Contributions of Ancient African Civilizations to Science In Ivan Van Sertima's (1984) book Blacks in Science: Ancient and Modern, countless examples of African science from articles by several different authors are given. A few examples will be listed below for each of the major scientific disciplines.

Chemistry

1. 1,500 to 2,000 years ago near Lake Victoria, carbon steel was made in blast furnaces. The temperature achieved in the furnaces, 1,8000C, was much higher than was managed in Europe until modern times (Van Sertima, 1984, p. 9).

2. Fire was first used 1,400,000 years ago in Chesowanja, near Lake Baringo in Kenya (Van Sertima, 1984, p. 293). Physics and Earth Science

Astronomy

1. The Dogon of Mali had an excellent understanding of the solar system and the universe 700 years ago. The Dogon had detailed knowledge of a white dwarf companion star to Sirius A which was not visible to the naked eye. Western scientists stated that there was no way that the Dogon could have uncovered this knowledge on their own and that it must have been supplied to them by a visiting European or an extra-terrestrial visitor. (Van Sertima, 1984, p. 13)

2. The Yoruba tribe had an exceedingly complex number system based on twenty. (Van Sertima, 1984, p. 15)

3. An 8,000 year old bone found in Zaire, the Ishango bone, covered with series of notches is thought to be the world's earliest number system. (Van Sertima, 1984, p. 14)

4. There was a very accurate calendar system in Eastern Africa by the first millenium B.C. (Lynch & Robbins, 1984, p. 55).

5. A megalithic site similar to stonehenge dating to 300 B.C. was found in northwest Kenya. Its nineteen basalt pillars were aligned extremely accurately with the stars and constellations (Lynch & Robbins, 1984, p. 51).

6. Beatrice Lumpkin discusses the development of the pyramids from African technology, "...from mud bricks to huge stone monoliths..." (Lumpkin, 1984, p. 67). The Egyptians of that time possessed sophisticated mathematical skill which was the foundation of the western science still to come.

7. A model of a glider dated to the 4th or 3rd century B.C. was found in Egypt. The structure of the object was most definitely aerodynamically designed (Messiha et al, 1984, p. 92).

8. An iron-ore mine in Swaziland, the oldest found in the world, was dated as 43,000 years old. The ore specularite was used as a cosmetic and pigment (Zaslavsky, 1984, p. 110).

9. The concepts of distance, area, weight, volume and time were all used by the Egyptians. Egypt also invented standards, units and methods of measurement (Pappademos, 1984, p. 184).

10. Egyptians invented geometry, trigonometry and many other mathematical techniques such as Algebra (Pappademos, 1984, p. 184).

11. Africans developed technology to build sea-worthy boats and the ability to navigate over long expanses of ocean . There is ample evidence to suggest that African explorers reached South and Central

America long before Columbus made his journeys (Malloy, 1984, p. 163).

Biology

1. Africans were the first humans to raise crops and to domesticate cattle 15,000 years ago (Van Sertima, 1984, p. 20). "...between 17,000 and 18,500 years ago while ice still covered much of Europe-African peoples were already raising crops of wheat, barley, lentils , chick- peas, capers and dates" (Wendorf, Schild & Close, 1984, p. 58).

2. Africans developed their own aspirin and used kaolin to treat diarrhoea (Van Sertima, 1984, p. 22).

3. The Zulus had over 700 medicinal uses of plants (Van Sertima, 1984, p. 22).

4. Traditional African doctors carried out autopsies and were able to treat psychosis (Van Sertima, 1984, p. 23).

5. The Africans had a smallpox vaccine long before Jenner invented it. They used the same principle Jenner did and scratched a smallpox pustule with a thorn and then scratched themselves to acquire immunity to the disease (Van Sertima, 1984, p. 23).

6. Africans were skilled surgeons. In 1879 in East Africa, a European observed an African doctor carry out a caesarian section succesfully, using antiseptic techniques, before this type of operation had been done successfully in Europe (Van Sertima, 1984, p. 23).

