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Gateway Computing
March 6, 2019
Project B
Application Document

Applications of 'ProjectB.m'

Part 1: Simulations

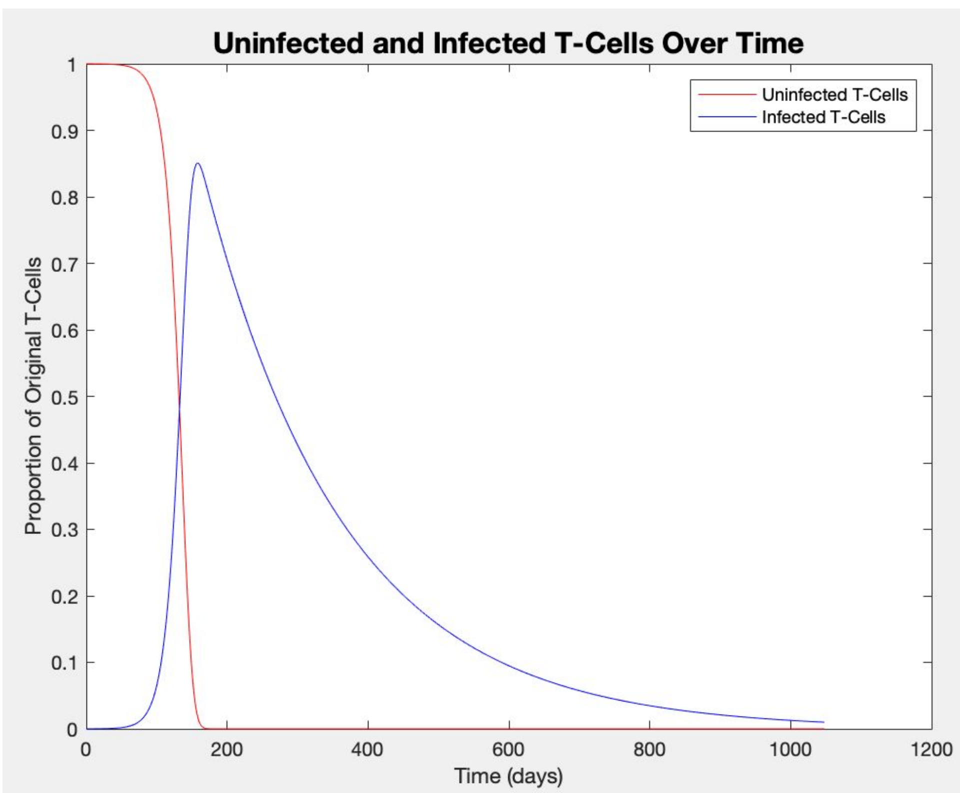
Run each of the following simulations with initial viral load 0.01, for a maximum time of 2000 days (5.5 years) and with a minimum T-cell count of 0.01.

