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### **MEMO TO TEACHERS USING THE VIDEO SERIES: "YOU ARE WONDERFUL"**

As producer of this series I sincerely hope you enjoy these lectures as much as I enjoyed producing them. Working with Dr. Brand has been one of the greatest experiences I have encountered.

Please make as many copies of any of the printed material as you need. The videos can be used in any way except broadcast and, of course, they cannot be copied. For permission to broadcast, please contact Norlynn Audio Visual Services.

We would appreciate receiving any suggestions, observations, or criticisms that you feel will make these lectures more effective. We plan to update the teacher's guide from time to time. New guides will be sent to those registering their purchase of this series, as they become available.

The questions listed are primarily to stimulate discussion. They are answered in the videos.

To receive future updates please complete the following and return to Norlynn:

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## **TEACHER'S GUIDE FOR "YOU ARE WONDERFUL" VIDEO SERIES**

### **Overview - Dr. Brand**

Dr. Brand, at eighty, is still one of the most sought after medical speakers in the world. He is constantly travelling around the world to speak at major medical conventions and to receive honours for the pioneer work he has done in hand surgery, leprosy and diabetes.

The cartoon sketches in the video introduction focus on a few points of his remarkable life, beginning with an imaginative portrayal of his conception and embryonic development. It goes on to his childhood in India, where he enjoyed swinging from Banyan trees and mountain climbing. His father knew and loved nature and passed this love on to Paul.

What he seemed to have failed to pass on to his son was his love for medicine. Paul was repulsed as he watched his father treat infected wounds and ulcers, as seen in the second illustration. At nine he and his younger sister left India for an education in London. His father died before Paul saw him again.

After high school Paul studied engineering and worked for a building contractor. He planned to go to India as a builder to build houses and hospitals for a mission society. However, a preliminary short course in tropical hygiene and public health stirred a love for human biology and medicine and his lifelong vocation began. Interning in London, during the blitz, of World War II gave him ample opportunity for surgery to repair damaged limbs. He built on this foundation and his engineering background to become, ultimately, one of the world's top experts in the surgery of the hand.

After the war he returned to India, as a surgeon. He made a special study of the deformities of leprosy and became the first surgeon in the world to successfully reconstruct leprosy hands and feet. It was his discovery that leprosy patients lost their fingers and feet because of lack of pain, not from "rotten flesh" as had been thought before. He also showed that with early treatment and special care, deformities need never occur. This fact radically changed the treatment of leprosy, worldwide.

Dr. Brand next moved to Carville, Louisiana, to do research in the U.S. Public Health Services Hospital, America's only leprosy hospital. His common sense approach to leprosy was also transferred to diabetes. Again he suggested the destructing ulceration of the feet, so often suffered by diabetics, and so often resulting in amputation, was due mainly to the lack of pain sensation. The healing of ulcers, and their prevention became routine when the cause was identified. In diabetic clinics where this technique was used, the amputation rate dropped 50% in a short time. This is very significant when you consider that previously more than half of all amputations in the U.S. were on diabetics.

The last illustration shows Dr. Brand working on a computer program that mimicked the motion of a human hand. The co-ordination of the muscular movements of a hand playing a piano proved so complex that no existing computer could produce the mechanical control.

The human body is an astounding machine. Dr. Brand has never lost his sense of wonder at its design. He projects this sense of wonder throughout this series.

As you watch the videos, please remember that this is not a slick presentation done in a studio, with a script, with many retakes and special effects. It is shot in a regular classroom, in real time, with a blackboard and a minimum of visuals added later. The original concept was to add many more visuals, but the wisdom of Dr. Brand and his passion for the subject, has come through so well that the producers felt that visuals would rob the students, rather than add to their learning experience.

The original lectures were given in a public school, to high school students studying biology. The lectures are equally suitable for college biology students, or to medical students.

