REMOVE HEAT PRODUCED
- (7) X-RAYS PRODUCED IN ALL DIRECTIONS
- (8) SOME FOCUSED ON SMALL WINDOW IN LEAD CASING = **DIAGNOSTIC X-RAY BEAM**



### ATOMIC LEVEL INTERACTIONS

- HIGH SPEED ELECTRONS BOMBARD TUNGSTEN ATOMS IN TARGET (ANODE)
- ELECTRONS COLLIDE WITH THE ELECTRONS IN THE TUNGSTEN ATOMS
- 2 TYPES OF COLLISION
  - HEAT PRODUCING COLLISIONS
  - X-RAY PRODUCING COLLISIONS

### HEAT-PRODUCING COLLISIONS

- **ELECTRON DEFLECTED BY OUTER SHELL ELECTRON CLOUD**
  - SMALL LOSS OF ENERGY = **HEAT**
- **ELECTRON COLLIDES WITH OUTER SHELL ELECTRON**
  - DISPLACES THE ELECTRON TO AN EVEN MORE PERIPHERAL SHELL (HIGHER ENERGY)
    - **EXCITATION**
  - DISPLACES THE ELECTRON FROM THE ATOM COMPLETELY
    - **IONISATION**
  - SMALL LOSS OF ENERGY = **HEAT**

## HEAT

- MOSTLY PRODUCED BECAUSE...
  - MILLIONS OF INCOMING ELECTRONS
  - MANY OUTER-SHELL TUNGSTEN ELECTRONS
  - EACH BOMBARDING ELECTRON CAN UNDERGO MANY HEAT PRODUCING COLLISIONS

### COPPER BLOCK

- HEAT NEEDS TO BE REMOVED QUICKLY AND EFFICIENTLY
- **WILL DAMAGE THE TARGET!!!** (IF IT GETS TOO HOT!)
- COPPER
  - HIGH THERMAL CAPACITY
  - GOOD CONDUCTION PROPERTIES

### X-RAY PRODUCING COLLISIONS

- INCOMING ELECTRON PENETRATES OUTER SHELL ELECTRONS
- PASSES CLOSE TO THE NUCLEUS OF THE TUNGSTEN ATOM
  - ELECTRON DRAMATICALLY SLOWED DOWN AND DEFLECTED BY NUCLEUS
  - **LARGE LOSS OF ENERGY → X-RAYS**
- INCOMING ELECTRON COLLIDES WITH AN INNER SHELL ELECTRON
  - DISPLACES IT TO AN OUTER SHELL (EXCITATION)
  - DISPLACES IT FROM THE ATOM COMPLETELY (IONISATION)
  - **LARGE LOSS OF ENERGY → X-RAYS**

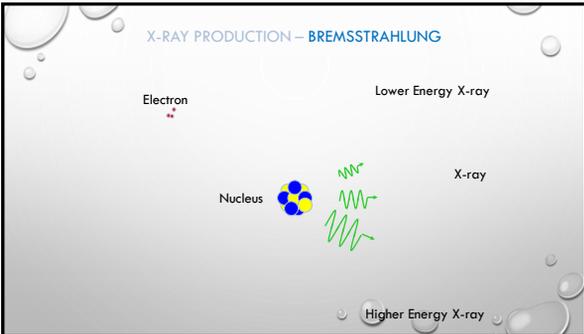
### X-RAY SPECTRA

- THESE ARE PRODUCED BY THE TWO TYPES OF X-RAY COLLISIONS
- (1) **CONTINUOUS SPECTRUM**
- (2) **CHARACTERISTIC SPECTRUM**

### CONTINUOUS SPECTRUM

- X-RAY PHOTONS EMITTED BY THE PASSING OF THE ELECTRONS CLOSE TO THE NUCLEUS = **BREMSSTRAHLUNG** (BRAKING RADIATION)
- ENERGY LOST BY THE BOMBARDING ELECTRON DETERMINED BY:
  - AMOUNT OF DECELERATION
  - DEGREE OF DEFLECTION
- **AMOUNT OF ENERGY LOST BY THE BOMBARDING ELECTRON → ENERGY OF THE RESULTANT PHOTON**
- WIDE RANGE/SPECTRUM OF PHOTON ENERGIES POSSIBLE
- CALLED THE CONTINUOUS SPECTRUM

- SMALL DEFLECTIONS = LOW ENERGY PHOTONS = MOST COMMON
- **LOW ENERGY PHOTONS**
  - LITTLE PENETRATING POWER
  - MOST WILL NOT EVEN EXIT X-RAY TUBE
  - WILL BE REMOVED FROM THE USEFUL X-RAY BEAM (FILTRATION)
- LARGE DEFLECTIONS = HIGH ENERGY PHOTONS = LESS LIKELY TO OCCUR
- **HIGH ENERGY PHOTONS**
  - VERY PENETRATING
  - MAKE UP THE PRIMARY BEAM
  - MAX ENERGY IS RELATED TO THE KV USED

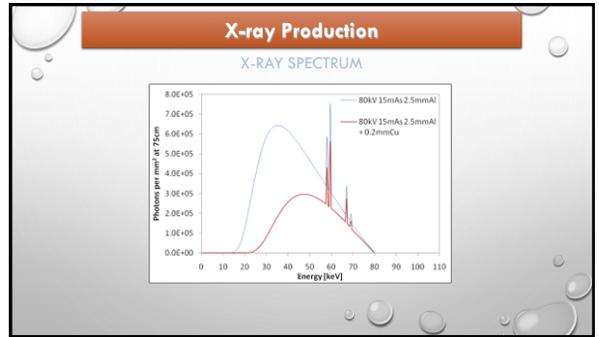
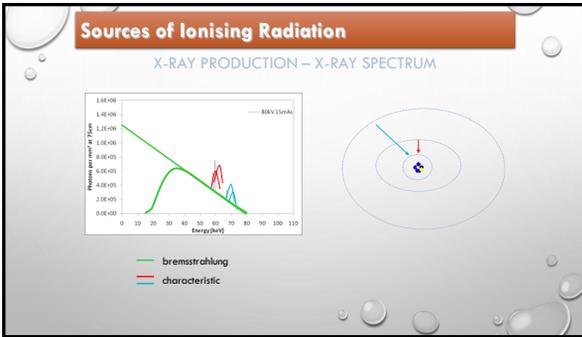
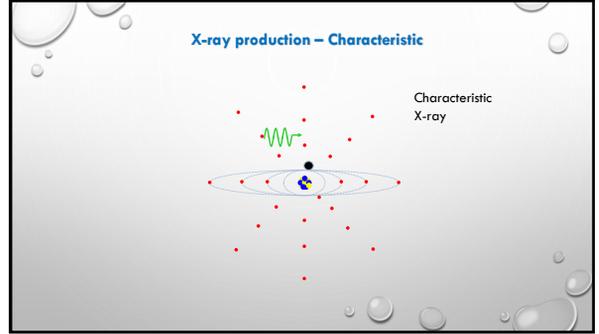


### CHARACTERISTIC SPECTRUM

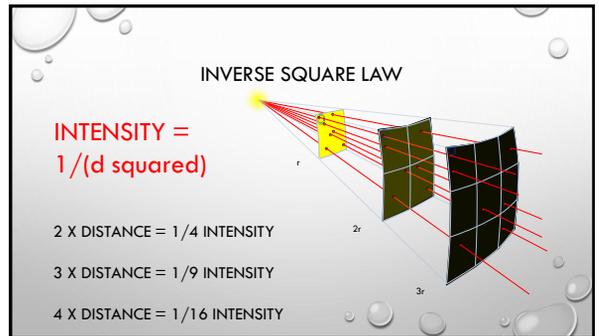
- ATOM EXCITED OR IONISED BY THE BOMBARDING ELECTRONS
- TUNGSTEN ELECTRONS WILL REARRANGE THEMSELVES → GROUND STATE
- **ELECTRONS JUMP BETWEEN SHELLS OF DIFFERENT ENERGIES → ENERGY RELEASED IN THE FORM OF X-RAY PHOTONS** (SPECIFIC ENERGIES DEPENDING ON THE MOVEMENT OF ELECTRONS)
- SHELLS/ENERGY LEVELS ARE SPECIFIC TO DIFFERENT ATOMS (EG TUNGSTEN)
- PHOTONS RELEASED ARE CHARACTERISTIC OF TUNGSTEN TOO
- THESE PHOTONS THEREFORE MAKE UP THE CHARACTERISTIC SPECTRUM

### PERIODIC TABLE OF THE ELEMENTS

The periodic table shows elements grouped by color. Tungsten (W) is circled in red in the 6th period, 6th column.