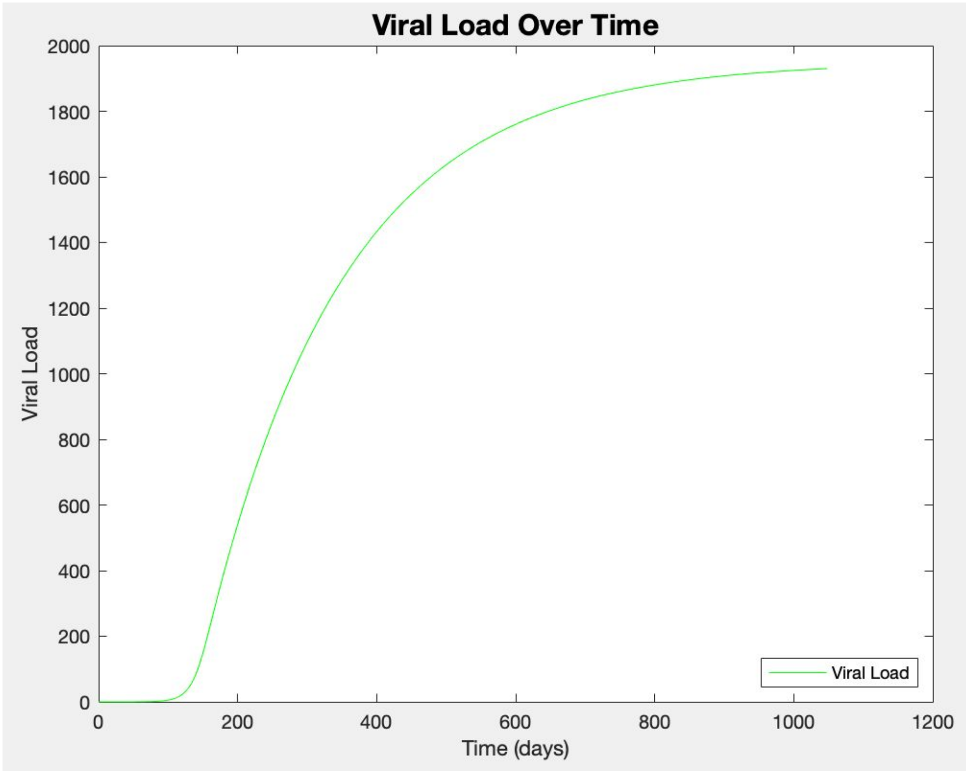
Test A: Q=0, no anti-retroviral therapy

```
>> ProjectB(0.01, 0, 2000, 0.01)

The simulation was stopped after 1048 days because
the T cell count is less than the minT value of 0.0100

After 1048 days with a 0 percent effective drug:
The uninfected T-Cell count is 0.0000
The infected T-Cell count is 0.0100
The viral load is 1930.0158
```



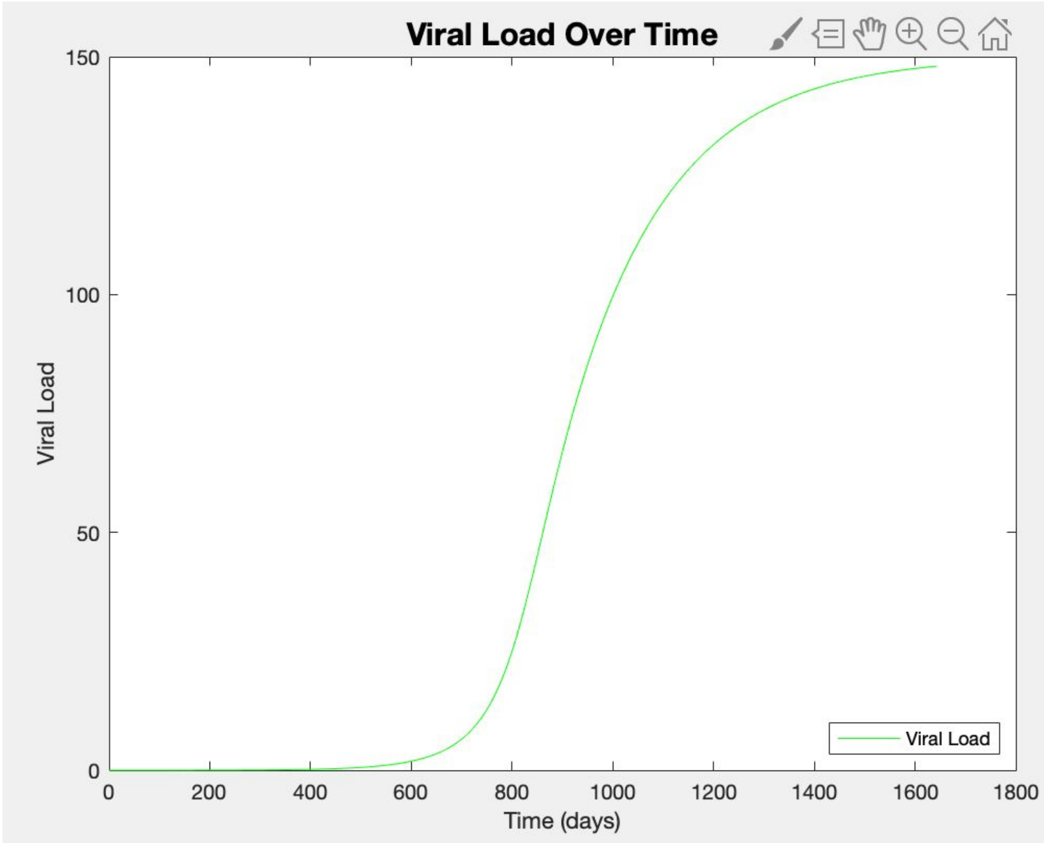


Test B: Q=0.9, 90% effective in blocking viral replication.

