Massachusetts Institute of Technology
ESD.00 Introduction to Engineering Systems
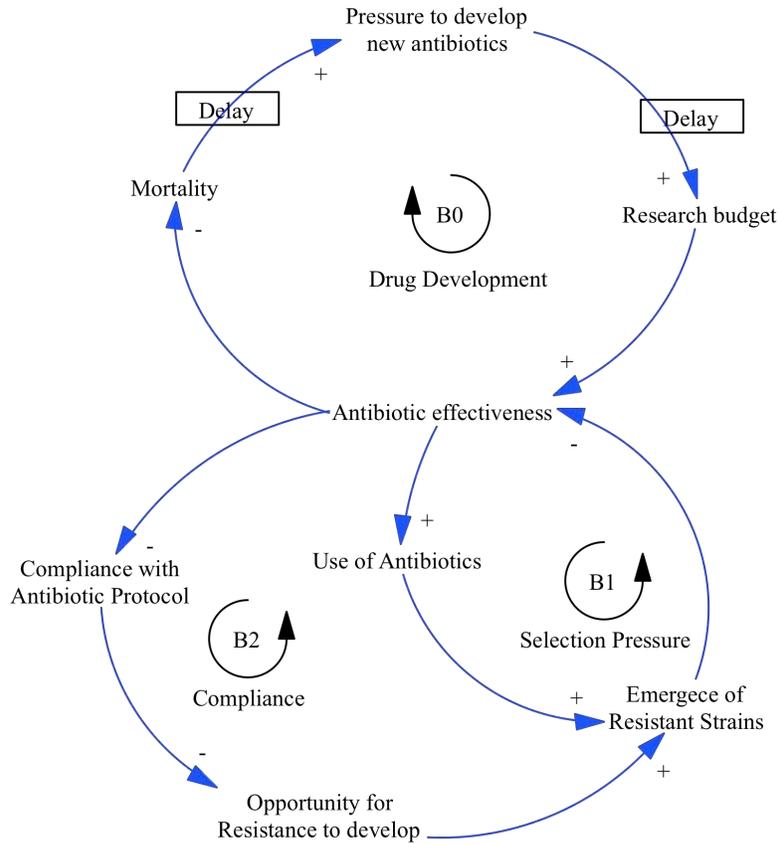
Spring, 2011

Assignment # 2 (Solutions)

Assigned Date: Lecture 2
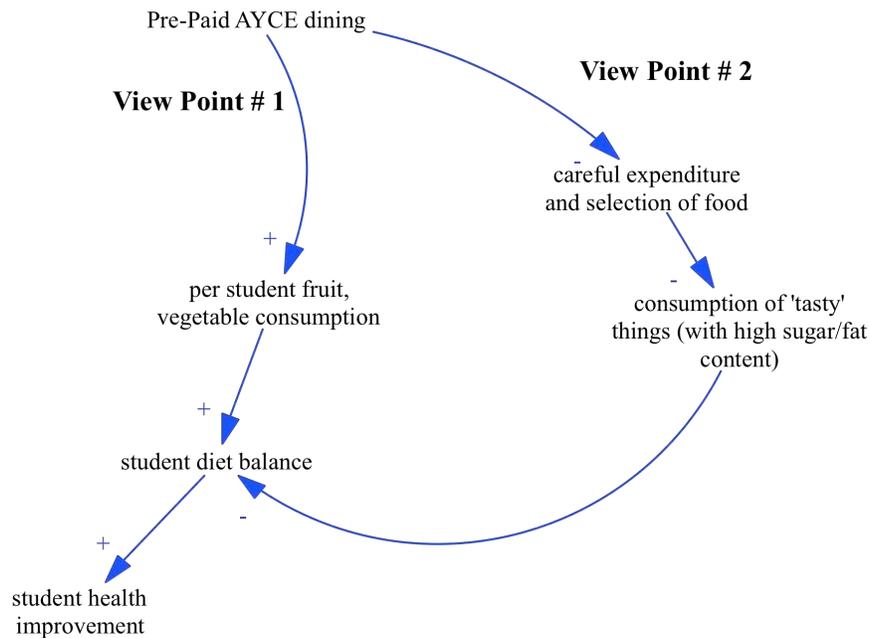Due Date: Lecture 4

