

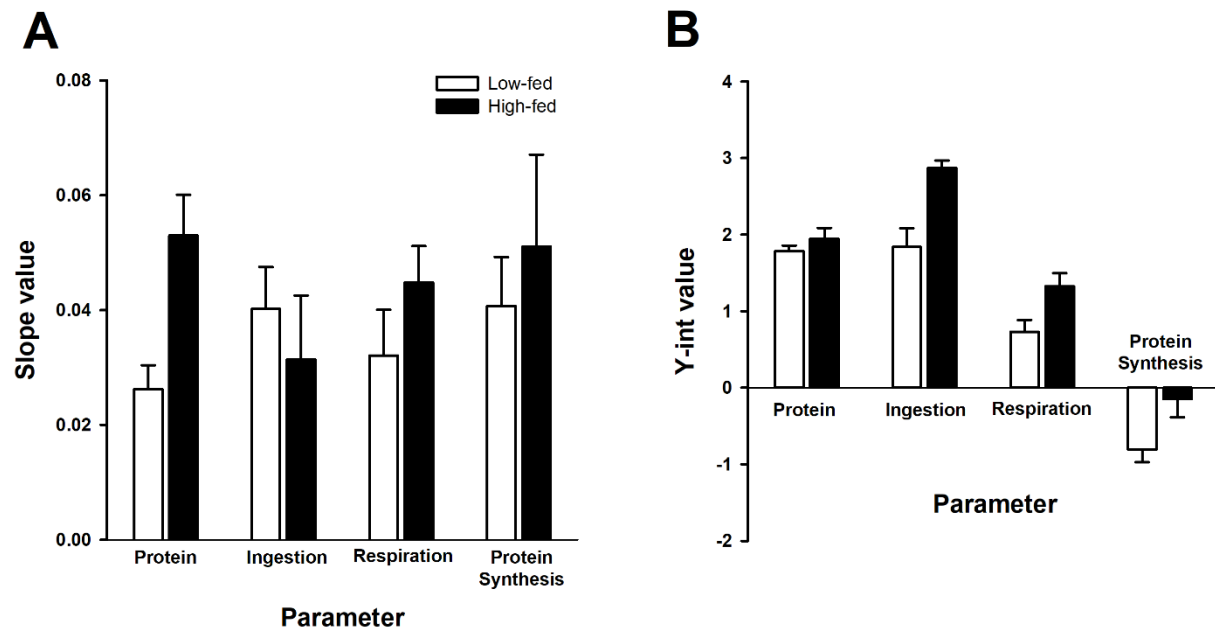
**Table S1. Amino acid composition of protein in larvae of *D. excentricus*.**

Amino Acid	Mean mole-percent composition in protein <i>N</i> = 3 (+/- <i>SD</i> )
Aspartate/Asparagine*	9.3 (± 0.61)
Threonine	4.6 (± 0.30)
Serine	5.8 (± 0.45)
Glutamate/Glutamine*	10.5 (± 0.62)
Proline	4.7 (± 1.94)
Glycine	11.5 (± 0.93)
<b>Alanine**</b>	<b>9.5 (± 0.61)</b>
Valine	6.3 (± 0.32)
Isoleucine	4.7 (± 1.18)
Leucine	7.4 (± 0.53)
Tyrosine	2.4 (± 0.20)
Phenylalanine	2.6 (± 0.74)
Histidine	1.6 (± 0.10)
Lysine	6.6 (± 0.24)
Arginine	6.6 (± 0.56)
Cysteine	2.3 (± 0.87)
Methionine	2.6 (± 0.14)
Tryptophan	1.0 (± 0.34)
Mole-percent corrected MW <sub>P</sub> (g mole <sup>-1</sup> )†	126.0 (± 0.25)

