The Chemistry of Black & White Photography

A camera takes a picture with "light". Electrons reduce silver ions.
(exposes a *latent image* on the film or paper)

The film then undergoes processing which magnifies the reduction of silver ions.

- DEVELOPER
  a. *Reducing Agent* - silver ions (Ag^{1+} are reduced to Ag)
     Hydroquinone [pH = basic (slippery feeling)]

  b. *Activator* - removes H^+ from the reducing agent.
     Sodium hydroxide, NaOH or a salt of CO_3^{2-}
     $CO_3^{2-} + H_2O \text{ -----> } HCO_3^{1-} + OH^{1-}$

  c. *Restrainer* - inhibits the reduction of unexposed silver ions
     Potassium bromide, KBr
     (image is low contrast if not agitated due to buid up of Br^{1-})

  d. *Preservative* - keeps reducing agent from being oxidized (or worn out)

- STOP BATH
  An acidic solution [pH = acid (not slippery feeling)]
  Acetic acid, CH_3COOH, neutralizes base (activator) from developer and dilution occurs.

  $H^{1+} + OH^{1-} \text{ -----> } H_2O$
  $CH_3COOH + NaOH \text{ -----> } H_2O + CH_3COO^{1-}$

- FIXER or "hypo"
  Insoluble silver halide is converted to a soluble material

  $AgBr + 2\ S_2O_3^{2-} \text{ -----> } Ag(S_2O_3)_2^{2-} + Br^{2-}$
  *thiosulfate
  "hypo"

*Without "hypo" it would take 2500 gallons of water to dissolve 1 g AgBr!

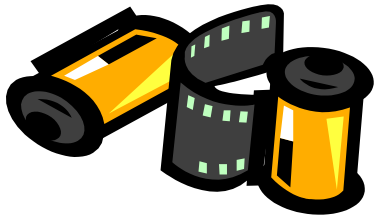
Silver image is superimposed on a background of pale yellow silver halide. If you turn on room lights, undeveloped silver halide will be exposed to light, activated, developed and picture will turn to black (no image).

Sulfur $(S_2O_3)^{2-}$ yellows if not completely washed off. This is why photographs yellow with age if not properly processed and washed.

Photographic film or paper is an emulsion (backing) with a thin coating of silver halide (generally silver bromide). Faster films (more light sensitive) have a thicker emulsion with more silver bromide in it to "catch light".

You can also process film longer to increase its sensitivity to light. This is called "push-processing", but has the problem of "grain".

A silver ion is either reduced or is not reduced (its all or nothing). If only a few grains are exposed to light processing will magnify few grains to become very large.



Protocol for Processing of Black & White Photographic Paper

1. DEVELOP for 90 seconds with slight agitation of developer solution.
2. STOP-BATH for 30-45 seconds.
3. FIXER for 3-5 minutes.
1. WASH in water for 5-30 minutes.

Method for formation of latent image and “Turnballs Blue” image with U.V. light.

1. 10% solution of ammonium citrate on paper - "film/paper"
2. dry 10 minutes in 55 ^{o}C oven
3. Expose “film” 5 – 10 minutes in sunlight
4. Develop 5 seconds in 10% potassium ferricyanide solution
5. Rinse 5 seconds.