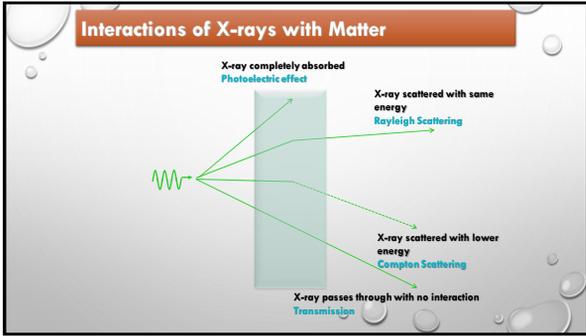


- ### X-RAY PROPERTIES
- WAVE PACKETS OF ENERGY THAT ORIGINATE AT ATOMIC LEVEL
  - ELECTROMAGNETIC RADIATION
  - WAVE PACKET = QUANTUM OF ENERGY = PHOTON
  - X-RAY BEAM = MILLIONS OF PHOTONS (DIFFERENT ENERGIES)
  - X-RAYS TRAVEL IN STRAIGHT LINES
  - OBEY INVERSE SQUARE LAW
  - NO MEDIUM REQUIRED
  - SHORTER WAVELENGTH = MORE PENETRATING X-RAYS
  - X-RAY ENERGY CAN BE ATTENUATED OR ABSORBED BY MATTER
  - CAN PRODUCE IONISATION → DAMAGE TO BIOLOGICAL TISSUES (CALLED IONISING RADIATION)
  - UNDETECTABLE BY HUMAN SENSES
  - CAN CAUSE CERTAIN SALTS TO FLUORESCENCE AND EMIT LIGHT (INTENSIFYING/SCREENS)



### DIAGNOSTIC X-RAY BEAM

- **INTENSITY = NUMBER** OF X-RAY PHOTONS
- **QUALITY = ENERGY** OF X-RAY PHOTONS (PENETRATING POWER)
- THESE FACTORS ARE EFFECTED BY:
  - SIZE OF THE KV (TUBE VOLTAGE)
  - SIZE OF THE MA (TUBE CURRENT)
  - DISTANCE FROM THE TARGET
  - TIME (LENGTH OF EXPOSURE)
  - FILTRATION
  - TARGET MATERIAL



### DEFINITIONS

- **SCATTERING**
  - CHANGE IN DIRECTION OF A PHOTON
  - CAN BE WITH LOSS OF ENERGY OR NOT
- **ABSORPTION**
  - REMOVAL OF ENERGY FROM THE BEAM
- **ATTENUATION**
  - REDUCTION IN BEAM INTENSITY BY SCATTER OR ABSORPTION
  - **ABSORPTION + SCATTER = ATTENUATION**
- **IONISATION**
  - REMOVAL OF AN ELECTRON FROM A NEUTRAL ATOM
  - LEAVES 2 IONS AS A RESULT
  - **NEGATIVE ION = ELECTRON, POSITIVE ION = REMAINING ATOM**

### INTERACTIONS AT ATOMIC LEVEL

- **PHOTOELECTRIC EFFECT**
  - PURE ABSORPTION (BEAM ENERGY IS DEPOSITED/LOST)
- **RAYLEIGH SCATTERING**
  - PURE SCATTER (ELECTRON IS DEFLECTED WITH NO CHANGE)
- **COMPTON EFFECT**
  - SCATTER AND ABSORPTION (ELECTRON IS DEFLECTED WITH LOSS OF SOME ENERGY)
- **PAIR PRODUCTION**
  - PURE ABSORPTION

### DENTAL IMPORTANCE

- ONLY 2 OF THESE INTERACTIONS ARE IMPORTANT IN DENTAL USE
- (1) **PHOTOELECTRIC EFFECT**
  - PURE ABSORPTION
- (2) **COMPTON EFFECT**
  - SCATTER AND ABSORPTION (ELECTRON DEFLECTED WITH LOWER ENERGY)

### PHOTOELECTRIC EFFECT

- INCOMING X-RAY PHOTON INTERACTS WITH INNER SHELL ELECTRON OF TISSUE ATOM
- INNER SHELL ELECTRON IS EJECTED WITH CONSIDERABLE ENERGY (PHOTOELECTRON)
- PHOTOELECTRON TRAVELS INTO THE TISSUES
- X-RAY PHOTON DISAPPEARS HAVING DEPOSITED ALL IT'S ENERGY (PURE ABSORPTION)
- VACANCY IN INNER SHELL IS FILLED BY OUTER SHELL ELECTRONS → ENERGY RELEASED AS HEAT OR LIGHT
- ATOMIC STABILITY RESTORED BY CAPTURE OF A FREE ELECTRON TO FILL THE VOID
- PHOTOELECTRON BEHAVES LIKE ORIGINAL HIGH ENERGY X-RAY PHOTON CAUSING THE SAME RESULTS IN NEW TISSUE ATOMS
- IONISATION INTERACTIONS WITHIN TISSUES → POSSIBLE TISSUE DAMAGE

- PHOTOELECTRIC EFFECT HAPPENS MOST AT LOW KV
  - HIGH ABSORPTION
  - GOOD CONTRAST RADIOGRAPHS
- HIGHER KV TECHNIQUES MEAN LESS ABSORPTION OF X-RAYS

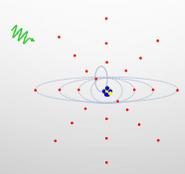
**\*PROBABILITY =  $1/kV^3$  (cubed)\***

- OVERALL RESULT IS **IONISATION OF THE TISSUES**

### Interactions of X-rays with Matter

#### PHOTOELECTRIC EFFECT

Ionisation

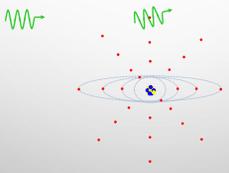


### Interactions of X-rays with Matter

#### RAYLEIGH SCATTER

Elastic scattering

Same energy



### COMPTON EFFECT

- INCOMING X-RAY PHOTON INTERACTS WITH A FREE OR LOOSELY BOUND OUTER SHELL ELECTRON OF THE TISSUE ATOM
- OUTER SHELL ELECTRON IS EJECTED (COMPTON RECOIL ELECTRON)
- PHOTON LOSES SOME ENERGY (ABSORPTION)

- EJECTED ELECTRON (COMPTON RECOIL ELECTRON) AFFECTS FURTHER ATOMS
- PHOTON IS SCATTERED, AND MAY:
  - UNDERGO FURTHER COMPTON INTERACTIONS IN TISSUES
  - UNDERGO PHOTOELECTRIC INTERACTIONS IN TISSUES
  - ESCAPE FROM THE TISSUES (SCATTER RADIATION OF CONCERN IN CLINIC)
- ATOMIC STABILITY REGAINED BY CAPTURE OF A FREE ELECTRON AGAIN