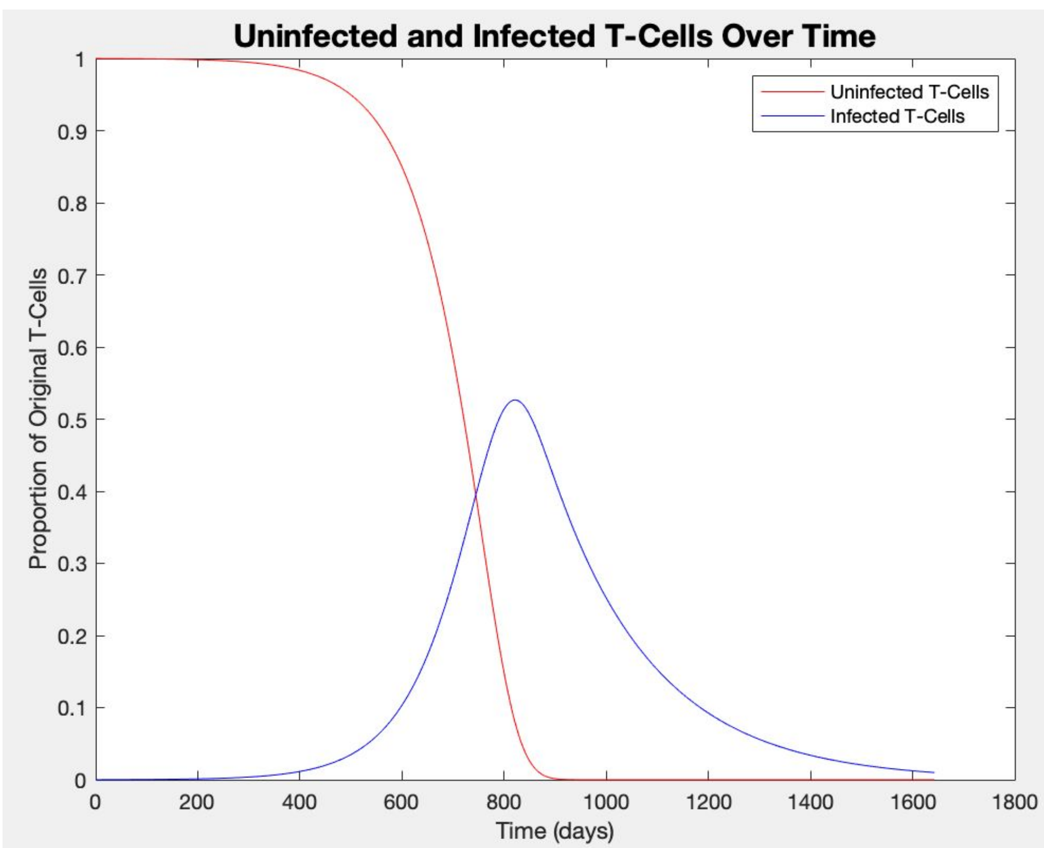
```
>> ProjectB(0.01, 0.9, 2000, 0.01)

The simulation was stopped after 1643 days because
the T cell count is less than the minT value of 0.0100

After 1643 days with a 90 percent effective drug:
The uninfected T-Cell count is 0.0000
The infected T-Cell count is 0.0100
The viral load is 148.0133
```



Viral Load Over Time
Viral Load
Time (days)
Viral Load
0
50
100
150
0
200
400
600
800
1000
1200
1400
1600
1800



Uninfected and Infected T-Cells Over Time
Uninfected T-Cells
Infected T-Cells
Proportion of Original T-Cells
Time (days)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
200
400
600
800
1000
1200
1400
1600
1800

