integument are similar in color in some areas, but not in others, wetting changes not only the overall reflectance of the insect but its pattern as well (Fig. 1, G and H).

The ability to change reflectance in parallel with their substrate probably protects these bugs from visually oriented predators. Many bark-living Heteroptera, especially Aradidae, are slow-moving. When feeding, they cannot move to escape potential predators until their elongate mouthparts are extricated from the wood. Camouflage, aided by their coloration, often flattened shapes, and quiescent behavior, plus exocrine glands in some species, are their main lines of defense (*7, 8*). Wetting and darkening of tree trunks by rain would destroy the protective value of the insects' coloration. In these two species, effective camouflage is maintained in spite of such changes in background reflectance, simply by being wettable (*9*).

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3. The observations were made on Barro Colorado Island, Panamá.
4. Estimates of reflectance between 400 and 700 nm were made photographically by densitometric comparison of negatives with simultaneously photographed white-standards attenuated by stepped neutral-density filters. Details of this technique are given by R. E. Silberglied [*Functional Photogr.* **11** (No. 2), 20 (1976); *ibid.* **11** (No. 3), 30 (1976); K. Daumer, *Z. Vgl. Physiol.* **41**, 49 (1958)].
5. Unlike many of their near relatives, *Dysodius* and *Ceratozygum* have enlarged pronotal lobes (and, in *Ceratozygum*, elongate cephalic horns) that are usually the first parts of the body to enter water droplets.
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7. Many bark-inhabiting Heteroptera (including some Aradidae) affix particles of bark or soil to the dorsal surfaces of their bodies, gaining both visual camouflage and the physical properties of their coverings, including wettability.
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The Heart Is a Target Organ for Androgen

Abstract. *Autoradiographic and biochemical analyses of the hearts of female rhesus monkeys and baboons indicate that atrial and ventricular myocardial cells contain androgen receptors. Although the specific effects of nuclear uptake and retention of androgen on the function of heart muscle cells are not known, the presence of this receptor suggests that sex steroid hormones may affect myocardial function directly and may explain some of the peculiar differences in heart disease between men and women.*

Among the most puzzling features of coronary heart disease are the differences in morbidity and mortality from this disease in men and women. White men have more severe coronary artery atherosclerosis and more frequently experience myocardial infarction and sudden death than do white women. On the other hand, there is greater incidence of angina pectoris among women. These differences are not as great in nonwhite persons. There is little or no sex differential in other forms of arteriosclerotic heart disease.

In attempting to explain these relationships, emphasis has been placed on the possibility of a protective role of estrogen in reducing risk of arteriosclerotic disease, particularly through an effect on serum lipoproteins. However, the administration of estrogens to men who have experienced one myocardial infarct is accompanied by increased mortality; and the oral contraceptives, which have estrogenic activity, increase the risk of myocardial infarction in women, particularly in those who also smoke (*1*).

The observation that atrial, but not ventricular, myocardial cells possess specific estrogen receptors (*2*) indicates that the atrium may be affected directly by circulating estrogenic hormones. We now have demonstrated androgen receptors in both atrial and ventricular myocardial cells of two species of nonhuman primates by both autoradiography and biochemical analyses, an observation suggesting that androgens also may affect cardiac function directly.

For these experiments we used six adult, normally cycling female rhesus monkeys (*Macaca mulata*) and baboons (*Papio cynocephalus*), three of each species. One animal of each set of three was a control. On day 1 of the experiment we removed both ovaries and the right adrenal gland from each animal. On day 3 we removed the left adrenal gland. At this second operation, the test animals received 100 mg of hydrocortisone. On day 4, we injected intravenously into the test animals 1 μg of 5α-dihydro[1, 2, 4, 5, 6, 7-^{3}H]testosterone ([^{3}H]DHT) (101 Ci/mmole) per kilogram of body weight. We injected the two control animals with the labeled material together with 100 μg of unlabeled hormone per kilogram of body weight. One hour later, we exsanguinated each animal rapidly and perfused the vascular system with chilled Ringer solution. Tissue samples were mounted on tissue holders, frozen in liquefied propane, and stored in liquid ni-

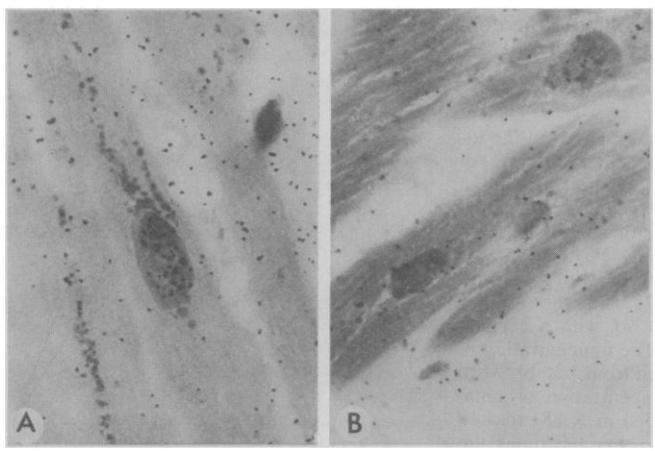

Fig. 1. Autoradiographs of baboon heart muscle. (A) Section from animal injected with [^{3}H]DHT shows scattered silver grains due to free or bound steroid, with a marked concentration of grains over a nucleus of a myocardial fiber. Lighter gray granules adjacent to the nucleus are parts of sarcoplasm, not silver grains. (B) Section from a control animal injected with [^{3}H]DHT and unlabeled DHT shows no nuclear localization of silver grains, and thus demonstrates saturability of binding by competition.

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trogen. We cut frozen sections of selected tissues, mounted them on emulsion-coated slides, exposed them at 15°C for 3 months, and processed photographically and stained them with methyl green pyronin (*3*).

The autoradiographs (Fig. 1A) of cardiac muscle from the test animals injected with [^{3}H]DHT showed intense concentration of radioactivity in nearly every nucleus of ventricular myocardial cells of both rhesus monkeys and baboons and in most nuclei of atrial myocardial cells. The number of grains per nucleus was about equal in all portions of both left and right lateral ventricular walls and the interventricular septum. Autoradiographs of tissues from control animals given excess unlabeled hormone (Fig. 1B) showed no localization of radioactivity.

We also assayed cardiac tissue from uninjected baboons for the presence of androgen receptor. Left ventricular cardiac muscle from anesthetized, exsanguinated baboons was immediately frozen in liquid nitrogen and stored at −70°C. Cytosols were prepared by homogenizing the tissue with a polytron in buffer (75 m*M* phosphate, 0.01 percent monothioglycerol, and 10 percent glycerol, *p*H 7.4 at 4°C). The homogenate was centrifuged for 30 minutes at 105,000*g* and the supernatant (cytosol) was withdrawn for assay by the hydroxylapatite method (*4*). Cytosol (200 μl diluted to 5 to 8 mg of protein per milliliter) was mixed with 50 μl of buffer containing [^{3}H]DHT (101 Ci/mmole), or with 50 μl of buffer containing labeled methyltrienolone (R1881; [17α-methyl-^{3}H]trienolone; 87 Ci/mmole), such that the final concentration of ^{3}H-labeled steroid ranged from $1 \times 10^{-8}M$ to $2 \times 10^{-10}M$. Competing steroids, when tested, were present at either 10 times (steroid specificity only) or 100 times (both Scatchard analysis and steroid specificity) the concentration of ^{3}H-labeled steroid.

The results of the Scatchard analyses are shown in Fig. 2. The data were normalized to the total amount of receptor (B_{max}) and each line represents a linear regression analysis of three individual Scatchard analyses. The dissociation constant (K_d) was approximately $2 \times 10^{-9}M$ and the quantity of androgen receptor was 5.29 ± 1.65 fmole per milligram of cytosol protein. The binding specificity of the androgen receptor was similar to that reported for androgen in the rat heart (*5*) and in other tissues (*6*). The relative ability of other androgens to compete with [^{3}H]DHT was as follows: testosterone > 5α-androstan-3β,17β-diol > 5β-dihydrotestosterone > 5α-androstan-3α,17β-diol > R1881 > fluoxymestrone. 17β-Estradiol showed a limited capacity to compete for binding, whereas diethylstilbestrol, estrone, estriol, progesterone, and cortisol showed no significant competition.

A variety of observations suggest that the concentration of circulating androgens has several direct effects on the heart. Speculation must be limited because we do not know the specific effect of the steroid on cardiac muscle cells. However, the observation that androgens augment hypertrophy of the right ventricle of the heart in rats exposed to high altitude hypoxia (*7*) suggests that androgens have a role in cardiac growth and development. The effect of androgens in diminishing the systemic depressor effect of arachidonic acid in rats (*8*) suggests that they also have a role in modifying cardiac function. Potentiation of the vasopressor effect of noradrenaline in cats (*9*) and inhibition of noradrenaline uptake in rat heart muscle (*10*) indicate that androgens affect the heart's response to catecholamines. The higher incidence of angina pectoris in women, despite the greater severity of coronary atherosclerosis in men, may be related to androgenic modulation of the heart's response to ischemia in the presence of coronary atherosclerosis.

There is less information about the direct effect of estrogens on cardiac function. Most attempts to explain the lower incidence of coronary heart disease in women have focused on the amelioration of risk factors by estrogens, but risk factors do not account for all of the sex differential (*1*).

We propose that the distribution of receptors for estrogen and androgen in the primate heart may be important in regulating maturation, function, and response to injury of the heart. The presence of receptors for both in cardiac muscle offers new ways to investigate the enigmatic sex difference in the incidence of coronary artery disease, and possibly some of the cardiovascular effects of oral contraceptives. More precise definition of the effects of the sex steroid hormones on the heart at both the cellular and organ levels could provide a physiological basis for the role of the sex steroid hormones in modulating cardiovascular disease.

Note added in proof: We have developed a new assay for the measurement of androgen receptors which stablizes the receptor during preparation of the cytosol. With the new assay we estimate the concentration of receptor in the myocardium to be between 50 and 100 fmole per milligram of cytosol protein.

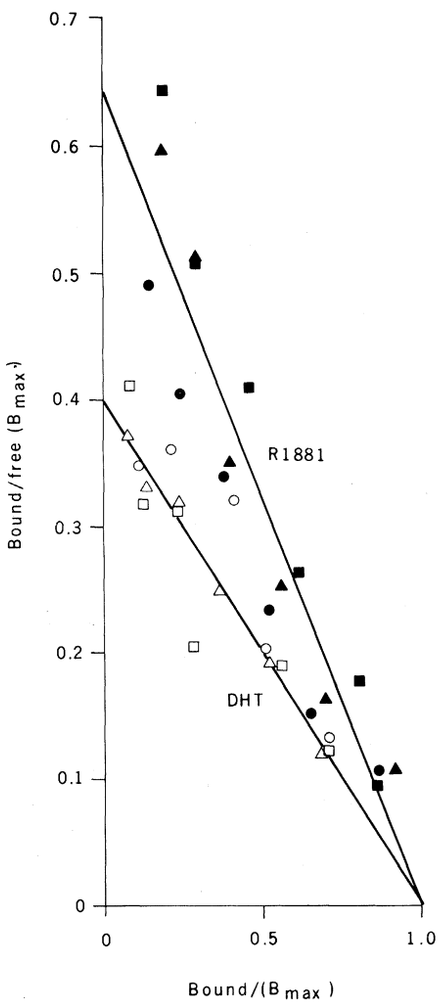

Fig. 2. Scatchard plots, normalized to the total concentration of receptor (B_{max}), of [^{3}H]DHT and [^{3}H]R1881 binding to baboon heart cytosol androgen receptor. Each line represents a linear regression analysis of three individual Scatchard analyses. The K_d for [^{3}H]R1881 was $1.56 \times 10^{-9}M$ with a correlation coefficient of .937, and the K_d for [^{3}H]DHT was $2.62 \times 10^{-9}M$ with a correlation coefficient of .929. The concentration of ^{3}H-labeled steroids ranged from $1 \times 10^{-8}M$ to $2 \times 10^{-10}M$ and the concentration of unlabeled DHT (open symbols) or R1881 (closed symbols), when present, was 100 times the concentration of ^{3}H-labeled steroid. Specific binding was determined by the hydroxylapatite assay.

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Cell Growth with *trans* Fatty Acids Is Affected by Adenosine 3′,5′-Monophosphate and Membrane Fluidity

Abstract. *Two positional isomers (9 and 11) of* trans *octadecenoates did not support growth on glucose of an* Escherichia coli *mutant that requires unsaturated fatty acids. However, the* trans *fatty acids provided sufficient fluidity to produce much higher cell yields when the concentration of adenosine 3′,5′-monophosphate was raised. The effectiveness of the* trans *acids rose from 0 to 1 cell per femtomole to 15 to 20 cells per femtomole as the concentration of adenosine 3′,5′-monophosphate was increased. The corresponding* cis *positional isomers supported high yields (35 to 40 cells per femtomole) independent of supplementation. The enhanced growth with adenosine 3′,5′-monophosphate supplementation is not due to an increased uptake and incorporation of the* trans *isomers relative to the* cis *isomers, since the 9-*trans *isomer was incorporated more rapidly than the 9-*cis *isomer into the membrane phospholipids under all growth conditions and represented 21 ± 2 mole percent of the acids. The finding that cells growing with* trans *fatty acid isomers have a higher requirement for adenosine 3′,5′-monophosphate may indicate that some fatty acids can alter the metabolic regulation normally exerted by the cyclic nucleotide.*

Although *trans* fatty acids are minor components of most naturally occurring lipids, they provide interesting models in which a structural difference produces physical (*1*) and metabolic (*2*) properties that are clearly different from those of the *cis* acids. These properties may have practical significance in human metabolism, since American, Polish, Canadian, and German margarines may contain as much as 55 percent *trans* isomeric fatty acids (*3*, *4*). Although no toxic effect has been proved for moderate dietary intake of *trans* acids, some physiological and long-term pathological consequences have been reported (*5*, *6*). Enig *et al.* (*7*) suggested that the *trans* fatty acid content of the diet could explain the significant positive correlation between increases in dietary fat intake and mortality over a 60-year period for either total fat or vegetable fat. Studies with yeast mutants showed that *trans* fatty acids could stop phospholipid synthesis and lead to an accumulation of triglyceride and free fatty acid (*8*). The present study describes the influence of the Δ9 and Δ11 positional isomers of *cis*- and *trans*-octadecenoate on the growth of an *Escherichia coli* double mutant (*9*) that was defective in synthesis of unsaturated fatty acid and in β oxidation. Although *trans* acids were inadequate to fully support cell growth in glucose, adenosine 3′,5′-monophosphate (cyclic AMP) could reverse the inadequacy. The fluidity of cell membranes has often been thought to be lowered by the presence of lipids containing the higher melting *trans* acids. Our results show that the effect of *trans* fatty acids on growth depends not only on the fluidity they give to the cellular membrane but also on their effects on cellular metabolic states.

Table 1. Efficiencies of octadecenoate isomers in supporting cell growth. The efficiency of each isomer, defined as the number of cells produced per femtomole of fatty acid, was obtained from the slope of cell yield plotted against fatty acid concentration (*11*). Medium A (*20*) was supplemented as indicated. Cell numbers were determined turbidimetrically at 660 nm by using an empirical equation that correlated absorbance with cell number: cell/ml $\times 10^{-8} = -0.004 + 4.5\ A + 34\ A^2 - 6.7\ A^3 + 42\ A^4$. Temperature was maintained at 37°C.

Supplement	Cells per femtomole			
	trans-9	*trans*-11	*cis*-9	*cis*-11
Glucose (0.5 percent)	1	0	43	32
Glycerol (1.0 percent)	18	2	43	
Glucose + cyclic AMP	19	18		
Glycerol + cyclic AMP	16	15	43	32

The growth response of the unsaturated fatty acid auxotroph in media having a different carbon source with or without cyclic AMP supplementation is listed in Table 1. Both *cis* isomers supported cell growth in all media. But neither *trans* isomer could support growth on glucose, and this inability could be corrected to a certain degree by switching to glycerol as the carbon source. Cells grown on glycerol are known to have higher intracellular cyclic AMP levels than cells grown on glucose (*10*). Addition of 2 m*M* cyclic AMP to cultures with either carbon source also enhanced the effectiveness of growth with the *trans* isomers. Apparently, *trans* fatty acids support cell growth fully only in the presence of sufficient cyclic AMP; the lower yield in glycerol cultures with the 11-*trans* isomer (Table 1) indicates that cells may have a higher requirement for cyclic nucleotide with the 11-*trans* isomer than with the 9-*trans* isomer. This was confirmed experimentally; the results are shown in Fig. 1.

Cells were grown in glucose medium supplemented with 48 μ*M* unsaturated fatty acid and different amounts of cyclic AMP. For the cultures supplemented with either 9-*trans* or 11-*trans* isomer, cell yields increased progressively above the threshold with added cyclic AMP until reaching a maximum cell yield. The maximum cell yield was independent of the exogenous cyclic AMP concentration for both 9-*cis* and 11-*cis* isomers; the maximum yields obtained with the *cis* isomers (35 to 40 cells per femtomole) were two times greater than those obtained with the *trans* isomers (15 to 20 cells per femtomole). When fatty acid supply limits growth, the maximum cell yield per femtomole of the nutrient acid is the inverse of the number of femtomoles needed to maintain membrane function of each cell, and lower yields per femtomole reflect a higher need for nutrient acid in the membranes. With adequate cyclic AMP, the maximum yield seems to be decided by the fluidity of the acid; the lower maximum yields with the *trans* isomers can be attributed to their lower fluidity. A similar relation is evident in the nutrient efficiencies (ε) of the 15 positional isomers of octadecenoate (*11*) that are closely correlated ($r = .9$) with the estimated state of expansion of their phospholipid esters: $\epsilon_{37} = 0.8\ (\Delta T) - 7$, where ΔT is the difference between the culture growth temperature (37°C) and the transition temperature (*12*) of phospholipid derived

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