- COMPTON EFFECT → HAPPENS AT HIGH KV
  - LESS ABSORPTION OF BODY TISSUES
  - POOR CONTRAST RADIOGRAPHS
- ENERGY OF THE SCATTERED PHOTON < ORIGINAL INCOMING PHOTON
- SOME OF THE ENERGY HAS BEEN GIVEN TO THE COMPTON RECOIL ELECTRON

### COMPTON SCATTER

- HIGH ENERGY SCATTERED PHOTONS = FORWARDS
- LOW ENERGY SCATTERED PHOTONS = BACKWARDS
- FORWARDS SCATTER = DEGRADATION OF IMAGE?
- ANTI SCATTER GRID COULD BE USED TO IMPROVE IMAGE QUALITY
- OVERALL RESULT IN THE TISSUES = IONISATION

### Interactions of X-rays with Matter

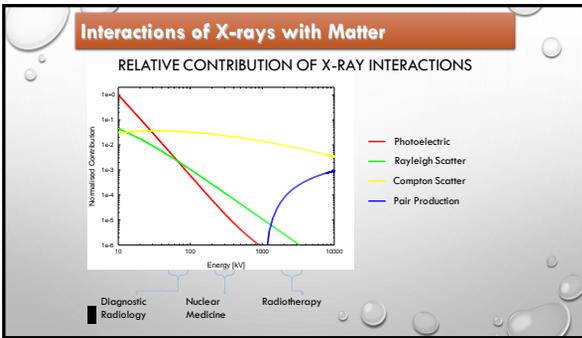
#### COMPTON SCATTER

Inelastic scattering

Lower energy

### Interactions of X-rays with Matter

Scatter → Radiation risk to staff  
→ Image blurring



### BIOLOGICAL EFFECTS OF IONISING RADIATION

Cell      Chromosome      DNA

### BIOLOGICAL EFFECTS OF IONISING RADIATION

#### Direct Damage

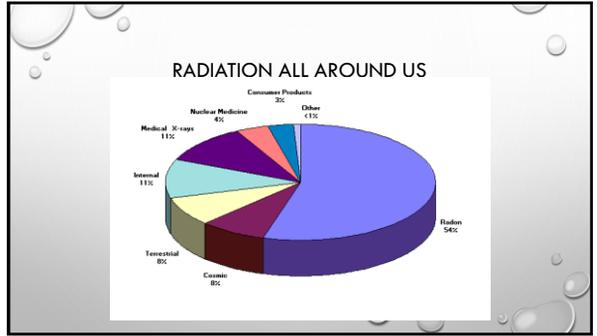
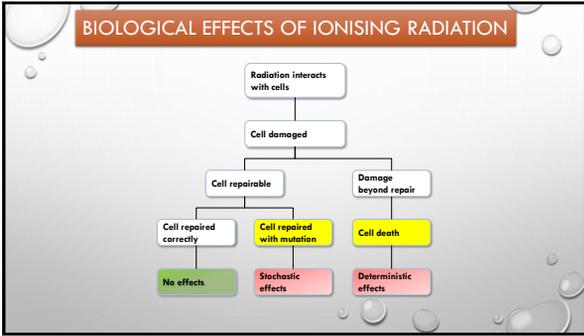
#### Indirect Damage

Electrons generated by ionisation reaction damage DNA bonds or produce reactive chemicals that do the damage indirectly

Water - H<sub>2</sub>O

### CELLS MOST AT RISK

- DAMAGE TO DNA CAN BE REPAIRED **GIVEN TIME**
- IF TIME IS NOT AVAILABLE, THE DNA WILL NOT BE HEALED
- RAPIDLY DIVIDING CELLS → NOT ENOUGH TIME FOR THE CELL TO REPAIR ITSELF BEFORE IT DIVIDES
- RAPIDLY DIVIDING CELLS ARE THEREFORE MOST AT RISK
- CHILDREN ARE MOST VULNERABLE TO RADIATION EXPOSURE!



### BIOLOGICAL EFFECTS

- **DETERMINISTIC EFFECTS**
  - OCCUR AFTER A CERTAIN THRESHOLD OF RADIATION EXPOSURE
  - CUMULATIVE
- **STOCHASTIC EFFECTS**
  - CAN OCCUR AFTER ANY RADIATION EXPOSURE (EG. CANCER)
  - SOMATIC – ACUTE OR CHRONIC/LATENT
  - GENETIC



### DETERMINISTIC EFFECTS

- HAIR LOSS
- ERYTHEMA/DESQUAMATION
  - SKIN
- CATARACTS
- FIBROSIS
- HAEMOPOIETIC DAMAGE
  - RED BONE MARROW




### STOCHASTIC EFFECTS

- EFFECTS CAN APPEAR IN BOTH THE EXPOSED PERSON (SOMATIC) OR FUTURE GENERATIONS (GENETIC)

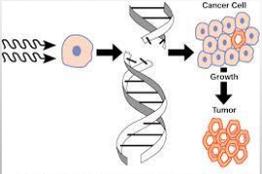
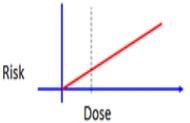



Figure 1. Development of cancer from mutation produced by ionising radiation.

### WHAT'S THE RISK?

- **LIFETIME CANCER RISK**
  - HIGHER IN MEN
- **UK RISK DUE TO DENTAL RADIOGRAPHS**
  - MILLIONS OF DENTAL RADIOGRAPHS
  - VERY FEW ASSOCIATED MALIGNANCIES
- **CHILDREN 2-3 X MORE AT RISK THAN ADULTS!!**
  - CELLS DIVIDING MORE RAPIDLY
  - MUTATED CELLS LESS TIME TO REPAIR THEMSELVES



### DOSIMETRY

- RADIATION DOSE IS MEASURED TO BOTH THE PATIENT AND STAFF
- THIS CAN BE DONE USING DOSIMETERS THAT ARE WORN BY THE STAFF
- RADIATION DOSES TO PATIENTS ARE DISPLAYED ON MOST EXTRAORAL UNITS
- INTRAORAL DOSES ARE MOSTLY CALCULATED USING THE EXPOSURE FACTORS USED

DOSIMETERS CAN LOOK LIKE THIS AND BE WORN BY **INDIVIDUAL STAFF** ON THEIR UNIFORMS



(THIS ONE IS JUST A CONTROL ONE)

THESE SHOULD BE CLIPPED ONTO UNIFORMS AND **FACING FORWARDS** AT ALL TIMES (NOT ON LANYARDS ETC)

### DOSIMETERS

- TRUNK (CHEST OR WAIST) LEVEL
- CHANGE AT APPROPRIATE TIME
  - NO LONGER THAN 3 MONTH PERIOD
  - RETURNED BY THE RPS
  - APPROVED DOSIMETRY SERVICE (ADS)
- **DO NOT**
  - LEAVE IN CONTROLLED AREA
  - LEAVE IN EXTREMES OF HEAT/HUMIDITY
  - GET WET
  - WEAR WHEN SUBJECT TO OWN MEDICAL EXPOSURE

OR THEY CAN BE USED TO RECORD THE RADIATION DOSE THAT STAFF MAY BE EXPOSED TO AT A **CONTROL PANEL**



(STUCK BESIDE THE CONTROL PANEL)

### PATIENT DOSE RECORDING

- WHERE AVAILABLE, THE PATIENT DOSE SHOULD BE RECORDED
  - WILL USUALLY BE AVAILABLE ON EXTRAORAL - OPT, CEPH, CBCT (EG. MGYCM2)
- FOR MOST PATIENTS, THE AVERAGE EXPOSURE FACTORS USED WILL BE TAKEN OFF THE EXPOSURE CHART (KV, MA, SECS)
- WHEN MODIFIED FROM AVERAGE EXPOSURE, THE EXPOSURE FACTORS SHOULD BE RECORDED TO INDICATE A DIFFERENT EXPOSURE WAS USED
- MEDICAL PHYSICS CAN USE THESE FIGURES TO CALCULATE A PATIENT DOSE IF REQUIRED