Test C: Q=0.98, 98% effective in blocking viral replication.

```
>> ProjectB(0.01, 0.98, 2000, 0.01)

After 2000 days with a 98 percent effective drug:
The uninfected T-Cell count is 0.9991
The infected T-Cell count is 0.0000
The viral load is 0.0001
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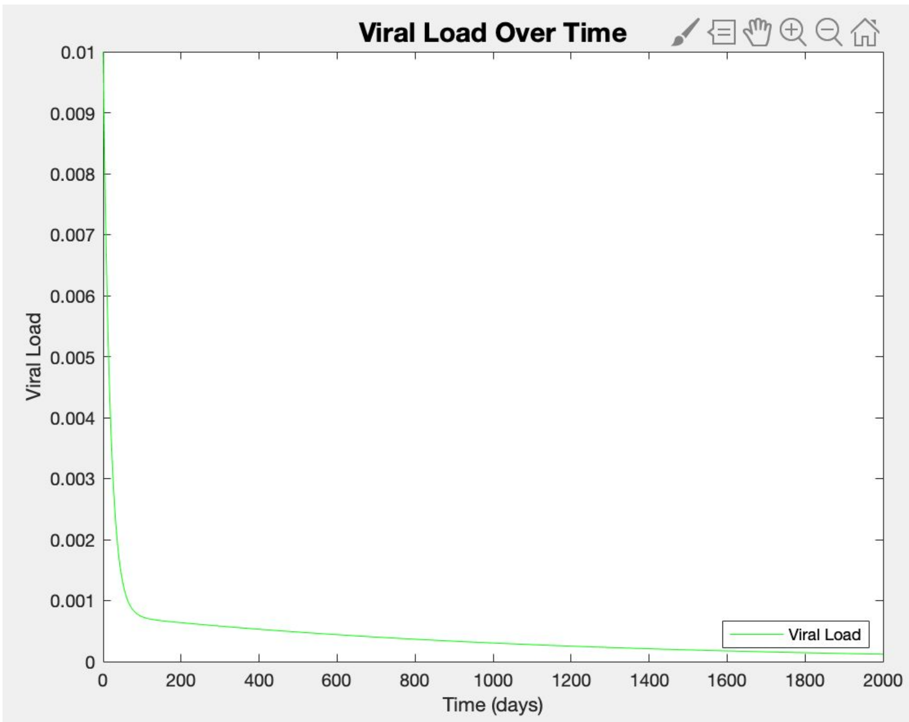

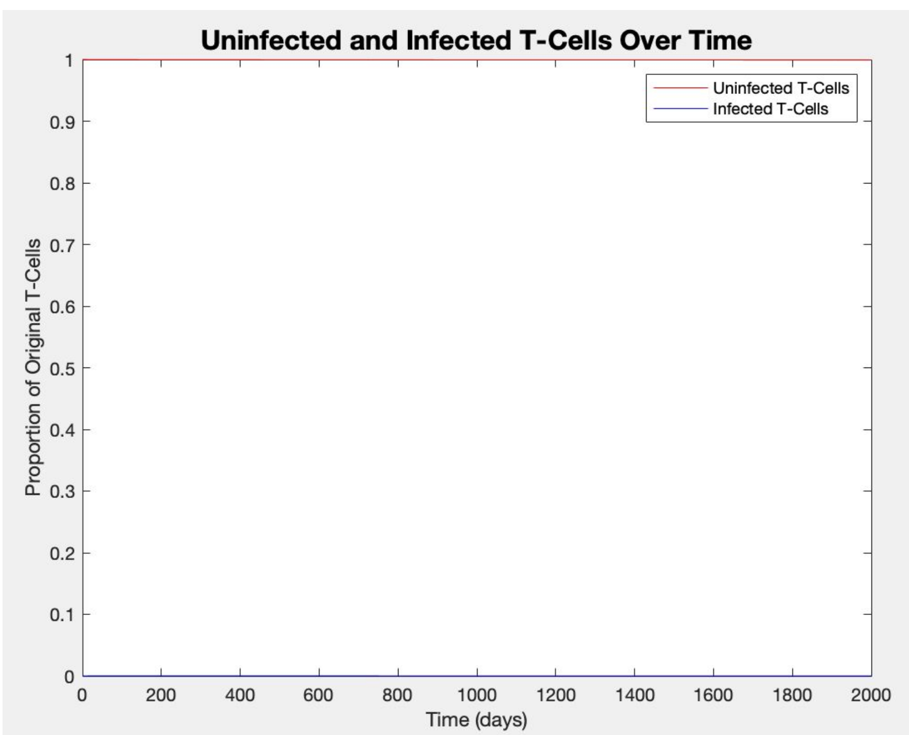

Part 2: Analysis

Write a 1 paragraph analysis that discusses the following issues:
Compare the predicted time from infection to AIDS diagnosis in each case expressed in years.
If the model is correct what does this imply for the development of this kind of drug therapy?

In part 1, three cases were modeled to determine the predicted time from infection to the AIDS diagnosis. All simulations were run with initial viral load 0.01 and a maximum time of 2000 days (5.5 years). The number of uninfected (T) and infected (I) T cells and the viral load (V) was modeled over time and the simulation was stopped if the number of total T cells dropped below the minimum T-cell count of 0.01. In Test A, there was no anti-retroviral therapy (Q = 0) and the patient was diagnosed with AIDS after 2.87 years (1048 days), when T = 0.000, I = 0.1000, V = 1930.0158. In Test B, there was moderate anti-retroviral therapy (Q = 0.9) and the patient was diagnosed with AIDS after 4.50 years (1643 days), when T = 0.000, I = 0.1000, V = 148.0133. In Test C, there was exceptional anti-retroviral therapy (Q = 0.98) and the patient was not diagnosed with AIDS within 5.48 years (2000 days), at which time T = 0.9991, I = 0.0000, V = 0.0001. If this model is correct, it has large implications for the development of this kind of drug therapy. As we learned from the tests, a drug that will mitigate the diagnosis of AIDS within 2000 days of the onset of the HIV virus must have an anti-retroviral therapy with a minimum of somewhere between 90% and 98% effectiveness at blocking the proliferation of the HIV virus after T-Cell death. We have shown that a 98% effectiveness anti-retroviral therapy works to stop the diagnosis of AIDS under the right conditions for the person's entire lifetime (results of a 60 year / 22,000 day maxtime simulation are below). In conclusion, further development into drugs that have such a high effectiveness rate is worthwhile research.

