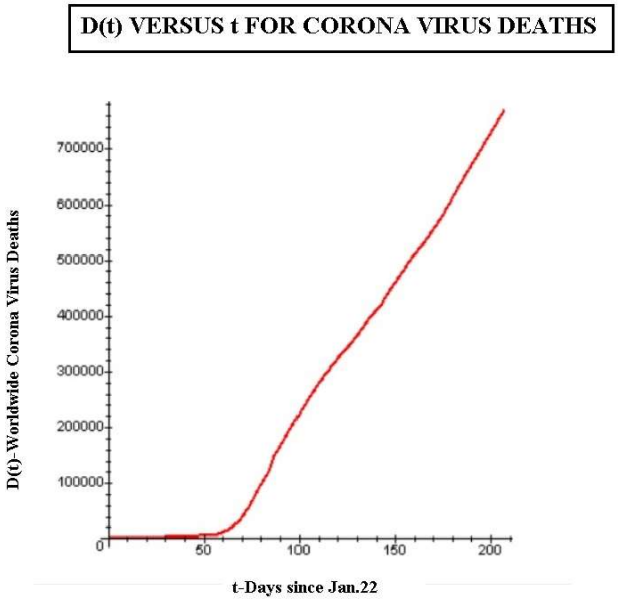
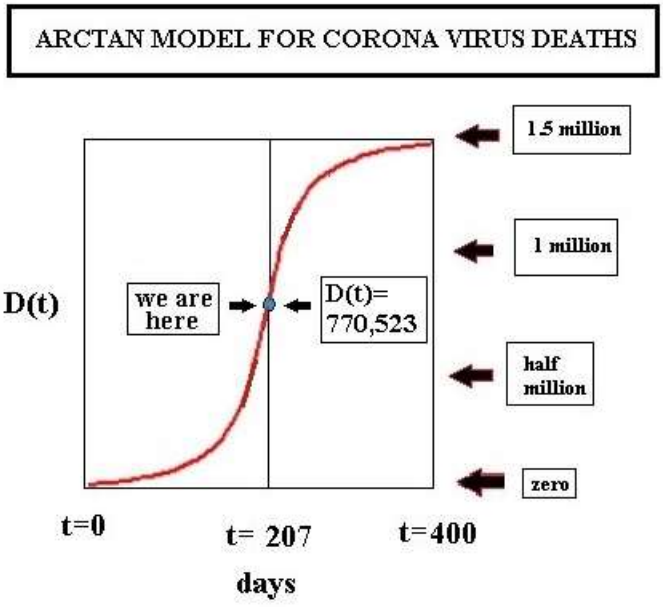
THE CORONA PANDEMIC, VACCINES, AND HERD IMMUNITY

It is now the t=207th day since January 22 when the World Health Organization(WHO) declared the Corona 19 Virus to be a world-wide pandemic. Since that time there have been about D(t)=770,000 world-wide deaths with 173,000 of these having occurred here in the US. We have been keeping a daily record of these numbers and have constructed charts indicating t versus D(t). One of the most informative of these graphs is the following-



One sees that the mortality due to the virus at first rose exponentially in time until about day t=60. After that it assumed a near linear straight-line behavior with a positive slope for the next 150 days. That is, the number of deaths have kept rising with no slow down indicated. There will be no lowering of the daily death numbers until D(t) shows a clear accelerated bending to the right with the curve eventually assuming a horizontal orientation when the pandemic is over. No one knows at this time how long the pandemic will last. What is clear is that a vaccine, wearing a mask, social distancing, and an anti-virus immune build-up by a large part of the population will slow down the growth rate of D(t). Remember that the main advantage of face masks is that they slow down the spreading of viruses sitting on water aerosols coming from an infected person's lungs.

To get an estimate of the duration of this pandemic we can construct what I call the Arctan Model in which one approximates the D(t) vs t curve as the left half of an adjusted arctan curve. This produces the following picture-



By putting todays point at the arctan center we can estimate that the Pandemic will be over by the end of February 2021 having caused 1.5 million world-wide deaths with slightly less than 345,000 in the US. A major problem with the arctan model is that the center point need not be at t=207. The straight line portion of the D(t) curve could center at D(t) of a million, making the final value D(t)=2 million or greater. Countries such as Brazil, Mexico, Russia , India and Iran are expected to be reporting many new additional deaths in the coming days while the US numbers will be on the decline.

The most effective way to reduce D(t) for the Corona Pandemic would be to find a workable vaccine with a minimum of side effects and producing long term immunity. Countries around the world are frantically searching for such a vaccine. It is estimated that one may be found by early next year. The idea behind a vaccine is that it stimulates the human immune system to produce antigens which will kill existing Corona viruses present in the body. Vaccination had its origin in 1796 with credit mostly going to Edward Jenner(1749-1823) an English doctor. He observed that milkmaids who often caught a mild virus disease known as cowpox where immune to smallpox which was much more dangerous causing numerous deaths and unattractive pox marks on surviving victims faces ("A pox on you"). Jenner noted that he could prevent small pox in individuals by scratching material from cowpox pustules onto the arm of an as yet unaffected person. It worked indicating the scraping contained material which stimulated the body's immune system. Indeed Jenner had found the world's first vaccine. Since that time numerous other vaccines have been developed including one for polio, chicken pox, whooping cough, influenza , hepatitis, and measles. Today most children in developed countries are inoculated against these viral diseases. When I was a child we did not have vaccinations for many of these and so had to develop our own lifetime immunity by

catching the particular viral disease and having our bodies produce its own protein antigens.

In connection with pandemics and vaccines one often hears of herd immunity. What is this? The short answer is that it describes a condition were a large portion of a population has already caught the viral disease and built up immunity so that active viruses will have a much harder time finding and attacking unprotected cells. We don't know exactly what fraction of the population must have been infected before herd immunity sets in. It appears that an effective vaccine against Corona 19 will reduce the time to herd immunity even if only a small fraction of the population will actually take the shot.

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