### DOSIMETRY UNITS

- RADIATION ABSORBED DOSE (D)
- EQUIVALENT DOSE (H)
- EFFECTIVE DOSE (E)
- COLLECTIVE DOSE
- DOSE RATE

### RADIATION-ABSORBED DOSE (D)

- MEASURE OF AMOUNT OF ENERGY ABSORBED FROM THE RADIATION BEAM PER UNIT MASS OF TISSUE
- SI UNIT = GRAYS (GY), MEASURE IN JOULES/KG
- SUB UNIT = MILLIGRAY (MGY)

### EQUIVALENT DOSE (H)

- MEASURE WHICH ALLOWS FOR THE DIFFERENT RADIOBIOLOGICAL EFFECTIVENESS OF DIFFERENT TYPES OF RADIATION
- MEASURED IN SIEVERTS (SV), MILLISIEVERTS (MSV), MICROSIEVERTS
- EG. ALPHA PARTICLES ONLY PENETRATE FEW MM INTO TISSUE, LOSE ALL THEIR ENERGY AND ARE **COMPLETELY ABSORBED** (MORE DANGEROUS EFFECT)
- X-RAYS PENETRATE MUCH FURTHER INTO TISSUE, ONLY LOSE SOME OF THEIR ENERGY AND ARE ONLY **PARTIALLY ABSORBED**
- RADIATION WEIGHTING FACTOR USED – DEPENDING ON TYPE OF RADIATION USED
  - WR = 1 X-RAYS, GAMMA RAYS & BETA PARTICLES
  - WR = 10 FAST NEUTRONS (10KEV-100KEV) & PROTONS
  - WR = 20 ALPHA PARTICLES

- **EQUIVALENT DOSE (H) =**  
**RADIATION-ABSORBED DOSE (D)**  
**X RADIATION WEIGHTING**  
**FACTOR (WR)**

### EFFECTIVE DOSE (E)

- MEASURE WHICH ALLOWS DOSES FROM DIFFERENT INVESTIGATIONS OF DIFFERENT BODY PARTS TO BE COMPARED
- ALSO MEASURED IN SIEVERTS (SV), MILLISIEVERTS (MSV) AND MICROSIEVERTS
- SOME BODY PARTS ARE MORE SENSITIVE TO RADIATION THAN OTHERS
- EACH TISSUE ALLOCATED A NUMERICAL VALUE CALLED THE '**TISSUE WEIGHTING FACTOR**' (WT) BASED ON ITS **RADIOSENSITIVITY** (RISK OF TISSUE BEING DAMAGED BY RADIATION)
- **GREATER RISK OF DAMAGE FROM RADIATION = HIGHER TISSUE WEIGHTING FACTOR**
  - BREAST / BONE MARROW = 0.12 (MORE SENSITIVE TO RADIATION DAMAGE)
  - SKIN / SALIVARY GLANDS = 0.01

- **EFFECTIVE DOSE (E) =**  
**EQUIVALENT DOSE (H) X TISSUE**  
**WEIGHTING FACTOR (WT)**

### EFFECTIVE DOSES IN DENTAL (MSV)

- IOPA / BITEWING = 0.001 – 0.008
- LATERAL CEPH = 0.002 – 0.003
- UPPER ANTERIOR OCCLUSAL = 0.008
- ORTHOPANTOMOGRAM = 0.004 – 0.03
- CT MANDIBLE = 0.36 – 1.2
- CT MAXILLA = 0.1 – 3.3
- CT HEAD = 2.0

### COLLECTIVE DOSE

- MEASURES THE TOTAL EFFECTIVE DOSE TO A POPULATION, FROM A PARTICULAR INVESTIGATION OR SOURCE OF RADIATION
- **COLLECTIVE DOSE** = EFFECTIVE DOSE X POPULATION
- UNIT = MAN-SIEVERT (MAN-SV)

### DOSE RATE

- MEASURE OF THE DOSE PER UNIT TIME
- EG. **DOSE PER HOUR**
- CAN BE MORE CONVENIENT THAN LARGER ANNUAL DOSES
- SI UNIT = MICROSIEVERT / HOUR

### DOSE OPTIMISATION

- CHOOSE CORRECT EXPOSURE FACTORS
  - USE CHART
- USE COLLIMATOR AS GOLD STANDARD
  - ALWAYS WHEN USING HOLDERS
- TAKE AS FEW IMAGES AS POSSIBLE
- ALWAYS OPT FOR IMAGING EXAMINATION THAT HAS LOWEST DOSE TO PATIENT
- WEIGH UP QUERY WITH DOSE REQUIRED TO ANSWER IT

### EFFECTIVELY COMMUNICATING RADIATION RISKS TO PATIENTS

- ▶ NEGLIGIBLE RISK
- ▶ SMALLEST RADIATION EXPOSURE OF ALL X-RAY EXAMINATIONS
- ▶ **BENEFITS VS RISK (JUSTIFICATION)**
- ▶ **BENEFIT = DIAGNOSIS CAN BE DETERMINED / CONFIRMED**
- ▶ **RISK = VERY SMALL RADIATION DOSE**
- ▶ 1 IOPA = EQUIVALENT OF A FEW DAYS BACKGROUND RADIATION (DEPENDING ON WHERE YOU LIVE)

**Dental X-rays**

**Your health**  
Dental X-rays help with making a diagnosis, planning treatment or monitoring the health of your teeth.

**Radiation**  
Everyone receives ionising radiation every day from radioactivity in the air, food we eat and even from space. The amount of radiation used for dental X-rays is similar to your everyday exposure over a few days, so the risks associated with them are very low for both adults and children.

**Our staff and equipment**  
All dental X-ray equipment is checked regularly to ensure it is safe and accurate. Our staff are trained to use the equipment safely and accurately.

**Your test**  
The main benefit of the X-ray is making the correct diagnosis or plan, or ensuring your teeth are healthy, so you can get the treatment that's right for you. The X-ray will have been approved by a specialist (usually your dentist) who has agreed that the benefit is far greater than the small risk from X-rays.

*If you have any questions, please ask*

**Dental X-rays**

**Your health**  
Dental X-rays help with making a diagnosis, planning treatment or monitoring the health of your teeth.  
They involve the use of ionising radiation (X-rays) to produce detailed images of teeth, gums and jaws.

**Radiation**  
Everyone receives ionising radiation every day from radioactivity in the air, food we eat and even from space. The amount of radiation used for dental X-rays is similar to your everyday exposure over a few days, so the risks associated with them are very low for both adults and children. The main benefit of the X-ray is making the correct diagnosis or plan, or ensuring your teeth are healthy, so you can get the treatment that's right for you. The X-ray will have been approved by a specialist (usually your dentist) who has agreed that the benefit is far greater than the small risk from X-rays.

**Our staff and equipment**

- Staff are trained to take the best possible images using the lowest amount of radiation.
- Equipment is regularly checked to make sure the test is safe and effective.

**Your test**

- You may have your X-ray taken during your dental examination or you may need to go to an X-ray room, depending on the type of team required to get the appropriate information.
- You will normally be informed of the outcome of the X-ray before you leave. If not, our staff will tell you when and how you will be told the outcome of your X-ray.

**If you have any questions, please ask**

**Communicating Radiation Benefit and Risk Information to Individuals Under the Ionising Radiation (Medical Exposure) Regulations (IR(ME)R)**

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March 2012

**SoR CoR**  
Society of Radiographers  
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**Diagnostic scenario 1**

A child has been referred for a chest x-ray, which has been justified by the IR(ME)R Practitioner. The child's mother asks whether it is safe and seeks assurance that her child will not develop cancer as a result.