7. Camille Yarbrough (1984) traced the development of cosmetic science in Africa. One of the results of the practice of cicatrization by African women, "...cutting and plucking their skin with sharp stone, twigs, thorns, crystal splinters or knives and then sprinkling the open wounds with ask, Africans stimulated their bodies to create protective antibodies and to resist disease" (Yarbrough, 1984, p. 90). According to Yarbrough (1984, p. 91) the reflected glare from the waters of the flooded Nile led to the invention of eyeshadow "...applying soothing salves to the eyelids and brows and then dusting the eyelids with powdered lead, copper, or any substance that could relieve the strain on the eyes..." In addition, African women invented wigs and breath fresheners, produced polished mirrors made of copper and jewlery, made perfumes and scented oils and pomades, and used henna to stain the fingernails and toenails (Yarbrough, 1984).

8. Beatrice Lumpkin (1988) and Margaret Alic (1986) have both described the life of Hypatia, " For fifteen centuries Hypatia was often considered to be the only female scientist in history. Hypatia is the earliest woman scientist whose life is well documented" (Alic, 1986, p. 41). Lumpkin provides evidence that Hypatia was not Greek and instead was an Egyptian and thus of African origin. It seems that contrary to the customs of Greek women at that time, "Hypatia remained unmarried and moved freely and publicly in her scientific pursuits" (Lumpkin, 1988, p. 155). Hypatia lectured on mathematics, philosophy, physics and astronomy (Lumpkin, 1988). She wrote important treatises on Algebra and Conic sections. Hypatia is credited with designing an astrolabe, a water still, an instrument to measure water level and an hydrometer (Alic, 1986, p. 44). Hypatia refused to convert to Christianity and in 415 A.D. she was murdered brutally by Christian fanatics (Lumpkin, 1988).

9. Margaret Alic (1986) in her book, Hypatia's Heritage, discusses women in science. Alic asserts that women were the first botanists. She attributes the following accomplishments to the women of prehistory, many of whom were undoubtedly African:

-methods of gathering, preparing and preserving food
-construction of devices to carry food and infants

-sticks, levers, hand axes for digging and processing plants
-invented the mortar and pestle Alic (1986, p. 13) states that "The tools developed by prehistoric women are still in evidence in modern-day chemistry laboratories."
-butchering of animals, tanning of hides
-production of needles, use of dyes
-drying, storage of herbs for use as medicines
-discovery of the uses of plants through trial and error and experimentation
-clay pottery, firing of clay in kilns
-domestication of crops
-selective breeding of plants

Alic (1986, p. 15) bases her claims on the assumption that "...evidence from the early scientific work of women can be traced..." from "oral traditions." Alic (1986, p. 15) goes on to say that Neolithic women were often thought to be possessed of magical powers, not only because of their ability to give birth, but also because of their skills in the domestic sciences - manufacturing, pottery, agriculture, the domestication of animals and healing. It was these achievements that early cultures personified in their goddesses.

10. Alic (1986, p. 21) relates that in the Kahun medical papyrus, women "...diagnosed pregnancy, guessed at the sex of the unborn child (if the mother's face was green it would be a boy), tested for sterility and treated dysmenorrhoea (irregular menstruation). Women surgeons performed caesarian sections, removed cancerous breasts, and set bones with splints."

11. Women are given credit for inventing weaving and spinning (Alic, 1986, p. 16).

12. Cleopatra wrote on gynecology, obstetrics, cosmetics and skin diseases (Alic, 1986, p. 33). Nkwankwo Ezeabasili (1977) wrote at length on the practice of medicine in Africa. Although African doctors do not have an Hippocratic oath, there is an unwritten but observed code of ethics. According to Ezeabasili (p. 32) a doctor should "...charge a patient according to his income..." there are "...no fixed fees for a disease", payment is by installment and in full only upon the successful cure of the disease, and a doctor is expected to reject a patient if he or she is incapable of treating a certain case. In addition, a doctor is required to taste any medicine he or she has prepared, before administering it to a patient. According to Ezeabalisi (p. 36) traditional African beliefs of causes of disease may be grouped into the following categories:

1. natural
2. mystical
   -neglect of ancestors
   -breaking taboos
   -reincarnation disorders
3. preternatural diseases
   -caused by sorcerers or witches
4. action contrary to nature
   -incest

Ezeabalisi feels that another important difference between African and Western medicine is that animal parts have great medicinal value in Africa while in the West their use is relatively insignificant. It should be pointed out that many important therapeutic drugs have been extracted from animals, for example anti-blood clotting substances from leeches. African doctors also have different notions of poisons and antidotes. Ezeabasili (43) states that "Traditional healers claim that complex poisons require simple antidotes, and simple poisons such as hydrocyanic acid (from fungus and tubers) need complex antidotes." It is also asserted that African medicine is very effective with many mental disorders which fail to respond to Western therapy.