```
>> ProjectB(0.01, 0.98, 22000, 0.01)

After 22000 days with a 98 percent effective drug:
The uninfected T-Cell count is 0.9990
The infected T-Cell count is 0.0000
The viral load is 0.0000
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Part 3: Testing Another Solution

A researcher has come up with an expensive therapy that can flush all the infected T-cells from a patient's body and restore them to a normal healthy level of uninfected T-cells (T=1, I=0). Since the anti-retroviral therapy has discomforting side-effects some doctors are suggesting that if a patient is on the 98% effective therapy for 2000 days it should be possible to use this additional therapy to restore their T-cell count and then remove them from the anti-retroviral therapy permanently. Use your program to perform one additional simulation that will show whether the model indicates that this therapy is likely to succeed in curing the patient.

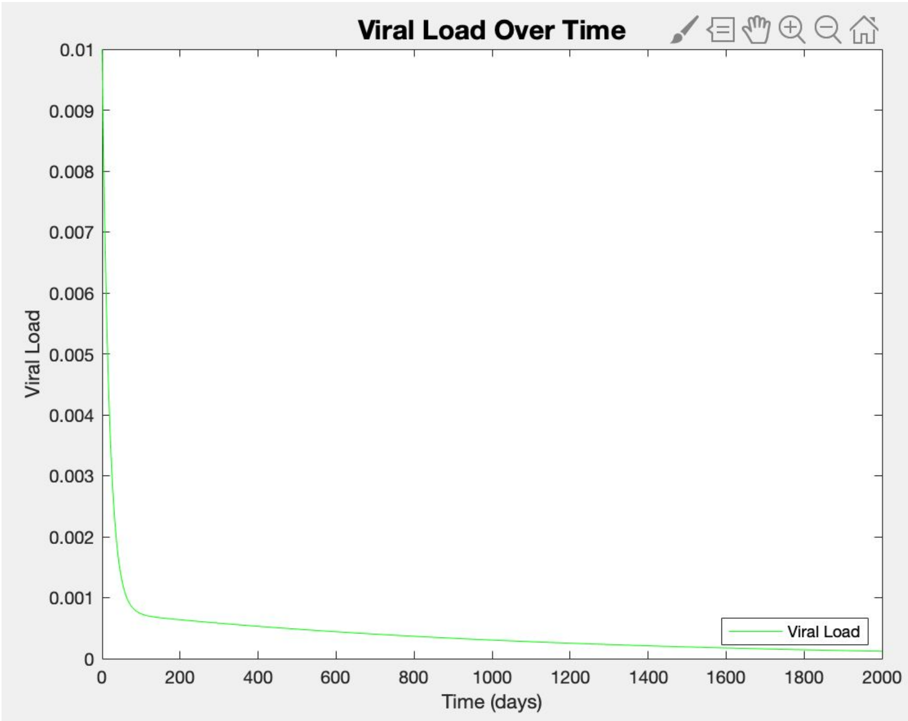
a. Provide two graphs for this simulation as above.