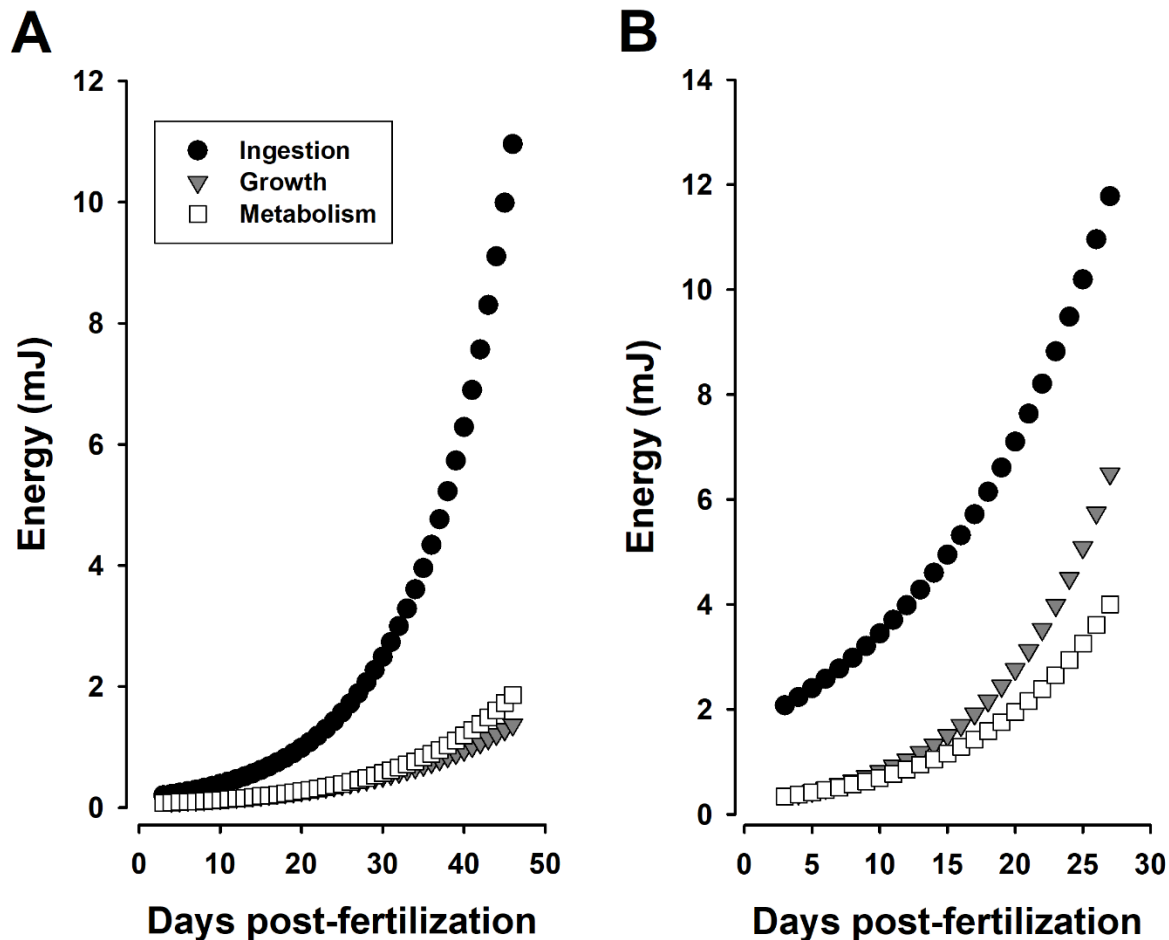
\* Asparagine and glutamine are converted to aspartate and glutamate respectively during mole-percent analysis. Therefore these values represent the sum of both amino acids.

\*\* Alanine is the amino acid tracer used in this study to measure protein synthesis rates