Ezeabasili blames the rise of drug-resistant strains of bacteria in Africa on abuse of Western medicine. Ezeabasili (p. 58) states that "The philosophy is basically wrong. Man is trying to exterminate microbes. Also, antibiotics are known to have dangerous side effects. Streptomycin damages the eighth cranial nerve. Patients on a long-term course of isonaizid or tetracycline have to be constantly watched for leukaemia." Ezeabasili (p. 58) argues that a better approach "...is that man should seek to come to terms with bacteria and live in a sort of mutual symbiosis or even immunity. This requires a good understanding of man's psychological and physiological defenses against diseases."

As an example of the skepticism by which traditional medicine is received by Western science, Ezeabasili (p. 74) cites a interesting account by a British surgeon, a Dr. Esdaile, who attempted to publish accounts of 300 cases of major surgical operations carried out in India using hypnotism as the only anaesthetic. Major medical journals declined to publish the results and in addition "...fellow surgeons said they believed the Indians bore the excruciating pain just to please them" (Ezeabasili, p. 74).

Chiekh Diop is an expert on ancient Egyptian cilization. In Diop's article Africa's Contribution to World Civilization: The Exact Sciences (1985) he relates some of the sophisticated science Africans were doing long ago. 1,700 years before Archimede's time the Egyptians were able to calculate the surface area of a hemisphere and the volume of a cylinder using a fairly accurate value of Pi, i.e. 3.16. They were also able to determine the volume of a pyramid's frustrum. Among other things, Egyptians were able to calculate square roots, they used imaginary numbers and they invented trigonometry and Pythagoras' theorem long before Pythagoras did. Algebra was also a product of Egyptian mathematicians. The Egyptians used levers, inclined planes and screws long before Archimede's "discoveries" of these same concepts. Diop wonders if it was a coincidence that Archimedes and other famous Greek scientists such as Socrates, Aristotle and Plato studied extensively in Egypt?

According to Diop (1985) the Egyptians used siphons to transfer liquids and thus had knowledge of air pressure. Diop relates that Egyptian medicine was very sophisticated for its time. The Egyptians were skilled bone surgeons and they gave detailed accounts of brain injuries. They had located areas of the brain for specific body functions three thousand years before the European, Broca did. In addition, Egyptians discovered the circulation of the blood and the workings of the heart long before the Englishman Harvey.

John Pappademos in The Newtonian Synthesis in Physical Science and its Roots in the Nile Valley (1985) discusses the origins of Newton's theories. Pappademos maintains that Newton's work was based on work on mathematics, astronomy and mechanics that was begun in ancient times. This led to Egyptian science which in turn influenced scientists such as Kepler, Copernicus, Decartes and Galileo who in turn provided the basis for Newton's work. Pappademos gives the example of Galileo's discoveries to show how this occurred. The name of Philoponus was frequently found in Galileo's notebooks. It turns out that this ancient Alexandrian scientist had demonstrated and subsequently reported that heavier objects did not fall faster than lighter objects. Galileo himself reported that he had studied the works of Egyptian, Greek and Muslim scientists.

Pappademos (1985, p. 93) states that "...Newton also was thoroughly familiar with the scientific works of much more ancient writers, especially those of Africa, whose opinions he held in high esteem and from which he drew to support his own arguments." Newton gave as examples the atomic theory and heliocentric theory of the solar system as two ancient theories which he utilized. Pappademos (1985, p. 95) also says that Newton's "...law of universal gravitation had been anticipated two thousand years earlier by the Pythagorean philosophers, and this was the real meaning of the "harmony of the spheres"". Pappademos (1985) gave some other examples of Egyptian contributions to science such as the 365 day calendar based on astronomical observations, the sundial, water clocks, a device to measure stellar azimuths, knowledge of constellations, the methods used to precisely align the pyramids and temples,

astronomy texts, prediction of eclipses, discovery of the spherical shape of the earth, precession of the equinoxes and the heliocentric theory.