There are many excellent books visually showing the wonderful design of our bodies. Two favourites are "The Pictorial Dictionary of the Body" and Reader Digest's "The ABCs of the Human Body".

Two books which thoroughly discuss the possibilities and problems of evolution by random chance as compared with the evidence of intelligent design are *Pandas and People*: Davis and Kenyon, and *Evolution: A Theory in Crisis* by Michael Denton. Neither of these books promotes religious views, but both suggest the need to think beyond chance mutation and survival of the fittest.

Dr. Brand's books, co-authored with Philip Yancey, *Fearfully and Wonderfully Made, In His Image, Pain: the Gift Nobody Wants* (now retitled *The Gift Nobody Wants*) and *The Forever Feast* all exemplify the range of his knowledge, delivered in an enthusiastic, easy to read style. Highly recommended reading for every student.

If you want to know more about Dr. Brand's life, his biography is *Ten Fingers for God* and his mother's biography is *Granny Brand*, both published by Zondervan. A delightful ninety-minute video interview with Drs. Paul and Margaret Brand, *Of Joys and Sorrows*, is available through Norlynn Audio Visual Services.

Dr. Brand has also authored a handbook for hand surgery. Surgeons around the world use this handbook, now updated by a surgeon who studied under Dr. Brand.

Dr. Brand's awards include:

**"COMMANDER OF THE ORDER OF THE BRITISH EMPIRE"** Awarded by Her Majesty Queen Elizabeth II (1961)

**"DISTINGUISHED SERVICE AWARD"** Department of Health and Human Services United States Public Health Service (1981)

**"THE SURGEON GENERAL'S MEDALLION"** Department of Health and Public Service United States Public Health Service (1987)

**"THE ALBERT LASKER AWARD"** for "Outstanding Leadership and Service in Rehabilitation of the Handicapped" (1960)

**"THE BASIN AND TOWEL AWARD" "SERVANT OF THE YEAR"** "For Your Noteworthy Service to Your Fellow Man" Christian Medical and Dental Society (1982)

## **PRODUCERS NOTES:**

Working with Dr. Brand has been a high point in my life. It has been a tremendous privilege working closely with one of the world's great thinkers. At eighty, Dr. Brand is not only retaining his great intellect, but also is still eagerly adding new ideas and seeking to learn the latest developments in his field. I have discussed this with Dr. Brand and have tried to identify some of the factors that contribute to his continuing success.

First his genetic make-up is the product of two very remarkable people. Evelyn and Jessie Brand, who devoted their lives to working with the simple-living hill tribal people in the mountains of South India. Their efforts spanned a wide spectrum of education, medical care, agriculture, building and public health. Jessie died young of blackwater fever, but not before he had passed on much of his wide knowledge of nature to his son. Evelyn lived and continued to work to the age of 95, by which time she was able to see the long-term results of some of their early work. This included the total eradication of the plaque of guinea worm, which had been the scourge of the mountain people.

Living in a log cabin without formal schooling, roads, automobiles, electricity, or plumbing, the Brand family had to face every daily problem with their own original solutions "by common sense, by trial and error, and by the grace of God." As I worked with Dr. Brand I was constantly reminded of Winston Churchill's remark that there was no problem on earth too great to solve, by applying common sense. Dr. Brand's approach to problems of leprosy and diabetes defied the conventional wisdom of the times and lead to unprecedented medical breakthroughs, resulting in millions of lives being changed for the better.

Dr. Brand attributes his long life and good health to a very simple lifestyle and simple diet. He shares these views with this wife of more than fifty years, who is also a doctor. Margaret Brand has also been a pioneer in the field of leprosy from her special background in ophthalmology.

Checking up on Dr. Brand, I have carefully observed his lifestyle and his eating habits and feel they are worthwhile passing on. He eats a lot of fruit and vegetables, with moderate amounts of meat. Breakfast at the Brand's home is a delight. Dr. Paul rises very early and prepares an amazing fruit salad. This is followed by; hot rolled oats, or bran cereal, with coffee and buttermilk as a beverage.