**Suggested dialogue:**

*The doctor looking after your child believes a chest x-ray will help to decide on the best treatment. A specialist in radiology agrees that this is the best test to answer the question your doctor has asked and that the benefit to your child of having the x-ray is greater than the risk.*

*A chest x-ray involves a very low dose of radiation, about the same amount of radiation that you would normally get in 2 to 3 days from the radiation that is naturally occurring all around us. This exposure to ionising radiation represents a very low risk to your child of developing a cancer in the future. The dose delivered will be kept as low as is practicable.*

**Diagnostic scenario 4**

A patient who has had multiple examinations involving exposures of ionising radiation asks how many examinations they can safely have.

**Suggested dialogue:**

*Each exposure must be justified which means an expert radiology practitioner believes there is sufficient net benefit to you of having this examination when weighed against the risks. Whilst the cumulative effect of your lifetime exposure to ionising radiation is taken into consideration, each new exposure is justified on its own merits and in light of the current question. The benefit to you is weighed against the risk of not having the examination and the availability of alternative techniques that do not involve ionising radiation. Each exposure is made using as low a dose of radiation as is reasonably practicable consistent with your individual needs.*

X-ray examination	Equivalent period of exposure from:	
	Background radiation	Radiation from time spent flying
Teeth Arms and legs/Hands and feet DEXA	A few days	<1hr
Chest/Head/Cervical spine	A few weeks	6hrs
Breast (mammography) Thoracic/lumbar spine Abdomen/Pelvis Kidney isotope scan	A few months to a year	60hrs
Angiography CT chest scan/CT abdomen scan Bone isotope scan	A few years	600hrs

**QUIZ TIME!**

# DIGITAL IMAGING

### AIM

- TO EQUIP DENTAL NURSES WITH THE KNOWLEDGE AND SKILLS TO UTILISE DIGITAL IMAGING SYSTEMS IN DENTAL RADIOGRAPHY, ENSURING HIGH QUALITY DIAGNOSTIC OUTCOMES AND ADHERENCE TO DATA PROTECTION STANDARDS

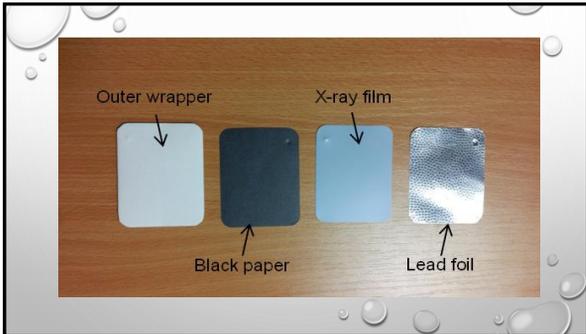
### LEARNING OBJECTIVES

- DESCRIBE PRINCIPLES OF DIGITAL IMAGE PRODUCTION
- COMPARE INTRAORAL AND EXTRAORAL DIGITAL SYSTEMS (EG. SOLID STATE SENSORS AND PHOSPHOR PLATES)
- IDENTIFY AND RECTIFY COMMON DIGITAL IMAGE FAULTS
- UNDERSTAND DATA STORAGE, RETRIEVAL AND PROTECTION PROTOCOLS
- APPLY RELEVANT LEGISLATION (EG. DATA PROTECTION ACT 1998)

### FILM PACKETS

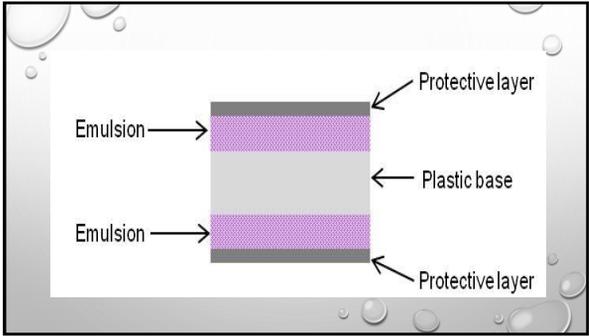
- **OUTER PACKET = NON-ABSORBENT PAPER OR PLASTIC**
  - PREVENTS INGRESS OF SALIVA
- SMOOTH OR PEBBLED SURFACE FACES THE TUBE (USUALLY WHITE)
- REVERSE SIDE USUALLY TWO COLOURS TO ENSURE NOT PLACED BACK TO FRONT

- **BLACK PAPER EITHER SIDE OF FILM**
  - PROTECTS FROM LIGHT
  - PROTECTS FROM FINGERS WHEN PROCESSING
  - PROTECTS FROM INGRESS OF SALIVA
- **THIN SHEET OF LEAD FOIL BEHIND FILM**
  - PREVENTS RESIDUAL RADIATION FROM PASSING INTO PATIENT TISSUES
  - PREVENTS SCATTER RADIATION COMING BACK TO FILM AND DEGRADING IMAGE
- LEAD FOIL HAS EMBOSSED PATTERN, SO WILL SHOW UP ON RADIOGRAPH IF FILM PLACED WRONG WAY AROUND
- EMBOSSED DOT ON ONE CORNER TO HELP ORIENTATE FILM
- RAISED DOT ALWAYS PLACED FACING FILM



### DIRECT ACTION RADIOGRAPHIC FILM

- **CLEAR PLASTIC BASE** (TRANSPARENT CELLULOSE ACETATE)
  - SUPPORTS THE EMULSION
- **THIN LAYER OF ADHESIVE**
  - FIXES EMULSION TO BASE
- **EMULSION ON BOTH SIDES OF BASE**
  - SILVER HALIDE CRYSTALS IN A GELATIN MATRIX
  - X-RAY PHOTONS SENSITISE THESE CRYSTALS
  - CRYSTALS LATER REDUCED TO BLACK METALLIC SILVER IN THE DEVELOPER
- **PROTECTIVE LAYER OF CLEAR GELATIN**
  - SHIELDS EMULSION FROM MECHANICAL DAMAGE



### NATURE OF THE IMAGE

X-RAYS PASS THROUGH THE OBJECT (PATIENT)

↓

INTERACT WITH PHOTOGRAPHIC EMULSION ON A FILM

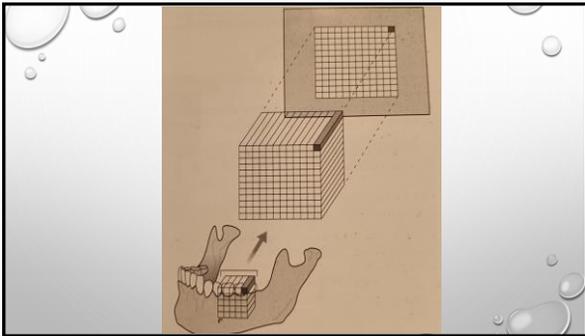
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BLACKENING OF THE FILM

**NOW BEING TAKEN OVER BY DIGITAL SENSORS**

### DIGITAL IMAGE PRODUCTION

- DIGITAL IMAGE IS CAPTURED IN PIXELS (TINY SQUARES) WITHIN EITHER SOLID STATE SENSORS OR PHOSPHOR PLATES
- EACH 2D PIXEL REPRESENTS A 3D VOXEL (CUBOID) OF THE PATIENT
- THE DEPTH OF THE CUBOID IS DEPENDENT ON THE THICKNESS OF THE BODY PART
- EACH PIXEL MEASURES THE TOTAL X-RAY ABSORPTION THROUGHOUT THE WHOLE OF EACH VOXEL
- THIS 2D LIMITATION HAS NOW BEEN OVERCOME BY CONE-BEAM CT (CBCT)



### SOLID STATE SENSORS

- SMALL, THIN, FLAT, RIGID BOXES
- THICKNESS ~5-7MM
- CABLE ATTACHED TO SENSOR → REMOTE DOCKING STATION → COMPUTER
- INSTANTANEOUS IMAGE
- CAN ALSO BE WIRELESS
  - BULKIER SENSOR
- NOT AUTOCLAVABLE
  - PLASTIC BARRIER ENVELOPE OVER SENSOR



