Oftentimes we have to critically think about the data provided. The data on the attached pages leads to an interesting result. Throughout this project, you should think about reasons why the fetal and placental weight/volume could be growing the way they show here.

1) First, read carefully the attached document, which has been extracted from a medical text, Human Body Composition, by G. Forbes, where the collected data is shown and explained. Pay particular attention to the graph on page 103 and determine whether the data is presented in the form of $w(t)$, $w'(t)$, or $w''(t)$, given that $w(t)$ represents the fetal/placental weight as a function of time. Explain why.

2) Refer to the Figure 3.1 on page 103 and use a grid paper and a ruler to estimate the coordinates of data points for each set (fetus and placenta). Make the units of measurement consistent and then transfer each set to MATLAB arrays that could be used to replicate the scatter plots in Figure 3.1. Make sure to use proper legends and labels (including units) on the horizontal (t) and vertical axes and name the plots *Fig. 1* and *Fig. 2*, respectively for fetus and placental growth data.

3) Next, use MATLAB Basic Fitting tool from the pull-down menu of the figure window to fit a polynomial of degree 1 (linear) to each set of data. Display the fitted equation and calculate the R-square values. How good is the fitting?

4) Repeat part (3) using a polynomial of degree 4 with at least 10 decimal digits. Display the results on the same graphs. How good is the new fitting? Explain why?

5) Using the fitted polynomial in part 4 and what you have learned in calculus, calculate $W_f''(t)$ and $W_p''(t)$ for fetal and placental weights respectively, and plot them on two new graphs, named *Fig. 3* and *Fig. 4*. You can also use MATLAB symbolic toolbox to calculate the derivatives. Make sure to use proper legends and labels (including units) on the horizontal (t) and vertical axes. Then, find the inflection points of fetal and placental weight data. Verify your answers on *Figs. 1* and *2*. What is the actual physical/physiological interpretation of these inflection points?

6) What do you notice about the inflection points of the placental weight and the inflection point of the fetal weight? Do they occur around the same week?

7) Using the fitted polynomial in part (4) and what you have learned in calculus, calculate two polynomials $W_f(t)$ and $W_p(t)$ that describe respectively the fetal and placental weight (grams) as a function of time (days), assuming at 112 days (16 weeks), a regular fetus is about 100 grams and a regular placenta weighs 120 grams. You can also use MATLAB symbolic toolbox to calculate the antiderivatives. Plot the fetal and placental weight as a function of time on two new graphs, named *Fig.*

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5 and *Fig. 6*. Make sure to use proper legends and labels (including units) on the horizontal (t) and vertical axes.

8) In a different study, researchers have looked at the effects of exercise on pregnancy. The results, which are summarized in the following table, show the average volume of placenta at several weeks of gestation in non-exercising mothers.

Week of Gestation (t)	Placental Volume (V_p) in mL
20	181
23	220
25	262
27	289
31	302
35	350
37	385
40	414

Enter the above data points as MATLAB arrays, and starting with time $t = 0$, plot the placental volume $V_p(t)$ (mL) as a function of time (weeks). Repeat part (4) using a polynomial of degree 4. Make sure to use proper legends and labels (including units) on the horizontal (t) and vertical axes and name this plot *Fig. 7*. Using the fitted polynomial, estimate the placental volume at time $t = 0$, and explain the procedure. Does this value make sense? What is the actual physical/physiological interpretation of the extrapolated value? Elaborate in your own words.

9) Suppose you want to compare the inflection point of placental volume data to that of the placental weight data from Forbes. How do you find the inflection point for the placental volume data? How did you find it from Forbes' data? Why can't you compare the data directly? Find approximately at what week the inflection point occurs for both sets of data (placental volume and placental weight).

10) MAKE A MEDICAL CONCLUSION: Both sets of data were collected by different experiments.

    a. Does the placental volume's inflection point match the same time period (approximately) for the placental weight for Forbes data?

    b. What does this say about the data? Do you trust the data in both experiments? Why or why not?

    c. What possible medical reasons can you provide for the inflection points occurring at different times for fetal weight and placental weight? List all you can think of. Remember to look up the fetal weight data from Forbes and check how this data was obtained.

All plots, calculations, and comments should be included in the project report.

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