Lunch is simple. He enjoys toast and Marmite, a vegetable yeast spread that is a great source of vitamin Bs that are essential to the health of our nervous system. Dinner is varied, but always includes fresh vegetables.

Dr. Brand believes in being prepared for whatever the future may bring. Having been a hand surgeon for many years, he has often observed the devastation when a patient has lost the use of his, or her, dominant hand. Knowing that many people his age lose the use of a hand due to a stroke he has started to train his left hand to do most of the things that he normally does with his right. If he has a stroke that knocks out his right hand, his left hand will already be prepared to take over.

The same philosophy has encouraged him to study ways of handing severe pain, without addictive drugs. Knowing how much the perception of pain depends upon mental attitudes, he has developed his own philosophy about pain (as seen in Video #2), and now teaches others to be ready for it when it comes. He wants doctors, therapists and parents to teach young people about the system of pain, long before they are ever likely to suffer severely themselves.

## **Overview The Lectures**

Dr. Brand shares his wonderful knowledge and respect for the human body in a intimate and meaningful way. His obvious love for the subject and concern for communicating truth shines though the entire series.

His objective is to make all of the students proud and excited about their own bodies and minds, especially those who have been left behind in the race to be Number One! His experience is that today's emphasis on being a "winner" leaves many feeling that they are "losers". He teaches that both "winners" and "losers" have wonderful bodies and minds and that "self-mastery" is the most important victory. Each student is challenged to experience the wonder of the body and to develop a sense of self-worth.

The joy of discovery remains with Dr. Brand, even after spending over half a century exploring the mysteries of the body. His study draws students into a search for learning and appreciating just how their bodies react and respond to the various types of stimuli, some friendly and some hostile. This series will have a lasting impact on everyone who experiences it.

## **1) Muscles and Motion (Part 1: Joints)**

The modern emphasis on becoming a "winner" has tended to create too many "losers". We should not judge ourselves against other, as in a race. That creates more losers than winners. We all need to strive to become "winners" over ourselves. If we have mastered our own abilities, and learned to be in control of our lives,, then we are winners indeed! We can all do that! What a wonderful machine we control! Enjoy your hands - the greatest machine on earth!

Dr. Brand uses the human hand to set the stage for the entire series. With the hand as a reference point, he explains the workings of joints, muscles and the motor nervous system. He compares artificial hands and hips with the real thing, continually instilling a sense of wonder.

Hands are examined from the standpoint of an injury to them. We are given an idea as to what resources our own systems have available in the healing process, above and beyond the doctor's skills. There is a look at the circulatory and skeletal system's response to damage caused by an accident.

## **1) Muscles and Motion (Part 2: Muscles)**

Dr. Brand once headed a major research project which consisted of putting all of the mechanics of the hand into a computer simulation which was to be three dimensional and interactive, so that each finger could be stimulated to move from orders from the keyboard. The engineers were amazed at the amount of precision required to control each muscle and joint to produce as simple a movement as a pinch between finger and thumb.

In the video Dr. Brand stated "off the cuff" that on the computer it took 2 million operations to compute the optimum position and force of each muscle-tendon unit to produce such a pinch against a given opposing force. Checking afterwards with one of the engineers he found he had underestimated the problem. He should have said 30 million operations! Think of this next time you try to pinch something, or someone.

Dr. Brand points out that even this measure of required precision deals only with mechanical force. He goes on to show something of the required precision of the chemistry of the protein elements of muscle, actin and myosin, and the neuro-transmitters that initiate the contraction, and the number of inhibitor enzymes that bring each contraction to an end. He pictures the dazzling speed required of these chemical reactions, in a microscopic environment, that permits hand to play a piano, then rock, or stroke, a baby to sleep.

Students leave the classroom looking at their own hands with a new respect, and an enhanced sense of their own potential.