### SOLID-STATE SENSORS

- INPUT THE INFORMATION FROM EACH PIXEL DIRECTLY TO THE COMPUTER'S ANALOGUE-TO-DIGITAL CONVERTER
- SENT IN THE FORM OF AN ANALOGUE VOLTAGE SIGNAL
- USUALLY DOWN THE CABLE

### CHARGE-COUPLED DEVICE (CCD)

- INDIVIDUAL SILICON PIXELS ARRANGED IN A MATRIX
  - 1.5 - 2.5 MILLION PIXELS
  - 20 - 70 MICRONS
- SCINTILLATION LAYER
  - SIMILAR TO AN INTENSIFYING SCREEN
  - X-RAY PHOTONS → LIGHT
- CHARGE PACKET CREATED FOR EACH PIXEL
  - READ IN ROWS
  - READ-OUT AMPLIFIER
  - ANALOGUE VOLTAGE SIGNAL DOWN CABLE
  - ANALOGUE-DIGITAL CONVERTER (IN DOCKING STATION)

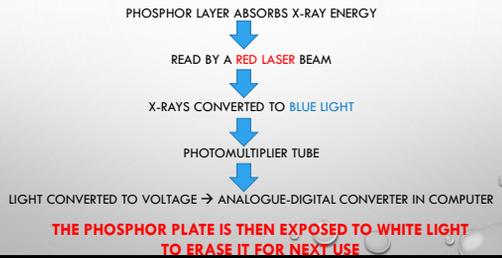


### PHOTOSTIMULABLE PHOSPHOR STORAGE PLATES (PSP)

- BARIUM FLUOROHALIDE LAYER ON FLEXIBLE BACKING SUPPORT
- NOT CONNECTED TO A CABLE
  - READ BY SCANNER
- RANGE OF PLATE SIZES AVAILABLE
- RE-USABLE
  - PLACED IN LIGHT BOX TO CLEAR
  - WHITE LIGHT IN SCANNER
- PLASTIC BARRIER ENVELOPES REQUIRED
  - INFECTION CONTROL



### PSP TECHNOLOGY



- **ANALOGUE – CONTINUOUS WAVE-LIKE SIGNAL OR SYSTEM**
- **DIGITAL – DISCRETE CHANGE (EG. NUMERICAL VALUE)**

DIGITAL IS MORE EASILY MEASURED

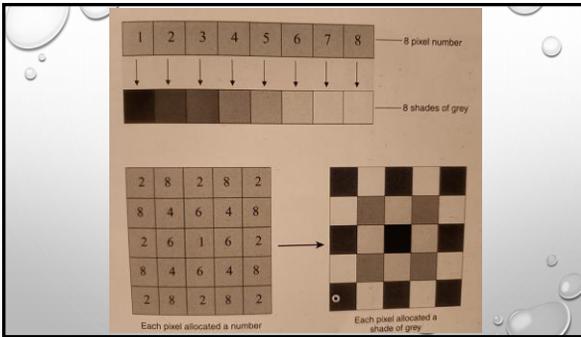


### COMPUTER PROCESSING

- COMPUTERS DEAL WITH NUMBERS
- ANALOGUE VOLTAGE FROM EACH PIXEL IS CONVERTED INTO A DISCRETE **NUMERICAL** DIGITAL SIGNAL
- THIS IS DONE BY THE ANALOGUE-TO-DIGITAL CONVERTER
- EACH PIXEL HAS A X AND Y CO-ORDINATE AND IS ALLOCATED A NUMBER
- GREY SCALE = TYPICALLY 256 NUMBERS TO SELECT FROM
- **0 = ALL RADIATION GETS THROUGH PATIENT (MAX VOLTAGE RECEIVED) = BLACK**
- **255 = NO RADIATION GETS THROUGH PATIENT (MIN VOLTAGE RECEIVED) = WHITE**
- THE COMPUTER ALLOCATES A NUMBER BASED ON THE VOLTAGE RECEIVED TO CREATE AN IMAGE OF BLACK, WHITE AND GREY

### IMAGE INFORMATION

- IMAGE INFORMATION IS DETERMINED BY:
  - NUMBER OF PIXELS
  - SIZE OF PIXELS
  - NUMBER OF SHADES OF GREY AVAILABLE
- THESE 3 THINGS ALSO DETERMINE THE:
  - SIZE OF THE IMAGE FILE
  - RESOLUTION OF THE FINAL IMAGE



**MORE PIXELS OF SMALLER SIZE = BETTER IMAGE RESOLUTION**



### IMAGE MANIPULATION

- DIGITAL IMAGES CAN BE CHANGED BY CHANGING THE NUMBERS ALLOCATED TO PIXELS
- CHANGED PIXEL NUMBER = CHANGED SHADE OF GREY
- LOWER NUMBER = DARKER SHADE**

TWO MOST COMMON WAYS OF CHANGING AN IMAGES ARE:

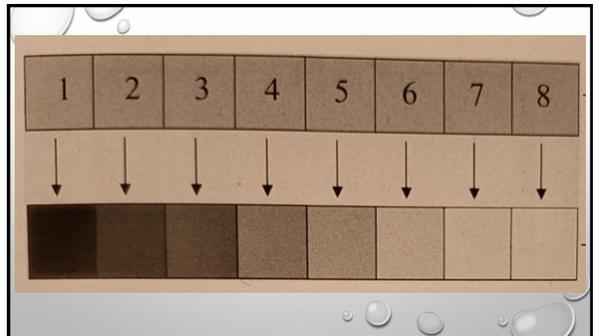
- BRIGHTNESS
- CONTRAST

### EFFECTS OF IMAGE MANIPULATION

- CANNOT** PROVIDE ANY ADDITIONAL INFORMATION TO THAT CONTAINED IN THE ORIGINAL IMAGE
- ADVANTAGE = LOOKS MORE AESTHETICALLY PLEASING**
- DISADVANTAGE = MAY CAUSE CLINICAL INFORMATION TO BE LOST AND DIAGNOSIS COMPROMISED**

### BRIGHTNESS

- DEGREE OF BLACKENING ON AN IMAGE
- MAKES THE IMAGE LIGHTER
- INCREASE THE NUMERICAL VALUE OF EACH PIXEL = LIGHTER GREY SHADES**
- EG. ADD 2 TO EACH PIXEL NUMBER**
- MAX = ALL PIXELS HIT MAXIMUM VALUE OF 8 = WHOLE IMAGE IS WHITE



### INCREASING BRIGHTNESS OF AN IMAGE

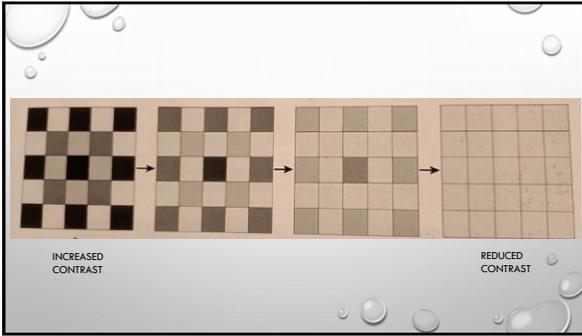
ADDING 2 TO EACH PIXEL NUMBER = BRIGHTENS EACH SHADE OF GREY

2	8	2	8	2
8	4	6	4	8
2	6	1	6	2
8	4	6	4	8
2	8	2	8	2

4	8	4	8	4
8	6	8	6	8
4	8	3	8	4
8	6	8	6	8
4	8	4	8	4

### CONTRAST

- VISUAL DIFFERENCE BETWEEN BLACK AND WHITE
- DECREASE PIXEL NUMBERS IN THE DARKER HALF OF THE GREY SCALE (DARKER)**
- INCREASE PIXEL NUMBERS IN THE LIGHTER HALF OF THE GREY SCALE (LIGHTER)**
- LARGER DIFFERENCE BETWEEN DARK AND LIGHT GREY SHADES = **INCREASED CONTRAST**
- REDUCED CONTRAST = GREY IMAGE WITH LITTLE DIFFERENCE BETWEEN PIXELS



## LEGISLATION

### Data Protection Act 1998

Article Talk

From Wikipedia, the free encyclopedia

The **Data Protection Act 1998** (c. 29) (DPA) was an act of Parliament of the United Kingdom designed to protect personal data stored on computers or in an organised paper filing system. It enacted provisions from the European Union (EU) Data Protection Directive 1995 on the protection, processing, and movement of data.

