Formula's used for writing the differential equations

$$bacterial\ growth = \frac{growthrate * nutrients * bacteria}{K_{sx} + nutrients} * \frac{1 - (lactate - lactate_{ix})}{lactate_{mx} - lactate_{ix}} * \frac{K_{ix}}{K_{ix} + nutrients}$$

$$bacterial\ death = \omega * bacterial\ growth$$

$$lactate\ production = (\beta * bacterial\ growth) + \left(\frac{\delta * nutrients * bacteria}{K_{sl} + nutrients}\right) * (\frac{1 - (lactate - lactate_{il})}{lactate_{ml} - lactate_{is}} * K_{il} + nutrients$$

$$glucose\ consumption = \left(\frac{\alpha * nutrients * bacteria}{K_{ss} + nutrients}\right) * \frac{1 - (lactate - lactate_{is})}{lactate_{ms} - lactate_{is}} * \frac{K_{is}}{K_{is} + nutrients}$$

$$K_2PO_4\ consumption = \left(\frac{K_2PO_4 * pH}{K_{aphos}}\right)$$

$$KH_2PO_4\ consumption = \left(\frac{K_{aphos} * K_2HPO_4}{pH}\right)$$

$$lactate\ k\ production = \left(\frac{K_{alac} * lactate}{pH}\right)$$

$$dummy\ nisin\ production = \beta_1 * bacterial\ growth + \frac{\delta_1 * nutrietns * bacteria}{K_{sn} + nutrients} * \frac{1 - (lactate - lactate_{in})}{lactate_{mn} - lactate_{in}} * \frac{K_{in}}{K_{in} + nutrients}$$

$$nisin\ production = dummy\ nisin\ production; zeros(2 * xdim, 1)$$

$$dummy\ ahlase\ production = \beta_1 * bacterial\ growth + \frac{\delta_1 * nutrietns * bacteria}{K_{sn} + nutrients} * \frac{1 - (lactate - lactate_{in})}{lactate_{mn} - lactate_{in}} * \frac{K_{in}}{K_{in} + nutrients}$$

$$ahlase\ production = dummyahlasesproduction; zeros(2 * xdim, 1)$$

$$dummy\ DspB\ production = \beta_1 * bacterial\ growth + \frac{\delta_1 * nutrietns * bacteria}{K_{sn} + nutrients} * \frac{1 - (lactate - lactate_{in})}{lactate_{mn} - lactate_{in}} * \frac{K_{in}}{K_{in} + nutrients}$$

$$DspB\ production = dummy\ DspB\ production; zeros(2 * xdim, 1)$$

$$pathogen\ 1\ growth = \frac{(growth\ rate\ 1 * nutrient\ 1 * pathogen\ 1)}{(K_{sa} + nutrient\ 1) * (\frac{1 + nutrient\ 1}{K_{ia}})}$$

$$pathogen\ 1\ death = zeros(xdim, 1)$$

$$for\ j = 1{:}\ xdim$$
$$if(nisin\ production\ (2 * xdim + j) > 100$$
$$pathogen\ 1\ death\ (j) = \left(natural\ decay + \omega * nisin\ production\ (2 * xdim + j)\right) * pathogen\ 1\ (j)$$
$$else$$
$$pathogen\ 1\ death\ (j) = natural\ decay * pathogen\ 1\ (j)$$
$$end$$
$$end$$

$$pathogen\ 2\ growth = \frac{(growth\ rate\ 2 * nutrient\ 1 * pathogen\ 2)}{(K_{sb} + nutrient\ 1) * (\frac{1 + nutrient\ 1}{K_{ib}})}$$

$$dummy\ quorum\ molecules\ production\ 1 = \beta_1 * pathogen\ 1\ growth + \frac{\delta_1 * nutrient\ 1 * pathogen\ 1}{K_{sa} + nutrient\ 1}$$

$$quorum\ molecules\ production\ 1 = dummyquorummoleculesproduction\ 1; zeros((ydim - 1) * xdim, 1$$

$$quorum\ molecules\ 1\ decay\ = \omega\ 1 * quorum\ molecules\ production\ 1$$

$$dummy\ quorum\ molecules\ production\ 2 = \beta_1 * pathogen\ 2\ growth + \frac{\delta_1 * nutrient\ 1 * pathogen\ 2}{K_{sb} + nutrient\ 1}$$

$$quorum\ molecules\ production\ 2 = dummy\ quorum\ molecules\ production\ 2; zeros\big((ydim - 1) * xdim, 1\big)$$

$$quorum\ molecules\ 2\ decay\ = \omega * quorum\ molecules\ production\ 2 * ahlasesproduction$$

$$nutrient\ 1\ consumption\ = \frac{\alpha_1 * nutrient\ 1 * pathogen\ 1}{K_{s1} + nutrient\ 1} + \frac{\alpha_2 * nutrient\ 1 * pathogen\ 2}{K_{s2} + nutrient\ 1}$$

$$rate\ for\ nutrients\ = -glucose\ consumption + diffusion\ nutrients$$

$$rate\ for\ bacteria\ = bacterial\ growth - bacteria\ death$$

$$rate\ for\ lactate\ = lactate\ production + diffusion\ lactate$$

$$rate\ for\ K_2HPO_4\ = K_2HPO_4\ consumption + diffusion\ K_2HPO_4$$

$$rate\ for\ KH_2PO_4\ = KH_2PO_4\ consumption + diffusion\ KH_2PO_4$$

$$rate\ for\ lactate\ k\ = lactate\ k\ production + diffusion\ lactate\ k$$

$$rate\ for\ nisin\ = nisin\ production + diffusion\ nisin$$

$$rate\ for\ ahlases\ = ahlases\ production + diffusion\ ahlases$$

$$rate\ for\ dspb\ = dspb\ production + diffusion\ dspb$$

$$rate\ for\ quorum\ molecules\ 1\ = quorum\ molecules\ production\ 1 + diffusion\ quorum\ molecules\ 1 - quorum\ molecules\ 1\ decay$$

$$rate\ for\ quorum\ molecules\ 2\ = quorum\ molecules\ production\ 2 + diffusion\ quorum\ molecules\ 2 - quorum\ molecules\ 2\ decay$$

$$rate\ for\ pathogen\ 1\ = pathogen\ 1\ growth + diffusion\ pathogen\ 1 - pathogen\ 1\ death$$

$$rate\ for\ pathogen\ 2\ = pathogen\ 2\ growth + diffusion\ pathogen\ 2$$

$$rate\ for\ nutrient\ 1\ = -nutrient\ 1\ consumption + diffusion\ nutrient\ 1$$