While the videos can be understood and their message appreciated without any advanced knowledge of biochemistry, it certainly is better understood by students after their first year of chemistry and biology, rather than before.

## **2) Pain - Our Protector (Part 1)**

Dr. Brand takes the students through his own journey, from considering pain as the one major design flaw in the human body, to the realisation that without pain we can never experience the full potential of our bodies. He began in medicine believing the relief from pain was the highest calling. He discovered that without the luxury of pain you can really hurt yourself, to the point of becoming crippled, or even dead.

He tells of experiments trying to measure pain objectively and quantitatively and the problems encountered.

Dr. Brand's work with leprosy, diabetes and congenital pain deficiency have taught him how the body relies on pain. He shares many fascinating personal experiences with the students.

## **2) Pain - Our Protector (Part 2)**

The absolute need for pain and our reasons for disliking it are discussed.

Dr. Brand tells of the frustrations in his attempts to design a system that would serve to protect bodies of those who lost their normal pain system because of leprosy or diabetes. He gives powerful examples of the disasters that occur when individuals have the ability to turn pain off.

Students are given many helpful suggestions on coping with pain and in learning to heed its warnings.

The lecture ends with illustrations of how closely pain and pleasure are linked. Dr. Brand humorously describes himself taking a hot bath, as an illustration of this.

### **3) The Eye (Part 1)**

In this pair of lectures Dr. Brand challenges the students to design an eye. He outlines seven major systems that must all function correctly to produce the miracle of sight. Together, with the added requirement of precise co-ordination, they are seen as a triumph that is absolutely mind-boggling.

#### ***Surface Transparency Department***

Almost the entire first part of this lecture is devoted to the factors that are required to have a clear cornea and lens. There are the only portions of the body that are sustained without the benefit of a blood supply. The blood supply provides nutrients, waste disposal, protection against physical damage, bacterial protection, keeps living cells moist and assists in the healing process. Many highly specialised systems must be present to allow clear cell to survive, without blood. For instance our tears not only keep the surface of the eye moist, they remove foreign materials and are extremely anti-biotic. They are manufactured in a special, highly complex "factory" located on the side of the eye.

The properties of skin are used to illustrate the special needs of the cornea. Dr. Brand speaks in depth about the many things required to allow this clear window to function without blood.

A friend of the producer, who wrote his master's biology thesis on the functions of the human eye, was amazed at this lecture. He had never begun to realise all that is required to allow light to come into the eye.

### **3) The Eye (Part 2)**

Dr. Brand begins with the embryological formation of the eye. The line-up of the front and back cups of the eye are compared it the docking to two spacecraft.

He then goes on to briefly discuss the other six systems required for vision:

#### **The Optical Department**

The requirement of forming an image on the retina.

#### **The Transduction Department**

The system transforming this image into nerve impulses

#### **The Transmission Department**

Approximately 250 million impulses must be transmitted to the brain each second.

#### **The Translation Department**

These hundreds of millions of impulses must now be decoded for the brain to begin the process of meaningful sight.

#### **The Mental Imaging Department**

This digital information must now be assembled into a virtual three dimensional, coloured image.

#### **The Mental Recognition Department**

Finally, these visual images must be related to other sense and compared to images in our memory bank for image recognition.

Without all seven systems functioning perfectly sight would be limited, non-existent, or meaningless.

This complexity makes one appreciate Charles Darwin's remark, "To suppose the eye with all its inimitable contrivances for adjusting to differing amount of light and for the correction a spherical and chromatic aberrations could have been formed by natural selection, seems absurd in the highest degree."

An "on the ball" biology teacher has pointed out to Dr. Brand an error near the end of this lecture. The doctor apologises for the mistake he made in speaking of nerve conduction. Dr. Brand said in the axis cylinder, of the nerve, the ions on the inside of the tube carried a positive charge and those outside carried a negative charge, when in an off position. He asks that teacher explain to students that this should be reversed. This is true of all nerves in the body, when stimulated these positive and negative charges change places.