The preceding descriptions were sketchy but there are well documented descriptions of all the contributions made by Africans that have been discussed so far.

The contributions to science of present day Africans are many and varied and will not be discussed in this paper. A useful reference on this topic is Science and Technology in Africa by John W. Forje if further information is desired.

Contributions of African-Americans to Science Even though African- Americans have found themselves struggling to survive during much of their history in America they have still managed to produce great scientists. Because of the limited scope of this paper only a small sampling of important African-American scientists will be presented. In pre-civil war times there were basically two categories of African- Americans, free blacks and slaves. Both however were not living in conditions conducive to becoming a man or woman of science, i.e. being independently wealthy and well-educated. Norbert Rillieux, born in 1806, was a famous engineer who invented a multiple-effect vacuum evaporator which converted sugar cane juice into white sugar crystals (Hayden, 1984, p. 222).

Lewis Temple, born in 1839, was a blacksmith who produced whaling harpoons. He invented a harpoon known as the "Temple toggle" which revolutionized the whaling industry (Hayden, 1984, p. 224).

The most important black inventors after the Civil War were Elijah McCoy, Jan Matzeliger, Granville T. Woods, Lewis Latimer and Garret A. Morgan. McCoy invented a lubricating cup "that fed oil to machinery while it was still running...The confidence inspired by the reliability of his lubricating devices was such that the phrase "the real McCoy" was coined in regard to machinery that contained the McCoy device..." (Hayden, 1984, p. 220). He received 25 patents on various inventions. Jan Matzeliger invented a shoe-making machine which dramatically changed the shoe manufacturing industry (Hayden, 1984, p. 220).

Granville T. Woods obtained "...over 35 patents on electro- mechanical devices which he sold to American Bell Telephone, General Electric and Westinghouse Air Brake." (Hayden, 1984, p. 220). His ideas were used in electric railways, telegraphy, telephones, automatic cut-offs for electric circuits and electric motor regulators. His most important invention was the "Railway induction telegraph" (Hayden, 1984, p. 223).

Lewis Latimer had an illustrious career in science. He made the first drawings of Alexander Graham Bell's telephone. He invented longer- lasting carbon filaments for lamps. He worked extensively with Edison. Latimer supervised the initial installation of lighting in New York, Philadelphia and London, England(Clarke, 1984, p. 230). Latimer also wrote the first textbook on incandescent lighting (Hayden, 1984, p. 222).

Garret A. Morgan (b. 1877) invented a smoke inhalator which he, his brother and two other volunteers used to rescue several men who were trapped in a tunnel under Lake Erie after an explosion. He sold his invention of the automatic stop signal to the General Electric Company for $40,000. He was awarded a gold medal by the city of Cleveland, Ohio for his devotion to public safety.

Louise Meriwether's book (1972) The Heart Man describes the life of Dr. Daniel Hale Williams. Williams opened America's first hospital for blacks and whites. In 1893 Dr. Williams performed the first successful open heart surgery on a man who had been stabbed in the chest during a fight. Later Williams headed a government hospital in Washington, D.C. Benjamin Banneker was an expert mathematician

born in 1731. When he was 22 years old he constructed a famous wooden clock which kept almost perfect time for more than twenty years (Allen, 1971, p. 41). He calculated and published an almanac for ten years which Thomas Jefferson later sent to the Academy of Science in Paris. Scholars from all over the U.S. sent their difficult mathmematical problems to Benjamin Banneker. In 1876 Edward Alexander Bouchet obtained a PhD in physics from Yale University (Pearson and Bechtel, 1989, p. 13). Bouchet was the first black to receive a doctorate from an American university.