Under the 1998 DPA, individuals had legal rights to control information about themselves. Most of the Act did not apply to domestic use,<sup>[1]</sup> such as keeping a personal address book. Anyone holding personal data for other purposes was legally obliged to comply with this Act, subject to some exemptions. The Act defined eight data protection principles to ensure that information was processed lawfully.

It was superseded by the Data Protection Act 2018 (DPA 2018) on 23 May 2018. The DPA 2018 supplements the EU General Data Protection Regulation (GDPR), which came into effect on 25 May 2018. The GDPR regulates the collection, storage, and use of personal data significantly more strictly.<sup>[2]</sup>

www.gov.uk

## The UK's data protection legislation

Data protection legislation controls how your personal information is used by organisations, including businesses and government departments.

In the UK, data protection is governed by the [UK General Data Protection Regulation \(UK GDPR\)](#) and the [Data Protection Act 2018](#).

Everyone responsible for using personal data has to follow strict rules called 'data protection principles' unless an exemption applies. There is a [guide to the data protection exemptions on the Information Commissioner's Office \(ICO\) website](#).

Anyone responsible for using personal data must make sure the information is:

- used fairly, lawfully and transparently
- used for specified, explicit purposes
- used in a way that is adequate, relevant and limited to only what is necessary
- accurate and, where necessary, kept up to date
- kept for no longer than is necessary
- handled in a way that ensures appropriate security, including protection against unlawful or unauthorised processing, access, loss, destruction or damage

### Your rights

Under the legislation, you have rights in relation to your personal data, with some exceptions. These include the right to:

- be informed about how your data is being used
- access personal data
- have incorrect data updated
- have data erased
- stop or restrict the processing of your data
- data portability (allowing you to get and reuse your data for different services)
- object to how your data is processed in certain circumstances

You also have rights when an organisation is using your personal data for:

- automated decision-making processes (without human involvement)
- profiling, for example to predict your behaviour or interests

# DIGITAL IMAGING – PRACTICAL INSTRUCTION

## AIM

- TO DEVELOP THE PRACTICAL COMPETENCIES REQUIRED FOR THE EFFECTIVE HANDLING, MAINTENANCE AND TROUBLESHOOTING FOR DIGITAL IMAGING EQUIPMENT AND DATA IN CLINICAL SETTINGS

## LEARNING OBJECTIVES

- CORRECTLY STORE AND MAINTAIN DIGITAL RECEPTORS
- IDENTIFY AND RESOLVE DIGITAL IMAGING FAULTS
- SECURELY FILE AND RETRIEVE PATIENT RADIOGRAPHS
- MAINTAIN PATIENT CONFIDENTIALITY DURING DATA EXCHANGE
- APPLY BEST PRACTICES IN DIGITAL IMAGE HANDLING AND STORAGE

## STORAGE AND MAINTENANCE OF RECEPTORS (PSP)

- RECEPTORS SHOULD BE COVERED AT ALL TIMES
  - BARRIER ENVELOPES
- CONSISTENT EXPOSURE TO LIGHT WILL DEGRADE THE IMAGE
  - STORE IN A CONTAINER
- QUALITY ASSURANCE CARRIED OUT AT REGULAR INTERVALS (1-3 MONTHS)
  - RECEPTORS VISUALLY INSPECTED AND EXPOSED TO RADIATION
  - IMAGES INSPECTED FOR ARTEFACTS (CAN BE MISTAKEN FOR FOREIGN BODIES)
- RECEPTORS REPLACED AS NECESSARY

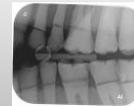
## IDENTIFY/RESOLVE DIGITAL IMAGING FAULTS

- PATIENT FACTORS
- EXPOSURE FAULTS
- POSITIONING ERRORS
- OPACITIES
- EQUIPMENT FAULTS
- DIGITAL PROCESSING ERRORS



## DIGITAL PROCESSING ERRORS

- PEELING OF PSP EDGES
- FINGERPRINTS / FINGERNAILS
- BENDING OF FILMS
- SCANNER ERRORS



## DUST PARTICLES



## SCANNER ERRORS

- **VERY RARE**
- SOMETIMES IMAGES WILL NOT BE PLACED IN CORRECT FOLDER
  - INTERNAL MEMORY ON SCANNER (TEMPORARY)
  - IMAGE MAY BE RETRIEVED
- DUST CAN CAUSE LINES DOWN IMAGE
  - LASER SCANS DUST PARTICLES OVER AND OVER AGAIN
- CASSETTES MAY GET STUCK IN SCANNER
  - NEVER ONES DON'T HAVE CASSETTES
- BARRIER ENVELOPES CAN GET INTO SCANNER DURING PROCESSING
  - USER ERROR



## AIM

- TO ENABLE DENTAL NURSES TO CRITICALLY ASSESS RADIOGRAPHIC IMAGES, UNDERSTAND THEIR DIAGNOSTIC LIMITATIONS, AND CONTRIBUTE TO PATIENT CARE THROUGH ACCURATE INTERPRETATION

## LEARNING OBJECTIVES

- DESCRIBE OPTIMAL VIEWING CONDITIONS FOR RADIOGRAPHS
- RECOGNISE LIMITATIONS OF PLAIN FILM IMAGING
- CRITICALLY ASSESS RADIOGRAPHIC IMAGE QUALITY
- SHARE INSIGHTS WITH THE DENTAL TEAM OF HOW RADIOGRAPHS SUPPORT DIAGNOSIS AND TREATMENT PLANNING
- CONTINUOUSLY UPDATE KNOWLEDGE OF RADIOGRAPHIC INTERPRETATION

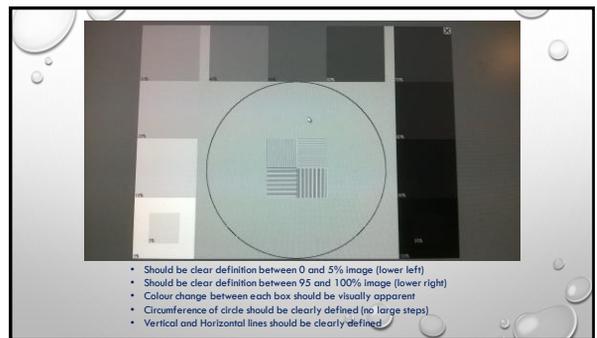
## OPTIMAL VIEWING OF RADIOGRAPHIC FILMS

- **VIEWING BOXES**
  - FLUORESCENT TUBES
  - CLEANING
- **SCREEN QUALITY**
  - BETTER RESOLUTION MEANS MORE ACCURATE DIAGNOSIS
  - MEDICAL GRADE SCREENS
  - "MONITOR CALIBRATION TEST"



## MEDICAL GRADE SCREENS

- GUIDANCE AVAILABLE
  - ROYAL COLLEGE OF RADIOLOGISTS (RCR)
- MINIMUM RECOMMENDED SCREEN RESOLUTION
  - 1.3 MEGAPIXELS (1280 X 1024)
- RESOLUTIONS UP TO 3 MEGAPIXELS (1500 X 2000)
- SCREENS AT SOD = **1.9 MEGAPIXELS** (1600 X 1200)



