

**Supplementary Material to accompany article:** Ren, C.C., Sylvia, K.E., Munley, K.M., Deyoe, J.E., Henderson, S.G., Vu, M.P, and Demas, G.E. Photoperiod Modulates the Gut Microbiome and Aggressive Behavior in Siberian Hamsters.

**Table S1. Effect of photoperiodic treatment and time on behavior of male hamsters.**

Behavior	P-value for Treatment x Time Interaction	LD			SD-R			SD-NR		
		Week 3	Week 6	Week 9	Week 3	Week 6	Week 9	Week 3	Week 6	Week 9
Frequency of Attack	0.174	11.33 ±3.23	8.00 ±1.93	4.78 ±1.39	9.22 ±2.22	8.56 ±1.94	15.11 ±3.91	16.25 ±5.61	6.25 ±2.14	7.50 ±3.44
Duration of Attack (s)	0.144	26.40 ±9.78	21.77 ±6.65	10.63 ±3.49	17.71 ±4.32	24.09 ±8.06	21.67 ±4.74	41.40 ±15.28	16.64 ±9.91	10.63 ±5.46
Frequency of Chasing	0.340	0.00 ±0.00	0.11 ±0.11	0.00 ±0.00	0.11 ±0.11	0.11 ±0.11	0.44 ±0.24	0.00 ±0.00	0.25 ±0.25	0.00 ±0.00
Duration of Chasing (s)	0.605	0.00 ±0.00	0.07 ±0.07	0.00 ±0.00	0.31 ±0.31	0.16 ±0.16	0.18 ±0.09	0.00 ±0.00	0.66 ±0.66	0.00 ±0.00
Latency to First Attack (s)	0.097	68.44 ±31.21	92.56 ±32.31	81.11 ±35.72	80.22 ±34.44	94.89 ±36.22	75.11 ±22.20	56.63 ±13.78	165.63 ±42.41	123.00 ±34.56
Duration of Head Neck Sniffing (s)	<b>&lt;0.0001</b>	26.22 ±9.40	25.94 ±8.70	20.91 ±7.00	22.01 ±6.31	18.02 ±5.07	20.91 ±7.00	18.48 ±4.87	24.38 ±5.08	14.00 ±4.45
Frequency of Head Neck Sniffing	<b>0.001</b>	13.11 ±3.74	15.89 ±4.45	12.78 ±3.85	11.67 ±2.94	9.00 ±1.88	7.71 ±4.06	10.50 ±2.64	15.00 ±2.44	9.50 ±2.40
Frequency of Scent Marking	0.066	0.56 ±0.44	0.78 ±0.66	1.33 ±0.99	2.11 ±0.90	1.11 ±0.99	3.11 ±1.84	2.11 ±0.90	1.11 ±0.99	0.25 ±0.25
Frequency of Grooming	0.406	6.33 ±0.83	9.67 ±2.23	9.67 ±2.40	9.44 ±1.73	9.33 ±1.64	10.56 ±1.44	9.25 ±1.98	8.38 ±1.38	10.56 ±2.01
Duration of Grooming (s)	0.821	10.42 ±2.01	20.01 ±6.95	13.93 ±6.60	24.50 ±7.16	23.62 ±6.98	27.88 ±8.49	20.18 ±11.35	16.95 ±5.18	12.03 ±2.93

Aggressive and non-aggressive social behaviors in long day males (LD), short day males that were responsive to changes in photoperiod (SD-R), and short-day males that were not responsive to changes in photoperiod (SD-NR) following 3, 6, or 9 weeks of treatment. Group means are presented as mean±s.e.m. (LD:  $N=9$ , SD-R:  $N=9$ , SD-NR:  $N=8$ ).  $P$ -values are shown for treatment x time interactions, and boldface font indicates a significant treatment x time interaction ( $P<0.05$ , mixed model ANOVAs).

**Table S2. Effect of photoperiod treatment and time on behavior of female hamsters.**

Behavior	<i>P</i> -value for Treatment x Time Interaction	LD			SD-R			SD-NR		
		Week 3	Week 6	Week 9	Week 3	Week 6	Week 9	Week 3	Week 6	Week 9
Frequency of Attack	<b>0.004</b>	5.00 ±1.41	6.78 ±2.10	6.44 ±1.86	7.11 ±2.10	6.33 ±1.26	10.00 ±2.63	2.28 ±0.94	3.50 ±1.32	4.75 ±1.29
Duration of Attack (s)	<b>0.003</b>	9.74 ±3.32	12.34 ±4.48	8.47 ±2.63	7.27 ±2.18	12.80 ±2.72	22.66 ±6.33	2.80 ±1.05	4.60 ±1.57	8.25 ±2.86
Frequency of Chasing	0.638	0.11 ±0.11	0.00 ±0.00	0.00 ±0.00	0.11 ±0.11	0.11 ±0.11	0.00 ±0.00	0.25 ±0.25	0.00 ±0.00	0.00 ±0.00
Duration of Chasing (s)	0.944	0.06 ±0.06	0.00 ±0.00	0.00 ±0.00	0.18 ±0.18	0.11 ±0.11	0.00 ±0.00	0.21 ±0.21	0.00 ±0.00	0.00 ±0.00
Latency to First Attack	0.273	31.33 ±11.83	62.89 ±27.53	72.56 ±31.31	46.22 ±14.31	47.22 ±15.34	41.67 ±21.26	62.75 ±29.26	86.50 ±33.99	114.75 ±40.33
Duration of Head Neck Sniffing (s)	<b>&lt;0.0001</b>	13.36 ±3.57	15.03 ±5.41	11.24 ±1.98	13.00 ±4.34	15.27 ±5.39	10.36 ±3.53	14.51 ±6.12	14.09 ±3.73	23.91 ±4.13
Frequency of Head Neck Sniffing	<b>0.001</b>	9.44 ±2.17	9.67 ±2.04	8.56 ±1.21	7.44 ±2.40	9.22 ±2.72	7.78 ±2.28	9.25 ±3.27	8.75 ±2.42	12.63 ±2.25
Frequency of Scent Marking	0.052	1.89 ±1.32	2.33 ±1.65	4.00 ±2.66	0.00 ±0.00	0.44 ±0.24	0.89 ±0.77	0.13 ±0.13	0.00 ±0.00	0.00 ±0.00
Frequency of Grooming	0.063	6.44 ±1.83	3.89 ±0.93	7.00 ±1.99	7.22 ±1.28	8.00 ±2.10	10.67 ±2.00	4.25 ±1.58	4.50 ±0.96	4.75 ±1.16
Duration of Grooming (s)	<b>0.044</b>	7.96 ±2.36	12.94 ±7.65	15.63 ±6.71	16.12 ±7.52	18.38 ±6.80	13.27 ±3.08	4.26 ±1.40	4.79 ±1.00	5.80 ±1.88

Aggressive and non-aggressive social behaviors in long day females (LD), short day females that were responsive to changes in photoperiod (SD-R), and short-day females that were not responsive to changes in photoperiod (SD-NR) following 3, 6, or 9 weeks of treatment. Group means are presented as mean±s.e.m. (LD: *N*=9, SD-R: *N*=9, SD-NR: *N*=8). *P*-values are shown for treatment x time interactions, and boldface font indicates a significant treatment x time interaction (*P*<0.05, mixed model ANOVAs).

**Table S3. Effect of photoperiodic treatment on the relative abundance of bacterial phyla and families in the gut microbiome of male hamsters.**

Phylum or Family		P	LD			SD-R			SD-NR		
			Week 3	Week 6	Week 9	Week 3	Week 6	Week 9	Week 3	Week 6	Week 9
Phylum	Actinobacteria	0.904	0.004 ±0.002	0.009 ±0.003	0.006 ±0.003	0.007 ±0.003	0.007 ±0.005	0.008 ±0.003	0.006 ±0.003	0.006 ±0.003	0.007 ±0.003
	Bacteroidetes	<b>0.011</b>	1.053 ±0.322	1.716 ±0.361	2.328 ±0.517	1.266 ±0.197	1.806 ±0.386	1.655 ±0.310	0.932 ±0.177	1.274 ±0.221	2.344 ±0.652
	Deferribacteres	0.344	0.022 ±0.015	0.010 ±0.009	0.009 ±0.007	0.000 ±0.000	0.001 ±0.001	0.015 ±0.009	0.000 ±0.000	0.003 ±0.003	0.009 ±0.008
	Elusimicrobia	0.472	0.001 ±0.001	0.012 ±0.011	0.005 ±0.004	0.002 ±0.002	0.002 ±0.002	0.011 ±0.006	0.076 ±0.073	0.041 ±0.035	0.082 ±0.070
	Cyanobacteria	0.228	0.054 ±0.031	0.074 ±0.022	0.106 ±0.030	0.140 ±0.049	0.123 ±0.051	0.227 ±0.069	0.092 ±0.021	0.079 ±0.015	0.159 ±0.052
	Epsilonbacteraeota	0.228	0.020 ±0.004	0.018 ±0.003	0.044 ±0.005	0.056 ±0.018	0.100 ±0.056	0.056 ±0.023	0.031 ±0.008	0.035 ±0.007	0.085 ±0.047
	Euryarchaeota	0.730	0.008 ±0.004	0.002 ±0.001	0.009 ±0.005	0.007 ±0.006	0.006 ±0.004	0.009 ±0.004	0.002 ±0.001	0.005 ±0.004	0.028 ±0.027
	Firmicutes	0.217	2.715 ±0.723	2.502 ±0.400	4.394 ±1.078	2.642 ±0.692	4.039 ±1.298	5.080 ±0.702	1.853 ±0.261	4.000 ±1.250	7.776 ±4.534
	Patescibacteria	<b>0.007</b>	0.023 ±0.004	0.048 ±0.014	0.050 ±0.008	0.024 ±0.005	0.034 ±0.006	0.060 ±0.019	0.028 ±0.006	0.042 ±0.012	0.073 ±0.027
	Proteobacteria	0.448	0.135 ±0.034	0.094 ±0.017	0.187 ±0.067	0.075 ±0.023	0.110 ±0.050	0.326 ±0.164	0.080 ±0.012	0.117 ±0.045	0.289 ±0.206
	Spirochaetes	0.175	0.017 ±0.009	0.016 ±0.002	0.075 ±0.043	0.057 ±0.051	0.066 ±0.032	0.086 ±0.051	0.011 ±0.002	0.025 ±0.004	0.267 ±0.175
Tenericutes	0.128	0.084 ±0.035	0.143 ±0.054	0.128 ±0.048	0.148 ±0.093	0.128 ±0.054	0.177 ±0.066	0.046 ±0.020	0.024 ±0.005	0.045 ±0.014	
Family	Marinifilaceae	<b>0.005</b>	0.028 ±0.005	0.047 ±0.009	0.062 ±0.019	0.045 ±0.009	0.065 ±0.010	0.095 ±0.031	0.026 ±0.010	0.036 ±0.013	0.062 ±0.023
	Muribaculaceae	<b>0.015</b>	0.809 ±0.277	1.354 ±0.308	1.674 ±0.373	0.959 ±0.210	1.454 ±0.397	1.219 ±0.250	0.930 ±0.168	1.122 ±0.317	1.747 ±0.486
	Ruminococcaceae	0.075	0.459 ±0.104	0.534 ±0.095	0.984 ±0.178	0.388 ±0.070	0.779 ±0.244	0.934 ±0.205	0.450 ±0.116	0.703 ±0.160	1.817 ±0.933
	Saccharimonadaceae	<b>0.008</b>	0.023 ±0.004	0.048 ±0.014	0.050 ±0.008	0.024 ±0.005	0.034 ±0.006	0.060 ±0.019	0.028 ±0.006	0.042 ±0.012	0.073 ±0.027
	Uncultured Mollicutes Bacterium	<b>0.045</b>	0.007 ±0.004	0.033 ±0.021	0.007 ±0.004	0.000 ±0.000	0.001 ±0.001	0.000 ±0.000	0.003 ±0.003	0.000 ±0.000	0.000 ±0.000
	Uncultured Bacterium	0.068	0.035 ±0.015	0.047 ±0.017	0.064 ±0.022	0.182 ±0.079	0.138 ±0.059	0.208 ±0.073	0.080 ±0.030	0.052 ±0.015	0.071 ±0.020

Other	<b>0.028</b>	0.068 ±0.028	0.086 ±0.037	0.131 ±0.040	0.039 ±0.009	0.031 ±0.006	0.102 ±0.057	0.046 ±0.011	0.038 ±0.013	0.090 ±0.049
Anaeroplasmataceae	0.087	0.024 ±0.009	0.024 ±0.028	0.031 ±0.016	0.003 ±0.003	0.003 ±0.002	0.005 ±0.005	0.033 ±0.023	0.033 ±0.034	0.069 ±0.044
Bacteroidaceae	0.058	0.013 ±0.005	0.022 ±0.006	0.015 ±0.006	0.023 ±0.013	0.020 ±0.007	0.027 ±0.014	0.011 ±0.003	0.010 ±0.004	0.023 ±0.010
BacteroidalesRF16group	0.051	0.005 ±0.002	0.006 ±0.002	0.011 ±0.005	0.011 ±0.006	0.005 ±0.002	0.009 ±0.004	0.006 ±0.002	0.006 ±0.002	0.006 ±0.001
Desulfovibrionaceae	0.061	0.055 ±0.023	0.036 ±0.014	0.075 ±0.044	0.014 ±0.006	0.031 ±0.016	0.140 ±0.114	0.015 ±0.006	0.030 ±0.013	0.096 ±0.049
Lachnospiraceae	<b>0.038</b>	2.193 ±0.736	1.383 ±0.211	3.160 ±1.125	1.023 ±0.164	3.008 ±1.096	5.445 ±3.516	1.663 ±0.536	2.716 ±1.070	3.458 ±0.762
Lactobacillaceae	<b>0.030</b>	0.046 ±0.031	0.050 ±0.150	0.089 ±0.034	0.069 ±0.028	0.050 ±0.014	0.062 ±0.022	0.074 ±0.048	0.089 ±0.058	0.120 ±0.064
Marinifilaceae	<b>&lt;0.0001</b>	0.028 ±0.005	0.047 ±0.009	0.062 ±0.019	0.026 ±0.010	0.036 ±0.013	0.062 ±0.023	0.045 ±0.009	0.065 ±0.010	0.095 ±0.031
Muribaculaceae	<b>0.0001</b>	0.809 ±0.277	1.354 ±0.308	1.674 ±0.373	0.930 ±0.168	1.122 ±0.317	1.747 ±0.486	0.959 ±0.210	1.454 ±0.397	1.219 ±0.250
Mycoplasmataceae	0.099	0.006 ±0.002	0.005 ±0.002	0.008 ±0.002	0.009 ±0.004	0.011 ±0.004	0.150 ±0.007	0.011 ±0.003	0.020 ±0.009	0.018 ±0.004
Paracaedibacteraceae	<b>0.011</b>	0.015 ±0.008	0.003 ±0.001	0.034 ±0.023	0.007 ±0.004	0.018 ±0.010	0.030 ±0.015	0.004 ±0.003	0.015 ±0.010	0.042 ±0.021
Prevotellaceae	<b>0.020</b>	0.126 ±0.043	0.175 ±0.050	0.406 ±0.126	0.197 ±0.038	0.188 ±0.044	0.289 ±0.124	0.137 ±0.052	0.137 ±0.044	0.159 ±0.063
Rikenellaceae	<b>0.010</b>	0.059 ±0.019	0.097 ±0.027	0.131 ±0.040	0.079 ±0.030	0.093 ±0.027	0.205 ±0.132	0.097 ±0.031	0.119 ±0.025	0.137 ±0.038
Ruminococcaceae	<b>0.005</b>	0.459 ±0.104	0.534 ±0.095	0.984 ±0.178	0.450 ±0.116	0.703 ±0.160	1.817 ±0.933	0.388 ±0.070	0.779 ±0.244	0.934 ±0.205
Saccharimonadaceae	<b>&lt;0.0001</b>	0.023 ±0.004	0.048 ±0.014	0.050 ±0.008	0.028 ±0.006	0.042 ±0.012	0.073 ±0.027	0.024 ±0.005	0.034 ±0.006	0.060 ±0.019
Spirochaetaceae	<b>0.040</b>	0.014 ±0.009	0.008 ±0.002	0.066 ±0.041	0.004 ±0.002	0.017 ±0.004	0.240 ±0.154	0.055 ±0.051	0.061 ±0.033	0.080 ±0.049
Tannerellaceae	<b>0.045</b>	0.003 ±0.002	0.005 ±0.002	0.004 ±0.001	0.005 ±0.001	0.004 ±0.001	0.008 ±0.001	0.003 ±0.001	0.005 ±0.002	0.046 ±0.040
Uncultured	<b>0.043</b>	0.053 ±0.013	0.034 ±0.012	0.072 ±0.015	0.047 ±0.015	0.055 ±0.014	0.112 ±0.077	0.039 ±0.015	0.056 ±0.027	0.164 ±0.083
Veillonellaceae	<b>0.021</b>	0.011 ±0.004	0.007 ±0.003	0.016 ±0.006	0.006 ±0.001	0.018 ±0.007	0.025 ±0.011	0.008 ±0.004	0.013 ±0.007	0.021 ±0.008

Relative abundance of bacterial phyla and families in long day males (LD), short day males that were responsive to changes in photoperiod (SD-R), and short day males that were not responsive to changes in photoperiod (SD-NR) following 3, 6, or 9 weeks of treatment. Group means are presented as mean±s.e.m. (LD:  $N=6$ , SD-R:  $N=6$ , SD-NR:  $N=6$ ).  $P$ -values ( $P$ ) are shown for all treatment x time interactions in phyla and treatment, time, and treatment x time interactions in families with  $P<0.10$ . Boldface font indicates a significant  $P$ -value ( $P<0.05$ , mixed model ANOVAs).

**Table S4. Effect of photoperiodic treatment on the relative abundance of bacterial phyla and families in the gut microbiome of female hamsters.**

Phylum or Family		P	LD			SD-R			SD-NR			
			Week 3	Week 6	Week 9	Week 3	Week 6	Week 9	Week 3	Week 6	Week 9	
Phylum	Treatment x Time	Actinobacteria	0.424	0.001 ±0.001	0.004 ±0.002	0.009 ±0.004	0.000 ±0.000	0.003 ±0.003	0.037 ±0.032	0.002 ±0.002	0.003 ±0.001	0.011 ±0.010
		Bacteroidetes	0.308	0.895 ±0.302	1.155 ±0.343	1.895 ±0.329	0.956 ±0.217	1.040 ±0.324	8.701 ±6.933	0.900 ±0.184	1.169 ±0.370	2.198 ±0.441
		Deferribacteres	0.438	0.022 ±0.019	0.021 ±0.200	0.011 ±0.008	0.000 ±0.000	0.000 ±0.000	0.002 ±0.002	0.001 ±0.001	0.015 ±0.015	0.003 ±0.003
		Elusimicrobia	0.441	0.006 ±0.004	0.009 ±0.005	0.016 ±0.009	0.004 ±0.004	0.001 ±0.000	0.024 ±0.018	0.007 ±0.006	0.010 ±0.008	0.005 ±0.003
		Cyanobacteria	0.468	0.006 ±0.003	0.004 ±0.002	0.008 ±0.006	0.003 ±0.002	0.003 ±0.002	0.004 ±0.002	0.007 ±0.003	0.006 ±0.001	0.016 ±0.009
		Epsilonbacteraeota	0.351	0.030 ±0.008	0.031 ±0.013	0.042 ±0.015	0.029 ±0.012	0.024 ±0.008	0.248 ±0.203	0.030 ±0.010	0.026 ±0.006	0.066 ±0.029
		Euryarchaeota	0.406	0.026 ±0.009	0.018 ±0.003	0.042 ±0.018	0.029 ±0.012	0.024 ±0.008	0.248 ±0.203	0.030 ±0.010	0.026 ±0.006	0.066 ±0.029
		Firmicutes	<b>0.036</b>	2.531 ±0.803	2.862 ±0.510	3.223 ±1.042	2.262 ±0.532	2.609 ±0.752	9.429 ±4.592	2.789 ±0.719	3.930 ±0.755	6.691 ±1.900
		Patescibacteria	0.235	0.015 ±0.002	0.033 ±0.013	0.051 ±0.006	0.026 ±0.004	0.030 ±0.008	0.243 ±0.177	0.045 ±0.018	0.040 ±0.008	0.060 ±0.010
		Proteobacteria	0.176	0.179 ±0.054	0.310 ±0.172	0.135 ±0.057	0.178 ±0.098	0.163 ±0.048	0.634 ±0.395	0.084 ±0.026	0.133 ±0.033	0.260 ±0.126
		Spirochaetes	0.075	0.017 ±0.005	0.015 ±0.004	0.024 ±0.003	0.012 ±0.005	0.033 ±0.019	0.104 ±0.056	0.011 ±0.005	0.017 ±0.007	0.110 ±0.067
Tenericutes	0.511	0.052 ±0.043	0.138 ±0.111	0.095 ±0.046	0.061 ±0.025	0.050 ±0.016	0.396 ±0.336	0.092 ±0.031	0.062 ±0.021	0.126 ±0.028		
Family	Treatment x Time	Lachnospiraceae	0.071	1.970 ±0.600	1.748 ±0.433	2.133 ±0.953	1.585 ±0.446	1.791 ±0.626	3.545 ±1.444	2.045 ±0.620	2.854 ±0.697	4.546 ±1.625
		Peptococcaceae	0.067	0.015 ±0.002	0.033 ±0.013	0.051 ±0.006	0.026 ±0.004	0.030 ±0.008	0.243 ±0.177	0.045 ±0.018	0.040 ±0.008	0.060 ±0.010
		Ruminococcaceae	<b>0.033</b>	0.470 ±0.090	0.481 ±0.092	0.717 ±0.232	0.521 ±0.120	0.582 ±0.132	2.584 ±1.442	0.551 ±0.148	0.754 ±0.129	1.724 ±0.507
		Spirochaetaceae	0.081	0.018 ±0.005	0.012 ±0.004	0.019 ±0.004	0.007 ±0.004	0.031 ±0.020	0.091 ±0.046	0.010 ±0.006	0.015 ±0.007	0.095 ±0.062
	Time	Anaeroplasmataceae	<b>0.007</b>	0.004 ±0.004	0.002 ±0.002	0.002 ±0.002	0.039 ±0.022	0.022 ±0.009	0.020 ±0.007	0.002 ±0.001	0.005 ±0.002	0.009 ±0.008
		Other	0.065	0.033 ±0.011	0.041 ±0.007	0.074 ±0.020	0.042 ±0.016	0.021 ±0.007	0.255 ±0.204	0.019 ±0.005	0.022 ±0.004	0.080 ±0.024
		Bacteroidaceae	0.081	0.019 ±0.011	0.025 ±0.010	0.028 ±0.011	0.006 ±0.002	0.007 ±0.005	0.076 ±0.062	0.018 ±0.006	0.024 ±0.016	0.039 ±0.019

Lachnospiraceae	<b>0.009</b>	1.970 ±0.600	1.748 ±0.433	2.133 ±0.953	1.585 ±0.446	1.791 ±0.626	3.545 ±1.444	2.045 ±0.620	2.854 ±0.697	4.546 ±1.625
Lactobacillaceae	<b>0.002</b>	0.032 ±0.018	0.034 ±0.020	0.103 ±0.028	0.045 ±0.028	0.020 ±0.007	0.150 ±0.094	0.049 ±0.022	0.041 ±0.018	0.148 ±0.065
Marinifilaceae	0.074	0.030 ±0.007	0.071 ±0.026	0.076 ±0.035	0.042 ±0.013	0.037 ±0.015	0.093 ±0.049	0.018 ±0.010	0.023 ±0.007	0.050 ±0.027
Peptococcaceae	<b>0.006</b>	0.011 ±0.003	0.010 ±0.004	0.011 ±0.005	0.009 ±0.002	0.012 ±0.003	0.022 ±0.009	0.009 ±0.002	0.017 ±0.003	0.026 ±0.012
Ruminococcaceae	<b>0.003</b>	0.470 ±0.090	0.481 ±0.092	0.717 ±0.232	0.521 ±0.120	0.582 ±0.132	2.584 ±1.442	0.551 ±0.148	0.754 ±0.129	1.724 ±0.507
Saccharimonadaceae	0.092	0.015 ±0.002	0.033 ±0.013	0.051 ±0.006	0.026 ±0.004	0.030 ±0.008	0.060 ±0.177	0.044 ±0.018	0.040 ±0.008	0.060 ±0.010
Spirochaetaceae	<b>0.008</b>	0.018 ±0.005	0.012 ±0.004	0.019 ±0.004	0.007 ±0.004	0.031 ±0.020	0.091 ±0.046	0.010 ±0.006	0.015 ±0.007	0.095 ±0.062

Relative abundance of bacterial phyla and families in long day females (LD), short day females that were responsive to changes in photoperiod (SD-R), and short day females that were not responsive to changes in photoperiod (SD-NR) following 3, 6, or 9 weeks of treatment. Group means are presented as mean±s.e.m. (LD:  $N=6$ , SD-R:  $N=6$ , SD-NR:  $N=6$ ).  $P$ -values ( $P$ ) are shown for all treatment x time interactions in phyla and treatment, time, and treatment x time interactions in families with  $P<0.10$ . Boldface font indicates a significant  $P$ -value ( $P<0.05$ , mixed model ANOVAs).

**Table S5. Serum DHEA levels of male and female hamsters following 9 weeks of treatment.**

Sex	<i>P</i>	Serum DHEA Concentration at Week 9 (ng mL <sup>-1</sup> )		
		LD	SD-R	SD-NR
Male	0.692	3.637 ± 0.609	4.789 ± 1.052	4.402 ± 1.252
Female	0.463	2.419 ± 0.697	4.417 ± 1.257	3.393 ± 0.876

Serum dehydroepiandrosterone (DHEA) levels in long day males (LD), short day males that were responsive to changes in photoperiod (SD-R), short day males that were not responsive to changes in photoperiod (SD-NR), LD females, SD-R females, and SD-NR females following 9 weeks of treatment. Group means are presented as mean±s.e.m. (LD males: *N*=7, SD-R males: *N*=9, SD-NR males: *N*=5, LD females: *N*=8, SD-R females: *N*=8, SD-NR females: *N*=5). *P*-values (*P*) are shown for statistical comparisons across treatment groups for each sex (one-way ANOVAs).

**Table S6. Correlations between serum DHEA levels, the gut microbiome, and behavior of male and female hamsters.**

Behavior or gut bacteria phylum or family		Correlation coefficient with serum DHEA ( $r_s$ )	<i>N</i>	<i>P</i>
Males	Number of Attacks	0.796	14	<b>0.001</b>
	Attack Duration	0.733	14	<b>0.003</b>
	Patescibacteria	0.506	14	0.065
	Marinifilaceae	0.125	14	0.125
Females	Number of Attacks	-0.120	13	0.697
	Attack Duration	-0.115	13	0.710
	Anaeroplasmataceae	-0.011	13	0.971
	Firmicutes	-0.187	13	0.541
	Ruminococcaceae	-0.093	13	0.765

Correlations between serum dehydroepiandrosterone (DHEA) levels, the gut microbiome, and behavior in long day males (LD), short day males that were responsive to changes in photoperiod (SD-R), short day males that were not responsive to changes in photoperiod (SD-NR), LD females, SD-R females, and SD-NR females following 9 weeks of treatment. Correlations coefficients ( $r_s$ ), number of animals (*N*), and *P*-values (*P*) are shown for each analysis, which was performed across treatment groups (LD males: *N*=4, SD-R males: *N*=6, SD-NR males: *N*=4, LD females: *N*=5, SD-R females: *N*=5, SD-NR females: *N*=3). Boldface font indicates a significant *P*-value ( $P < 0.05$ , Spearman's rank correlations).