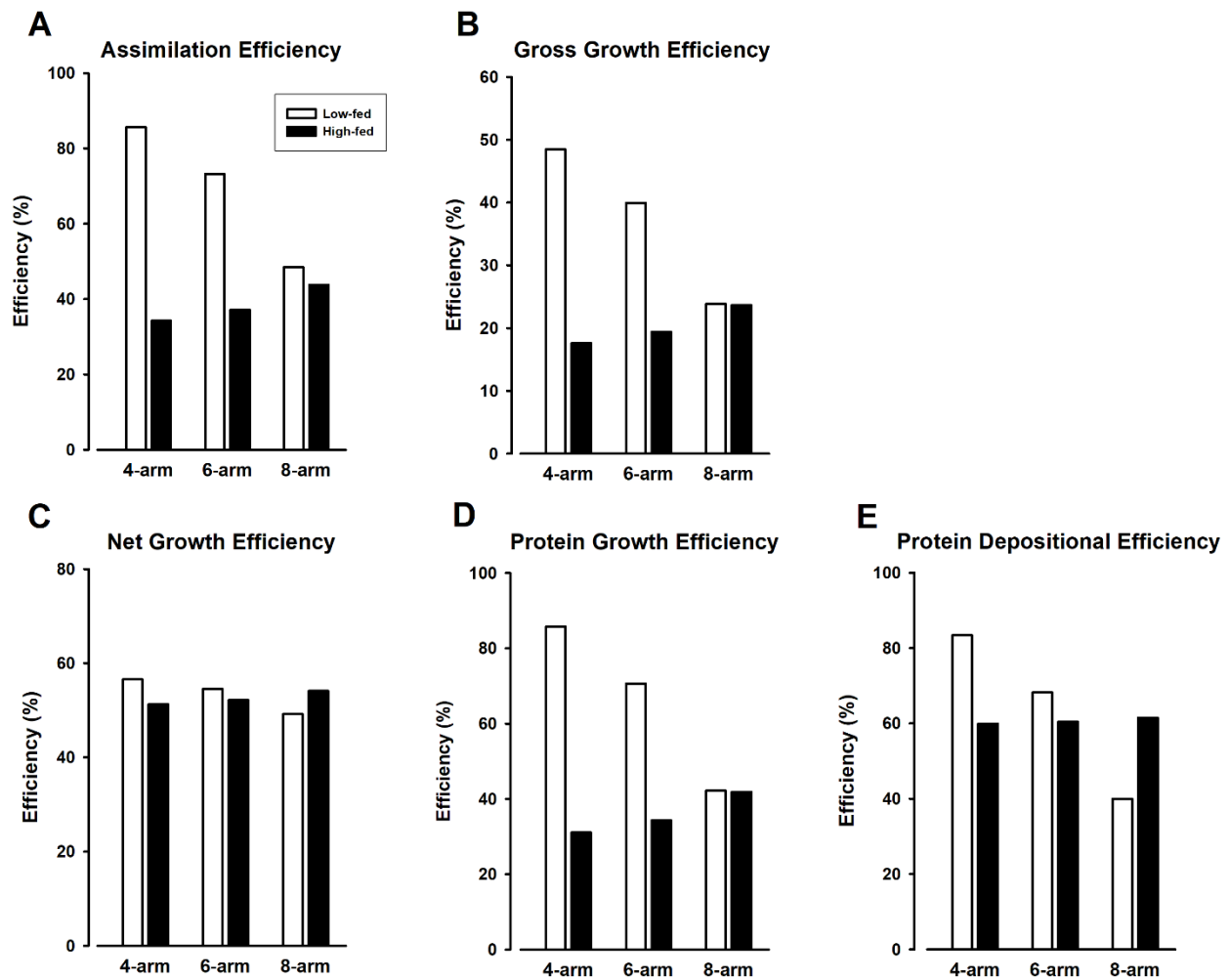
† MW<sub>P</sub> is calculated as the sum of the mole-percent value, in this table, multiplied by the respective molecular weight. This value represents the average molecular weight of an amino acid in the total protein pool of larvae of *D. excentricus*.