#### **4) Hormones (Part 1)**

A comparison is made between what are called "fast codes" or nerve impulses and "slow codes" or hormones, both exercising control over our bodies. The two systems are examined in terms of their need for pathway and cell responses, as well as chemicals and their coding and decoding.

He starts with adrenaline, comparing it to "code blue" in hospitals, then moves onto the sex hormones and how they control so much of our development and behaviour.

Estrogen is examined in light of its effect on female bone development to allow for childbirth. The role of osteoclasts and osteoblasts is discussed and the role of hormones in determining their activities.

#### **4) Hormones (Part 2)**

The roles of progesterone, in preparing the female body for childbirth, and prolactin, for stimulating the manufacture of milk for the baby, are examined in detail.

As the understanding of our bodies increases, we are encouraged to care for them and realise that as we treat ourselves well, we affect others positively.

He fittingly ends this set of lectures and the entire series, with the brain, the centre of our reasoning which gives each person the ability to make choices, considering all the facts and the consequences of our actions. Students are challenged to consider the consequences of allowing themselves to be controlled by their raging hormones.

Every segment of the lectures, by this man, who is undoubtedly one of the great intellects of this century, emphasises the self-worth of every human being. Expect your students to be profoundly influenced as they sit at the feet of a master communicator.

## **"YOU ARE WONDERFUL"**

### **1- Muscles and Motion (Part 1)**

- 1) a) What problems can you see developing in a highly competitive society which stresses winning as its goal?  
b) What advantages do you see in the same system?
- 2) What was the intent of the surgeon examining the undamaged hand of the patient before looking at the hand that was injured?
- 3) What are some of the problems the robotic expert runs into in trying to duplicate the human hand?
- 4) Why do people equipped with one artificial hand tend to use their real hand?
- 5) How are human joints lubricated?
- 6) What are canaliculi? What is synovial fluid?
- 7) How does the friction between a human joint and an artificial joint differ?
- 8) Name three major points Dr. Brand makes and how they affect the way you feel about ourselves?
- 9) What are collagen fibres? What is their function in the healing of bone?

### **1-Muscles and Motion (Part 2)**

- 1) What introduces acetylcholine into the muscle fibre and what is the effect in terms of:
  - a) it's role in the nerves system?
  - b) it's function in muscle contraction?
- 2) Describe the model Dr. Brand uses to explain the microscopic structure of muscle and the action of it's proteins.
- 3) How and why must muscles relax?
- 4) a) What is an enzyme? How does cholinesterase act as an enzyme in the action of muscle retraction?  
b) Describe the action of cholinesterase in the action of muscle retraction.
- 5) Why does the theory explaining muscle retraction from magnetic attraction and repulsion of myosin and actin seem unlikely? What is the new possible explanation?
- 6) What did Dr. John Chawnley develop?
- 7) Are joints self-repairing?

## **"YOU ARE WONDERFUL"**

### **2) Pain - Our Protector (Part 1)**

- 1) Before Dr. Brand's research, what was considered the reason for leprosy patients losing flesh?
- 2) What theory did Dr. Brand advance and then prove to be a fact?
- 3) Describe one way Dr. Brand's research has improved the lives of leprosy patients.
- 4) When Dr. Brand began to study medicine what was his motivation and understanding regarding pain?
- 5) Describe two experiments, tested by Dr. Brand and his fellow students, to quantify pain.
- 6) Were these experiments successful? Why?
- 7) Why is pain important to us?
- 8) How did the little girl who felt no pain use the lack of pain to control her parents.
- 9) What causes muscle cramps?
- 10) Describe the actions of your nervous system when you strike your thumb with a hammer.
- 11) Why do leprosy patients keep cats?