A. Understanding Policy Resistance:

A1. Evolution of anti-biotic resistance
Combined solution of a), b) and c) is:

Pressure to develop
new antibiotics

+

Delay   Delay

Mortality   +
                    B0   Research budget
-

Drug Development

+

Antibiotic effectiveness
                                        -

                        +
-           Use of Antibiotics   B1
Compliance with
Antibiotic Protocol   Selection Pressure

        B2   +   Emergece of
                                    Resistant Strains
    Compliance

-                            +

    Opportunity for
    Resistance to develop

A2. AYCE dining and Nutritious eating

Pre-Paid AYCE dining

View Point # 2

View Point # 1

careful expenditure
and selection of food

+

per student fruit,
vegetable consumption

-

consumption of 'tasty'
things (with high sugar/fat
content)

+

student diet balance

-

+

student health
improvement

The left chain of causality represents view #1, and the right chain represents view #2.

In order to counter the effect of increased intake of 'tasty' food, there can be efforts to increase awareness and encourage healthy choices etc.

B. Exponential Growth

i) The average double time is ~ 8 months based on tabular data provided.

ii)

$U(t) = U_o \exp(gt)$
$\ln (U/U_o) = gt$
$t = \ln (U/U_o)*(1/g)$

After substituting values of U_o = 1e6, U = 1e9, and g = 1.14:

t = 6.05 years.

iii) Nothing can grow for ever, and a number of factors can come into play that limit growth. Some factors that may eventually limit increase of number of face book

users include market saturation, competition, circumstances that may erode trust (e.g. privacy issues), and even control by regulators/governments etc.

C. Stocks and Flows: Graphical Integration

i) The highest number of patients is 20 at t= 4.

ii)
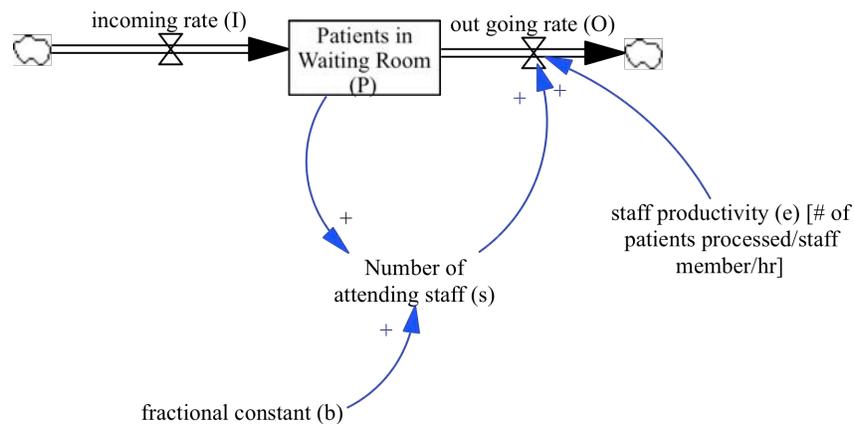
iii)

We have:

$$dP/dt = I(t) - O(t) \qquad - (1)$$

Now, number of attending staff, s, depends on waiting patients and a constant 'b':

$s = b\ P(t)$.

The outgoing rate, $O(t)$, is product of number of staff and staff productivity (i.e. # of patients attended per staff member per hour), denoted by e:

$O(t) = s\ e$
$O(t) = b\ P(t)\ e \qquad - (2)$

Since $O(t)$ depends on the number of waiting patients, substituting value of $O(t)$ from eq(2) in eq (1) above:

$$dP/dt = I(t) - bP(t)e$$

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