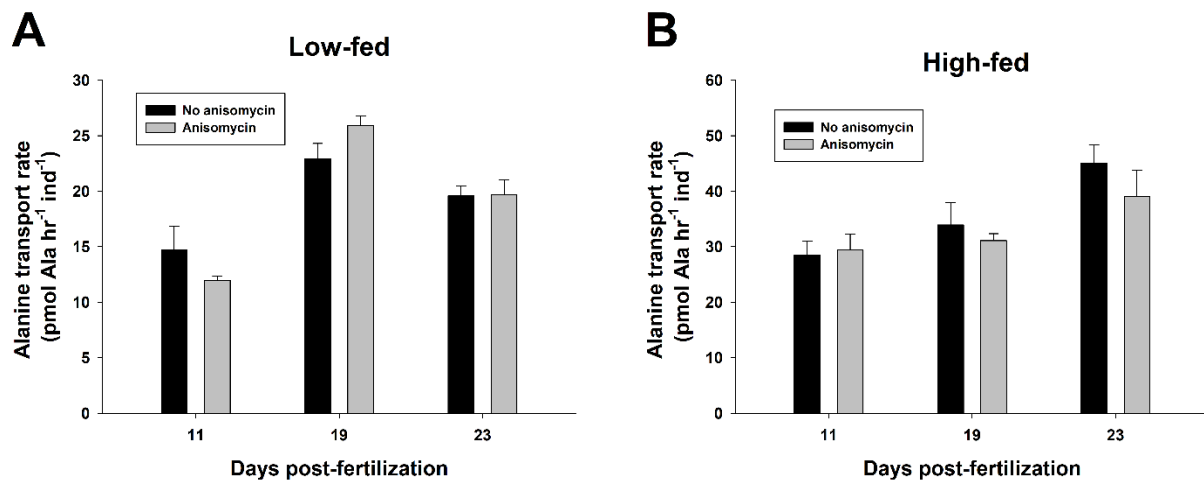
**Fig. S1. Weighted average regression variables for modeling physiological energetics and protein metabolism.** Values were calculated from the  $\log_{10}(x)$ -transformed data for protein growth (Fig. 2A), algal ingestion rates (Fig. 2B), respiration rates (Fig. 2C), and protein synthesis rates (Fig. 4A). **(A)** Weighted average values for slope estimates and **(B)** for y-intercept estimates. Error bars are the weighted average standard deviations for each respective parameter. Low-fed larvae = white bars, high-fed larvae = black bars. Sample sizes for each culture were as follows (cultures 1-3, respectively): low-fed protein: 8, 8, 9; ingestion low-fed ingestion rates: 38, 30, 30; low-fed respiration rates: 10, 8, 9; low-fed protein synthesis rates: 9, 7, 8; high-fed protein: 7, 6, 6; high-fed ingestion rates: 18, 18, 18; high-fed respiration rates: 7, 6, 6; high-fed protein synthesis rates: 6, 3, 5.