### **2) Pain - Our Protector (part 2)**

- 1) Considering it's benefits, why do we still dislike pain?
- 2) Name a \$60 billion industry in North America that thrives on our fear of pain.
- 3) Why does Dr. Brand feel that our reliance on painkillers can be detrimental to our well being?
- 4) Describe attempts to produce pain substitutes. Were they successful? Why?
- 5) What caused the patients in a Chicago hospital to suffer from frostbite?
- 6) What did these patient use to switch their pain system off?
- 7) Describe the difference between being "body oriented" and "task oriented."  
Which do you feel is best? Why?
- 8) What is the reason for Dr. Brand using a hairbrush on the arm of a patient?
- 9) Name a therapy Dr. Brand suggests when you are experiencing pain.

## "YOU ARE WONDERFUL"

### 3) The Eye (Part 1)

- 1) Name the seven departments Dr. Brand suggests are necessary if you were to design a human eye?
- 2) Briefly describe the function of each department.
- 3) Describe the characteristics of cells that are found within our skin.
- 4) What problems would skin present if it were to cover the eye?
- 5) How does the cornea deal with the following needs and still remain transparent?
  - a) defence
  - b) moisture
  - c) nutrients
- 6) What is the function of the lachrymal gland?
- 7) What is lysozyme?
- 8) Name two functions of the eyelids.

### 3) The Eye (Part 2)

- 1) Describe the embryological development of the eye.
- 2) What is ectoderm? What part of the eye does it form?
- 3) What is mesoderm? What part of the eye does it form?
- 4) What does Dr. Brand compare the joining of the two parts of the eyecup to?
- 5) What are the functions of rods and cones? How do they differ?
- 6) What area of the brain controls sight?
- 7) What is a transducer?  
How is a transducer used in modern street lighting?  
What parts of the eye are transducers?
- 8) Describe the polarisation and de-polarisation within a nerve.
- 9) If the message is the same from all sensory nerves, how does the brain determine what the message means?
- 10) Describe the need for "The Mental Integration Department."

## "YOU ARE WONDERFUL"

### **4) Hormones (Part 1)**

- 1) a) What is a "slow code"? What is a "fast code")  
b) How do "slow codes" and "fast codes" differ in terms of:
  - i) pathways they use?
  - ii) chemicals involved in relaying the codes?
  - iii) how they affect the cells they contact?
- 2) How is the action of a hormone like a "code blue" in a hospital?
- 3) Describe how adrenaline works in terms of::
  - a) what causes its release?
  - b) where is it released from?
  - c) how different tissues respond to it?
  - d) whether all smooth muscle reacts to it in the same way. Why?
- 4) What are the functions of osteoclasts and osteoblasts?
- 5) Describe the reaction of Estrogen on the female pelvis.
- 6) Why does the female tend to swing her hips?
- 7) What effect does this have on the male? Why?
- 8) Do male and female hormones affect intelligence?

### **4) Hormones (Part 2)**

- 1) Describe the effect of Estrogen on the breast.
- 2) When is Estrogen released?
- 3) When is progesterone released?
- 4) What is the effect of progesterone on the female pelvis? The breast?
- 5) When is prolactin released? What part of the body does it affect? How?
- 6) Once started, what controls the production of milk?
- 7) What effect does progesterone have on the muscles of the uterus?
- 8) How many letters are in the DNA code? What are they?
- 9) Name two human substances that are presently being manufactured in non-human living organisms through the introduction of human DNA.
- 10) Discuss abilities that humans have that make them superior to all other organisms.
- 11) Did viewing this series of videos change the way you think of yourselves? Of others?