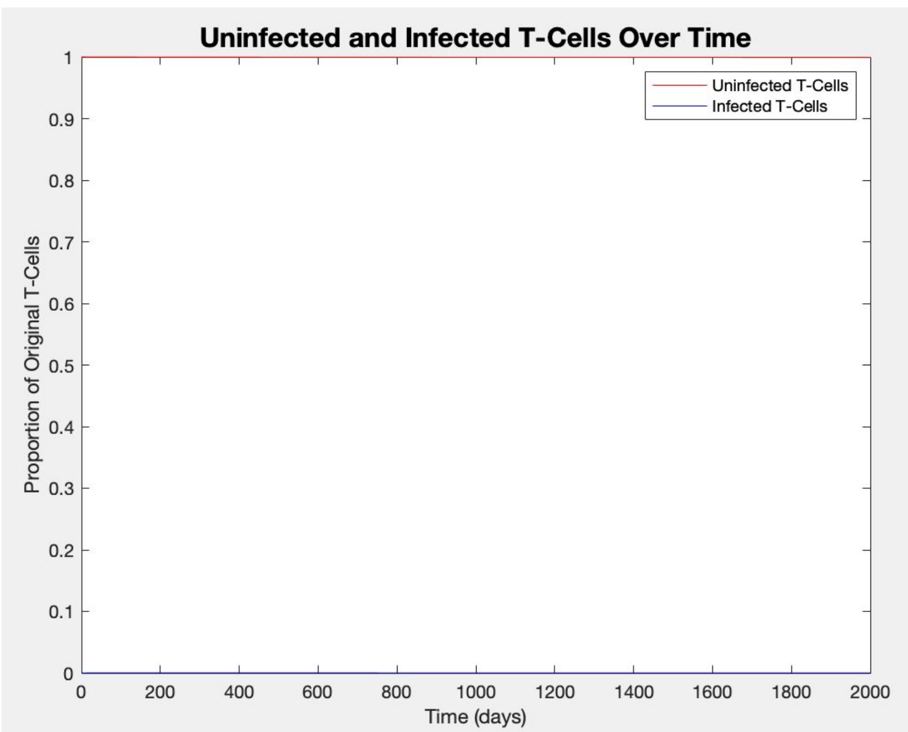
b. Explain in a paragraph why this therapy does or does not succeed in providing a cure. What outcome is predicted by your simulation?

For the first 2000 days: the patient is on the 98% effective therapy, so the inputs are V0 = 0.01, Q = 0.98, maxtime = 2000, minT = 0.01. This simulation produces an uninfected T-Cell count of 0.9991, an infected T-Cell count of 0.0000, and a viral load of 0.0001. At such point in time, the doctor would prescribe the alternative therapy to the patient. The number of infected T-cells would go to zero, but there already are none according to the first simulation. So, we will run another simulation of the patient's HIV status with the inputs V0 = 0.0001, Q = 0, maxtime = 10000, minT = 0.01, and the starting uninfected T cell population will be 0.9991. This simulation shows that the patient is diagnosed with AIDS after 1112 days, at which point T = 0, I = 0.01, V = 1928.2953. Therefore, this alternative solution to treating HIV/AIDS is not an effective method. However, the reasoning behind the treatment makes sense: treating HIV for 5.5 years with a 98% effectiveness drug reduces the viral load to 1/100th its original levels. After wiping out all infected T-cells the thought is that it may be possible for the body to naturally fight the virus, which is at such a low level. However, as we see, it is not possible to do that without anti-retroviral therapy.

Graphs are on the following pages.

First 2000 days:





1112 days after treatment before AIDS diagnosis: