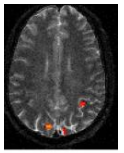
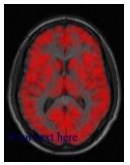
Medical Imaging - Radiology

CAT (or CT) - Computerized Axial Tomography
A computerized assembly of several x-ray images taken at different angles.

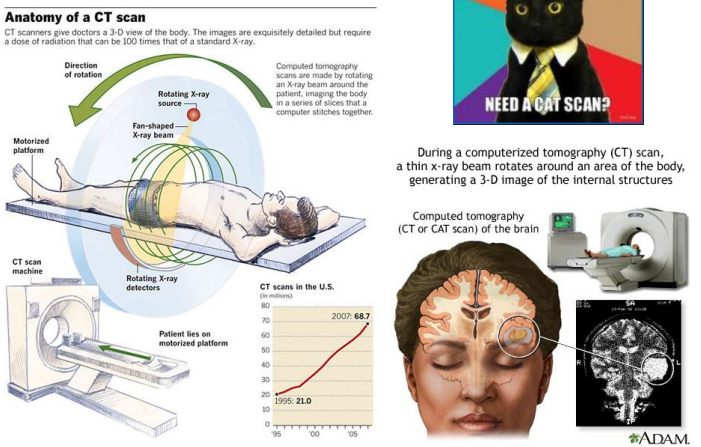
MRI (or NMRI) - Magnetic resonance imaging (MRI) produces high quality images of the inside of the human body. MRI is a noninvasive imaging technique that does not use x-rays. The fluid contrast between structures in the brain can then be visualized.



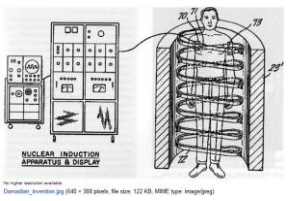
PET - positron emission tomography (PET); PET produces images of metabolic activity as opposed to images of the body's physical properties. A small amount of radioactivity in a metabolite is introduced into the body. These are concentrated and processed by tissues as part of their normal function. The source of the radiation in the body pinpoints the location of the metabolites.



CT Scan



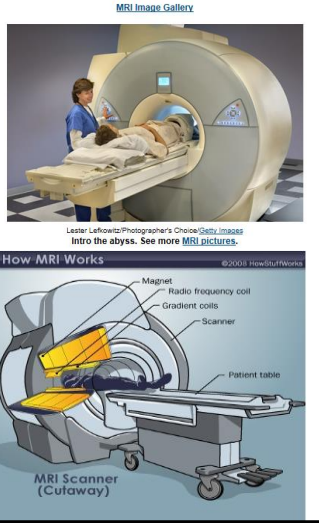
MRI Scan

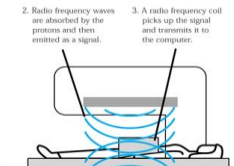


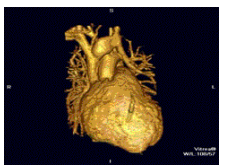
The first MRI of a human body was done on a graduate student of Dr. Raymond Damadian July 3, 1977. It took almost five hours to produce one image, and that original machine, named the "Indomitable," is now owned by the Smithsonian Institution. .

Imagine each hydrogen atom as a tiny magnet. In the MRI machine, they all line up. When the RF pulse disappears, they go back to their normal positions, releasing energy, which the system uses to make an image.

Gradient magnets are small magnets that change the field within an MRI system. When turned on and off very rapidly, they essentially change the focus of the overall field. This enables the MRI system to choose exactly where in the body to acquire an image.

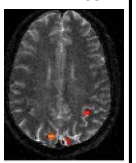






MR angiogram in congenital heart disease

MRI - knee



MRI – brain

PET Scans

The radioisotopes used in PET to label tracers are ^{11}C, ^{13}N, $^{15}0$, and ^{18}F. These radioactive forms of natural elements pass safely through the body.

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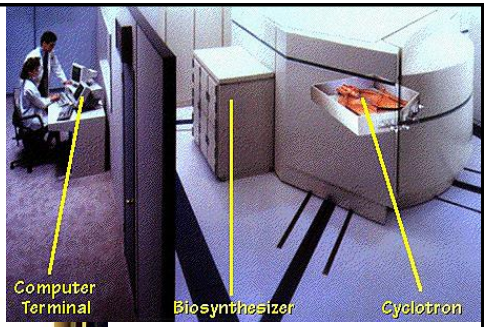
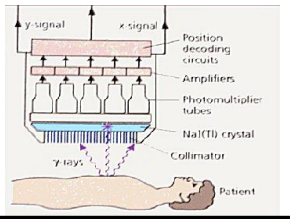
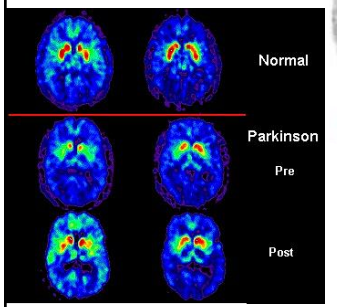
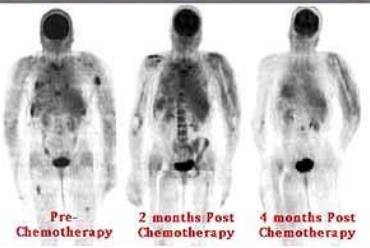
^{11}C decays to **^{11}B** by positron emission with a half life of 20.334 minutes.

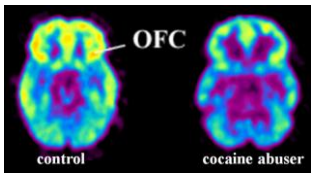




Web images of PET scans







Ultrasonography:

Introduction to Ultrasound Imaging

Ultrasound scanners - a form of 'medical' Sonar

SONAR = **So**und **N**avigation **a**nd **R**anging

RADAR = **Ra**dio **D**etection **a**nd **R**anging

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1877 - Lord Rayleigh – "The Theory of Sound" – sound waves

1912 - Underwater navigation - submarines WWI, Titanic sank

1935 - First practical RADAR using electromagnetic waves

1940s – Ultrasound therapy: **arthritis**, **craniotomies**

1952 – John Wild – "Application of Echo-Ranging Techniques to the Determination of Structure of Biological Tissues"

1958 – "Investigation of Abdominal Masses by Pulsed Ultrasound" (an important early paper on medical diagnostic uses of ultrasound)

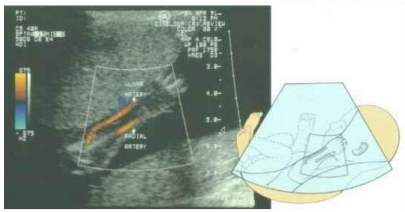
What are Obstetric Ultrasound Scans?

Obstetric Ultrasound is the use of ultrasound scans in pregnancy. Since the late 1950's ultrasonography has become a very useful diagnostic tool in Obstetrics. Currently used real-time scanners using very high frequency sound waves of between 3.5 to 7.0 megahertz (i.e. 3.5 to 7 million cycles per second) can provide a continuous picture of the moving fetus can be depicted on a monitor screen. and growth in the fetus. The conducting gel is non-staining but may feel slightly cold and wet. There is no sensation at all from the ultrasound waves.

Transducer (probe) on the abdomen

3-D scan of fetal face

Ultrasound
and
3D Ultrasound



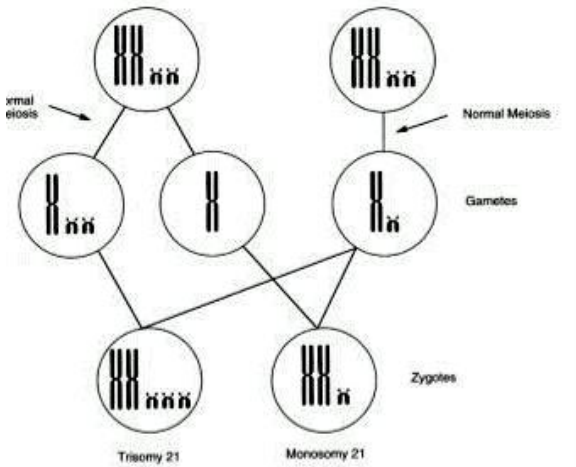
The fetal arm with the major arteries (radial and ulnar) clearly delineated.