### PLAIN FILM RADIOGRAPHY LIMITATIONS

- 2D IMAGE OF A 3D OBJECT
- ONLY VIEWING THE OBJECT FROM ONE ANGLE
- QUALITY OF IMAGE DEPENDENT ON THE RESOLUTION OF THE SCREEN
- POOR POSITIONING CAN LEAD TO DISTORTION OF THE IMAGE
- 3D IMAGING CREATES A MORE ACCURATE REPRESENTATION OF THE PATIENT'S ANATOMY

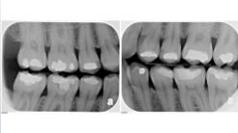
### IMAGE QUALITY ASSESSMENT

- DAILY COMPARISON OF IMAGES TO HIGH QUALITY TEST IMAGES IS RECOMMENDED (LEVEL A TEST)
- NATIONAL RADIATION PROTECTION BOARD (NRPB) GUIDELINES FOR ASSESSING THE QUALITY OF RADIOGRAPHS
- **GRADING SYSTEM**
  - GRADE 1 – VERY GOOD
  - GRADE 2 – GOOD ENOUGH FOR DIAGNOSTIC PURPOSES
  - GRADE 3 – UNACCEPTABLE

### GRADE 1 (QS1)



- EXCELLENT QUALITY
- **NO ERRORS OF PATIENT PREPARATION, POSITIONING, EXPOSURE, PROCESSING OR FILM HANDLING**



### GRADE 2 (QS2)



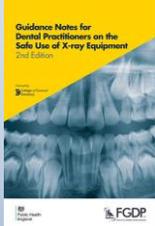
- GOOD QUALITY
- SOME ERRORS OF PATIENT PREPARATION, POSITIONING, EXPOSURE, PROCESSING AND FILM HANDLING
- **IMAGE IS STILL OF ADEQUATE DIAGNOSTIC QUALITY FOR THE PURPOSE INTENDED AND IS THEREFORE ACCEPTED**

### GRADE 3 (QS3)



- POOR QUALITY
- MANY ERRORS OF PATIENT PREPARATION, POSITIONING, EXPOSURE, PROCESSING AND FILM HANDLING
- **THESE ERRORS RENDER THE IMAGE DIAGNOSTICALLY UNACCEPTABLE, AND THE RADIOGRAPH MUST BE REPEATED**
- RECORD OF DATE, NATURE OF DEFICIENCY, KNOWN OR SUSPECTED CAUSE, NUMBER OF REPEAT RADIOGRAPHS

### PROFESSIONAL GUIDANCE



Intraorals and panorams audited separately

At least 100 images included

Ensures that both imaging methods are being audited independently

MINIMUM TARGETS FOR RADIOGRAPHIC QUALITY

QS Rating	% of radiographs taken
Grade 1	Not less than 70%
Grade 2	Not more than 20%
Grade 3	Not more than 10%

**New guidance recommends 95% A, and only 5% N**

REMEDIATION ACTION



QUALITY ASSESSMENT

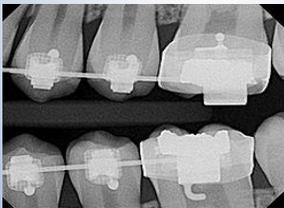
**ARE THESE DENTAL  
RADIOGRAPHS GRADE  
1, 2 OR 3?**

RADIOGRAPH 1



Grade 2  
Underexposed

RADIOGRAPH 2



Caries – Grade 2  
Bone levels – Grade 3 due to missing lower bone levels

RADIOGRAPH 3



Grade 3  
Double Exposure

RADIOGRAPH 4



Grade 2  
Posterior cone mark  
Distal surfaces of canine not visible (ideal anatomy not covered)

RADIOGRAPH 5



Grade 2  
Foreshortened teeth  
Incorrect angulation of tube

RADIOGRAPH 6



Centre tooth – Grade 2  
Adjacent teeth – Grade 3 for missed apices

RADIOGRAPH 7



Grade 3  
Lower border of mandible not included  
Radiolucency not entirely visualised

RADIOGRAPH 8



Grade 1

RADIOGRAPH 9



Grade 3  
Apices not included

**RADIOGRAPHS SUPPORTING DIAGNOSIS**

- CLINICAL EXAMINATION WILL LEAD CLINICIAN TOWARDS DIAGNOSIS, BUT THEY CANNOT ALWAYS BE SURE THIS IS CORRECT
- RADIOGRAPHS ARE REQUIRED TO **CONFIRM SUSPICION**
- THIS ALLOWS THE CLINICIAN TO BE SURE OF THE DIAGNOSIS AND PLAN THE TREATMENT TO RESOLVE THE PATIENT'S PAIN/SYMPTOMS

**ADJUNCT TO CLINICAL EXAMINATION**

- RADIOGRAPHS SHOULD **NEVER** BE USED TO GENERALLY SCREEN PATIENTS (EG. GENERAL OVERVIEW)
- IT IS NOT ACCEPTABLE FOR CLINICIANS TO IRRADIATE PATIENTS TO LOOK FOR RANDOM PATHOLOGY WITHOUT A REASON TO DO SO
- RADIOGRAPHS SHOULD **ONLY** BE TAKEN AFTER CLINICAL EXAMINATION HAS BEEN COMPLETED AND THE CLINICIAN SUSPECTS A PATHOLOGY/CONDITION
- EACH RADIOGRAPH SHOULD HAVE A **CLINICAL QUERY**

**CONTINUOUSLY UPDATING KNOWLEDGE**

- ALL STAFF WORKING WITH RADIOGRAPHIC EXAMINATIONS HAVE TO UPDATE THEIR KNOWLEDGE REGULARLY
- "CONTINUOUS PROFESSIONAL DEVELOPMENT" (CPD)
- GDC – EXPECT 5 HOURS IN EVERY 5 YEAR CPD CYCLE – HIGHLY RECOMMENDED
- FORMS OF CPD
  - FACE TO FACE TRAINING COURSES
  - E-LEARNING

**GDC GUIDANCE**

**RECOMMENDED CPD TOPICS**

- WE'RE RECOMMENDING THESE CPD TOPICS BECAUSE REGULARLY REFRESHING YOUR KNOWLEDGE AND SKILLS IN THESE AREAS WILL CONTRIBUTE TO IMPROVED PERFORMANCE AND PATIENT SAFETY.
- MAKE A PLAN FOR YOUR CPD TO ENSURE:
- YOU'RE MEETING THE MINIMUM NUMBER OF VERIFIABLE CPD HOURS
- THE CPD YOU DO IS VERIFIABLE
- IT'S RELEVANT TO YOUR FIELDS OF PRACTICE
- THE ACTIVITY LINKS TO ONE OR MORE DEVELOPMENT OUTCOMES
- THE CPD HAS BEEN QUALITY ASSURED.
- THE FOLLOWING CPD TOPICS ARE **HIGHLY RECOMMENDED**:
- **MEDICAL EMERGENCIES:** WE RECOMMEND AT LEAST 10 HOURS IN EACH CPD CYCLE, AND AT LEAST TWO HOURS OF THIS TYPE OF ACTIVITY EVERY YEAR.
- **DISINFECTION AND DECONTAMINATION:** WE RECOMMEND AT LEAST FIVE HOURS IN EACH CYCLE.
- **RADIOGRAPHY AND RADIATION PROTECTION:** IF YOU UNDERTAKE RADIOGRAPHY, WE RECOMMEND AT LEAST FIVE HOURS IN EACH CYCLE. FOR DENTAL TECHNICIANS WE RECOMMEND MATERIALS AND EQUIPMENT, INSTEAD OF RADIOGRAPHY AND RADIATION PROTECTION, AND AGAIN, AT LEAST FIVE HOURS IN EACH CYCLE.

**SPOT THE FILM FAULTS!**

**NONE OF US ARE PERFECT  
ALL OF THE TIME!**