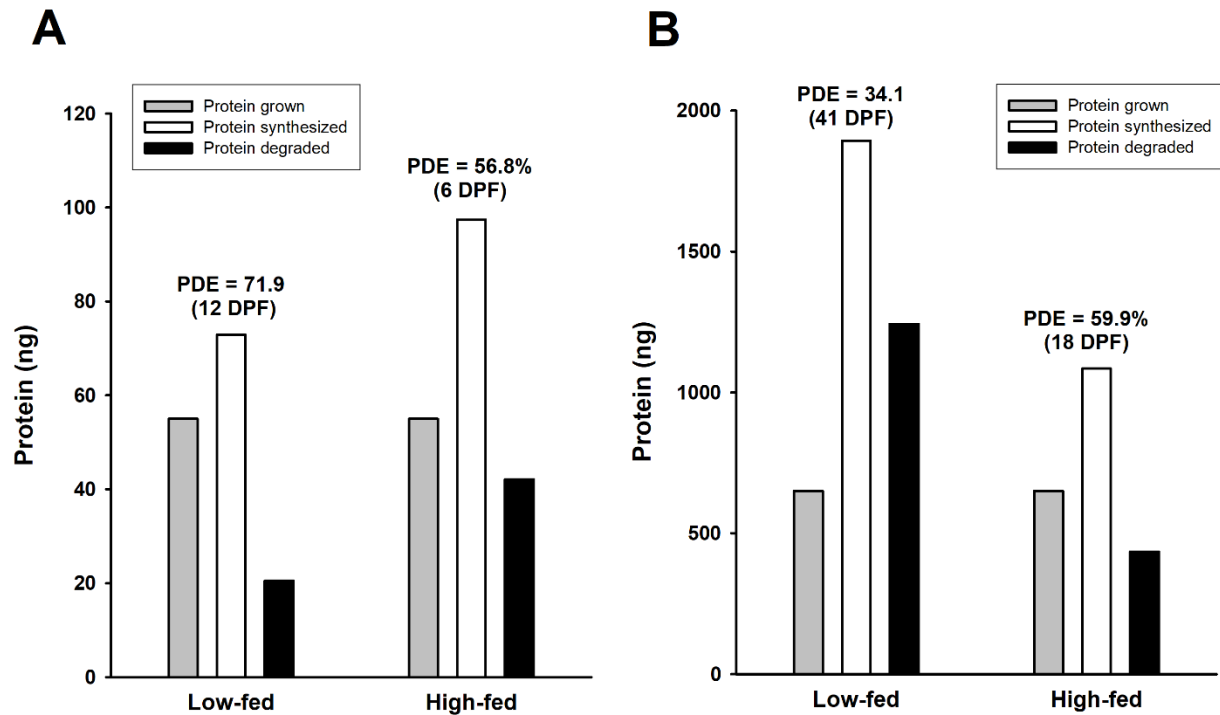
**Fig. S2. Physiological energetic models of energy acquisition and use for determining AE, GGE, NGE, and PGE. (A)** Daily changes in energetic budgets for low-fed larvae. **(B)** Daily changes in energetic budgets for high-fed larvae. Black circles represent energy acquired through algal feeding, gray triangles represents energy invested into protein growth, white squares represents energy consumed through aerobic metabolism (respiration). Each value represents the respective energetic equivalent for that day. All data were modeled from the weighted regression variables (slope and y-intercept) of the  $\log_{10}(x)$ -transformed data displayed in Figs. 2A-C. Individual regression variables are shown in Supplementary Fig. S1. Note that x- and y-axes are different for each panel.



**Fig. S3. Stage-specific physiological efficiencies.** Developmental ages for 4-arm stage were 3 dpf for low- and high-fed larva. Due to efficiency data requiring 2 consecutive days of physiological data, efficiency values at 4 dpf were used (i.e., feeding treatments started at 3 dpf). 6-arm pluteus stage was 10 dpf for low-fed and 6 dpf for high-fed larvae. Developmental ages for 8-arm pluteus stage were 26 dpf for low-fed and 10 dpf for high-fed larvae. **(A)** Assimilation efficiency, **(B)** Gross growth efficiency, **(C)** Net growth efficiency, **(D)** Protein growth efficiency, **(E)** Protein depositional efficiency. Data for (A) – (D) taken from Fig. 2D, data for (E) from Fig. 6A. For all figures, black bars = low-fed larval efficiencies, gray bars = high-fed larval efficiencies.



**Fig. S4. Comparison of alanine transport rates in low- and high-fed larvae of *D. excentricus* with and without exposure to the protein synthesis inhibitor, anisomycin. (A) Rates of alanine transport in low-fed larvae at the indicated days post-fertilization. (B) Rates of alanine transport in high-fed larvae at the indicated days post-fertilization. Error bars are the standard error of the slope for the increase in transported alanine over time. Anisomycin concentration was 20μM. Paired T-test comparison for low- and high-fed larvae between 'No anisomycin' and 'anisomycin' treatments were similar to each other [ $t(5) = 0.96$ ;  $P = 0.38$ ]. 'No anisomycin' transport rates are from Fig. 3A**



**Fig. S5. Analysis of protein metabolism in early and later larval stages of low- and high-fed larvae of *D. excentricus*.** (A) Analysis of protein growth, synthesis, and degradation to achieve ~50 ng of growth. (B) Analysis of protein growth, synthesis, and degradation to achieve ~ 650 ng of growth. Gray bars = protein growth, white bars = protein synthesized, black bars = protein degraded. Values above each data set indicate the corresponding protein depositional efficiency (PDE) and the larval age (dpf) when the respective amount of growth had been achieved.