Inherited Abnormalities

	/10^3 live births
Down's Syndrome*	1.3
Cystic Fibrosis	0.4
Familial Hypercholesterolaemia	2.0
PKU	0.1
Hypothyroidism	0.25

- First described **1866 - JLH Down**
- Clinical Features
  - Average life expectancy 30 years
  - Characteristic phenotype
  - Learning disability (IQ 20-60)
  - Developmental delay / Hypotonia
  - Delayed puberty / Early menopause

Downs Syndrome - Trisomy 21

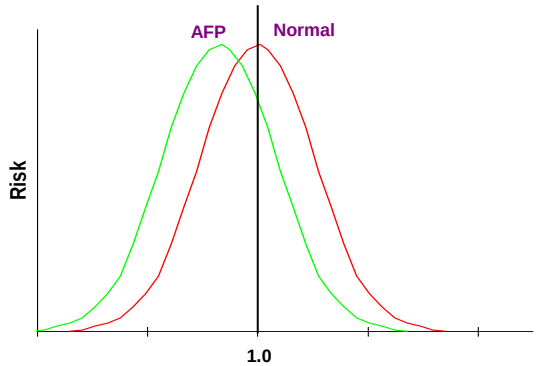


Screening Tests: Screening tests are used to look for potential problems and to identify those who **are at high risk of** having a baby with a genetic disorder.

The triple screen and the alpha-fetoprotein plus, and more recently, the quad test measure the **amounts of certain** hormones and proteins in the blood including alpha-fetoprotein, human chorionic gonadotropin, **unconjugated estriol and** inhibin. The results of these tests together with the woman's age, will provide an estimate of her **risk of having a child** with Down syndrome. These tests are usually performed between the fourteenth and sixteenth **week of gestation.** Approximately 60-80% of fetuses with Down syndrome can be identified prenatally by considering **the mother's age and** employing these screening tests.

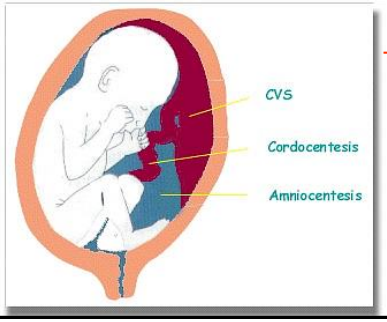
In addition ultrasound examinations are almost always performed. During an ultrasound examination **the physician looks** for "markers", such as a thickening of the skin at the back of the neck (nuchal fold), bright spots **on the kidneys or heart,** short arms or legs, reduced head size, congenital heart disease, and gastrointestinal problems. If **any of these "markers"** are observed, diagnostic testing is generally recommended.

Theoretical AFP Distributions



Non-invasive procedure

Amount of fluid behind the neck of the fetus (Nuchal translucency) scan



Three invasive procedures

chromosomal abnormality

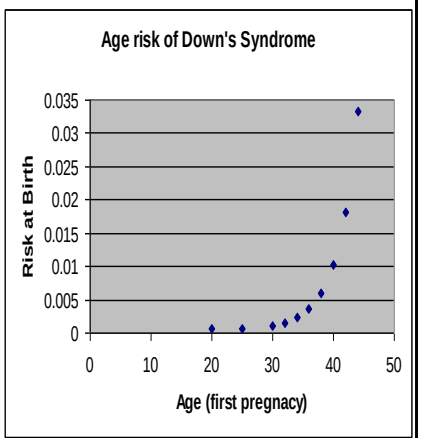
Chorion villus (placenta) sampling (11-14 wks)

Amniocentesis (>15 wks)

Cordocentesis (>20 wks)

Down's Syndrome (Trisomy 21)

MATERNAL AGE	RISK AT BIRTH
20	1/1527
25	1/1352
30	1/895
32	1/659
34	1/446
36	1/280
38	1/167
40	1/97
42	1/55
44	1/30



http://www.fetalmedicine.ac.uk/antenatal.htm