## **GLOSSARY**

### **"YOU ARE WONDERFUL"**

#### **Video 1 Muscles and Motion**

Capillaries	The finest branches of blood vessels which connect small arteries and small veins.
Tendons	(Sometimes called a leader) A tough, fibrous connection between a muscle and a bone. When a muscle contracts it pulls on the tendon which then moves the bone at the joint.
Fibroblast	A cell that specialises in making fibres to heal a wound, it is fibroblasts that make scars. They also make the fibres that connect various tissues together in a normal body.
Synovial Fluid	A clear slippery fluid which lubricates all of the joints in the body.
Cartilage	A tough smooth tissue that covers the ends of the bones, where they form a joint.
Canaliculae	Very tiny microscopic tubes or canals.
Sarcomere	This is the basic unit of which all muscles are made. Every muscle fibre is composed of a chain of these little units that contract and thus shorten the muscle fibre.
Myosin/Actin	These are the two proteins that form the substance of all muscles.
Interdigitate	A digit is a finger, but the word is also used for finger-like projections. Interdigitate refers to such projections alternating with each other like the fingers of one hand may alternate with the fingers of the other hand when they are clasped together.

#### **Video 2 - Pain**

Congenital	Congenital means something that a baby is born with. It may be a defect that is due to a fault in the embryo.
Neuron	A nerve cell. This includes both the body of the cell and the nerves that arise from it.
Cytoplasm	This is the ground substance inside the cell membrane. In the cytoplasm there are various formed bodies of such a nucleus.
Transducers	These are devices that change one type of energy to another. For example, light may be transduced to activate an electric current.

Threshold A level beyond which a specific action takes place. For example, rising floodwater will not enter a house until its level exceeds the height of the threshold or sill of the door. In the video it refers to thresholds of pain (detectable, tolerable, excruciating).

Orientation or Oriented means east (French). Orientation is used in finding one's bearings or priorities in life.

### **Video 3 - The Eye**

Mutation	When a cell divides it ordinarily gives rise to two daughter cells that are exactly the same as the parent cell. If, due to radiation, or some other influence, the daughter cells are different from the parent cell, that is called a mutation.
Germinal Layer	A germinal layer is a layer of cells that are actively multiplying.
Cornea	The transparent part of the globe of the eye.
Collagen	Collagen is the tough protein which forms the basis of ligaments and tendons and is an essential part of bone. It also forms the outer part of the globe of the eye.
Mucous	Mucous is the slippery substance in many fluids. It eases the passage of food through the mouth and intestines. In the eye it is formed into little "goblet" cells inside the eyelids. It mixes with the tears and smoothes the movement of the eyelids over the eye.
Conjunctivitis	(The conjunctiva is the covering of the inner surface of the eyelids and the outer surface of the visible white part of the globe of the eye.) Conjunctivitis is the inflammation of this membrane due to infection by a bacterium or a virus.
Retina	The lining of the back half of the globe of the eye. It contains the cells that are sensitive to light.
Neural Tube	The part of an embryo which gives rise to the brain and spinal cord.
Ectoderm	In the early stages, the embryo divides into three primary layers: the ectoderm (or outer layer), the endoderm (or inner layer) and the mesoderm between the two.
Impermeable	An impermeable membrane is one that does not allow anything to pass through it, it will hold water.
Semi-Permeable	A semi-permeable membrane will allow some substances to pass through it, but not others. It filters like a piece of muslin, or filter paper.

Ionizes When whole molecules, such as salt, dissolve in water they often break up into two "ions" or fragments, one of which is positively charged and the other negatively charged.

Chiasma The optical Chiasma is where some nerves from each eye cross over to the opposite side of brain.

#### **Video 4 - Hormones**

Smooth Muscle The big muscles of the body and those which are under the constant control of the brain are made of striated muscle fibres, so called because when they are examined, under a microscope, they appear to be striped from side to side. The muscles which are not under continuous control of the brain, but which respond to hormonal, or other types of control, it looks smooth under the microscope.

Adenine  
Guanine  
Cytosine  
Thymene These are four bases that are used as four letters of the genetic alphabet, DNA. The entire design and structure of the body is described and recorded by different arrangements of these four letters of the DNA "alphabet." Like a computer program, the four actual symbols have no chemical relation to the substances that make up the body. They are only a code of information and of record.