There are too many contemporary African-American scientists to mention all of them here so again only a few will be selected and discussed. Contributions of African-Americans to Space Science Lt. Col. Guy Bluford was the first black American in space (Graves and Van Sertima, 1984, p. 245). Isaac Gilliam IV was the Director of Dryden's Flight Research Center at Edwards Air Force base and subsequently director of Shuttle Operations (Graves and Van Sertima, 1984, p. 246). Robert E. Shurney was an aeronautical engineer involved with Skylab (Graves and Van Sertima, 1984, p. 249). He designed the commodes used in Skylab, a Solar Array Blanket Tube and aluminum tires for the moon buggy. Patricia Cowings studies space sickness and weightlessness (Graves and Van Sertima, 1984, p. 253). Christine Darden is an aerospace engineer at NASA's Langley Research center working on eliminating sonic booms in supersonic and hypersonic aircraft (Graves and Van Sertima, 1984, p. 255). George Carruthers is an astrophysicist who designed the Far Ultraviolet Camera/Spectrograph used on the Apollo 16 mission (Spady, 1984, p. 258). Elmer Samuel Imes established that "...quantum theory could be extended to include rotational states of molecules" (Spady, 1984, p. 263). Dr. Ronald E. McNair earned his doctorate from MIT in 1976. In February 1984 he became the second black astronaut in space. Dr. McNair was killed during the Challenger disaster on January 28, 1986.

Dr. Lloyd Quartermain worked on the Manhattan Project during the development of the atomic bomb (Van Sertima, 1984, p. 266). In addition, he worked on fluoride chemistry, synthetic blood and he was a spectroscopist. African-American contributions to biology and medicine Ernest Just was born in 1883 and he later became an eminent cell biologist who did most of his work at the Marine Biological Laboratories at Woods Hole (Pearson, 1989, p. 15). Just's area of interest was in the cytology and embryology of the eggs of marine animals. Kenneth Manning wrote a detailed biography of Just's life including descriptions of his scientific accomplishments and his trials and tribulations because of the color of his skin. Percy Julian, born in 1899, discovered cortisone which was used to treat arthritis (Pearson, 1989, p. 15). He also synthesized a compound called phystigmine which was used to treat glaucoma. The research of Charles Drew on blood plasma is thought to have saved many lives during World War II (Pearson, 1989, p. 16). Drew also set up the first blood bank in England. Charles Turner studied animal behavior and a phenomenon characteristic of insects called "Turner's circling" is named after him (Pearson, 1989, p. 16). William A. Hinton developed the Hinton Test for syphilis (Pearson, 1989, p. 16). He was also the first black professor of medicine at Harvard. Lloyd A. Hall developed "curing salts for processing and preserving meats" (Pearson, 1989, p. 16). Louis Tompkins Wright developed an intradermal method of smallpox vaccination and worked on drug therapy for cancer. Dr. Theodore K. Lawless (1892-1971) was one of the world's leading skin specialists and a philanthropist. This list of African- American scientists could go on and on. Two excellent sources on this topic are Blacks in Science: Astophysicist to Zoologist by Hattie Carwell (1981) and Black Contributors to Science and Energy Technology by the U.S. Department of Energy, Office of Public Affairs (1979). As can be seen there is a wealth of material available which could be used in a secondary school science curriculum. Integration of African Science into the Secondary School Science Curriculum Any successful introduction of African science into the secondary schools will have to be designed with great care. I believe that the best approach would be to prepare a list of key, uncontested "facts" about Africa, African- Americans and science which most scholars could agree on. A panel of experts could validate the usefulness and genuineness of all potential topics to be included in the science syllabi. These would then be used as appropriate throughout the different science courses. These key topics would have to be hammered home repeatedly throughout the grades K-12 until inventors such as Latimer, Rillieux and

McCoy become household words just like famous European inventors. For every unit in science the teacher should have available examples of African scientists or scientific developments, American scientists, women scientists, Chinese scientists etc. from which to choose to enrich his or her lessons. Textbooks will have to change. Every science book should have photos of people of all colors and kinds doing science. It should be stressed that the Western scientific method is one very successful path on the way to knowledge and that other cultures have developed equally valid means of explaining and dealing with the world which will complement modern science and make it even more effective.

If curriculum reform is to succeed, parental support will have to be enlisted and the public as a whole will have to learn these new aspects of science. Above all, the curriculum will have to be pretested and made as non-controversial as possible to avoid the fate of Jerome Bruner's Man A Course of Study. Because of the United States' diverse ethnic mix we have a wonderful chance to bring about a synthesis of the different cultural approaches to science and to teach it to our children. If this could be done it would free many minds from the shackles of our male-dominated, white, european mode of doing science. Who knows what discoveries might be made if we unleashed the mind power of the whole human race instead of depending on the views of a small but powerful minority, the white male?

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