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The Economist

October 02, 1999 , U.S. Edition

LENGTH: 1194 words**HEADLINE:** Race, law and **poverty** in the new South **Africa****DATELINE:** johannesburg**HIGHLIGHT:**

South **Africa's** policy of positive discrimination is intended to raise up the majority who were crushed under apartheid. Unfortunately, though many middle-class blacks are benefiting, poor blacks could end up even poorer

BODY:

UNDER apartheid, there was only one black employee at Koeberg, South **Africa's** high-security nuclear power plant. His job was to run away from the guard dogs, to train them to bite blacks. In the new South **Africa**, non-whites and other "previously disadvantaged" groups, which include women and the disabled, are entitled to preferential treatment in hiring, promotion, university admissions and the award of government contracts. In all, close to 95% of the population -- with blacks at the top of an undefined scale -- are newly privileged.

On the face of it, the case for corrective action to make up for the injustices of the past seems unanswerable. For the past half-century in South **Africa**, skin colour was the single most important determinant of a person's chances in life. Whites, no matter how lazy or dim, were all but guaranteed a secure job at a state-owned firm. Blacks, no matter how bright or energetic, were barred from most desirable forms of employment. The ruling African National Congress (ANC) believes, like the late Lyndon Johnson, America's president in the 1960s, that you do not take a person who, for years, has been hobbled by chains and liberate him, bring him up to the starting line in a race, and then say: "You are free to compete with all the others." So the ANC has passed a number of laws designed to help people to catch up.

Partly as a result, the black middle class has expanded apace. The proportion of black managers in the civil service was 6% in 1994: by 1997, the proportion was 38% in the central government and 66% in the provincial administrations. In private business, figures are harder to come by, but the proportion of black managers appears to have risen rapidly in 1994-96, and then to have stuck somewhere between 10% and 20%.

The reason, say businessmen, is that the supply of suitably skilled blacks has run dry. Under apartheid, blacks were deliberately deprived of a decent education. The first five years of ANC rule have done little to improve matters. South **Africa's** schools are still a mess, awash with guns, and desperately lacking textbooks and discipline; its universities train pitifully few black doctors, lawyers or engineers. The able new education minister, Kader Asmal, is trying to knock the system into shape. But the results will not be felt in the job market for years.

Since well-educated blacks are scarce, companies fight over them. For instance, a large industrial

firm, Barlow, offers newly-qualified black accountants roughly 20% more money than their white colleagues, plus an "entry-level BMW", pension, health benefits, in-house training and fine prospects for promotion. Even so, "after a few months, they are mercilessly head-hunted," says Tony Phillips, Barlow's chief executive. Demand for black high-fliers is ravenous; only the supply is lacking.

But the government still believes that black advancement is being blocked by racist white bosses, and that the solution is tougher laws. The case for this rests on the assumption that white businessmen will never treat blacks fairly without coercion.

This is questionable. Doubtless, many white South African bosses are bigots. But discrimination has costs. In the past, South African firms objected to many aspects of apartheid, because they affected profits. Job reservation for whites forced companies to overpay their white staff, denied them the benefit of black skills, and led to volcanic relations with black unions. As apartheid laws crumbled, market forces led to an improvement in black wages and jobs, well before the ANC came to power. Between 1975 and 1990, average real black earnings in manufacturing increased by almost 50%, according to the South African Institute of Race Relations. For whites, the figure was 1%.

Reverse discrimination is intended to help the poorest. But the policy's main beneficiaries are middle-class blacks, who have already largely overcome the results of past discrimination. The really poor, most of whom are black, lose in two ways.

First, they receive worse public services. Black-owned firms can charge more than white ones and still win government contracts. This helps black entrepreneurs, but means that the government builds fewer houses and lays fewer water pipes with its limited budget. Second, race laws hinder growth and aggravate unemployment. Academics at South African universities avoid the subject for fear of being branded racist, so there are no good estimates of the size of the problem. But hiring on a basis other than merit is unlikely to foster excellence.

One case illustrates how tricky it is to be racially correct. In 1997, Sarita van Coller, a white woman, applied for a job at Eskom, the state-owned electricity provider. She scored the highest mark by a wide margin on an aptitude test, but the job was given to a Coloured (mixed-race) applicant. She protested to a labour arbitrator, and won. The arbitrator ruled that there was nothing wrong with giving preference to blacks or Coloureds, but that Eskom should not discriminate unfairly against whites. It is, of course, impossible to do both.

Since the Eskom case, new legislation has complicated matters further. The Employment Equity Act, which came into force in August, obliges firms with more than 50 employees to submit annual progress reports to the government on their efforts to make their workforce "demographically representative": that is, roughly 75% black, 52% female and 5% disabled at all levels from the shop floor to the boardroom. Some allowance is made for the size of the pool of "suitably qualified" individuals. But if someone complains, it is up to the employer to prove his innocence. That a black applicant lacks the necessary qualifications is not sufficient reason for hiring a white instead. The employer must prove that the applicant could not have acquired the relevant skills in a reasonable time. Non-compliers face hefty fines.

Beyond this, a draft "promotion of equality" bill, which is due to be enacted next year, will affect all employers, no matter how small, as well as individuals, private clubs and professional bodies. It bans all discrimination on grounds of race or sex, as well as for pregnancy, age, disability, belief, culture, language or social or economic status. It also forbids the dissemination of views which might "promote inequality".

Many firms hope that, given the paucity of labour inspectors, they will escape uninspected. But the "promotion of equality" bill allows any disgruntled present, former or would-be employee, or any third party acting "in the public interest" to sue. Lawyers can accept cases on a no-win, no-fee basis.

Large firms will probably be able to cope with these laws, albeit at a cost in time and efficiency. Many small firms, already struggling with high interest rates, a skills shortage, crime and a stagnant

economy may go bankrupt. At the least, the laws will aggravate an already marked reluctance among businessmen to hire new staff. At a time when, by one estimate, only one new entrant to the labour market in 30 finds formal employment, this would do the poor no favours.

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The Economist

May 25, 1996, U.S. Edition

SECTION: Special; Pg. 23**LENGTH:** 3170 words**HEADLINE:** The poor and the rich**BODY:**

In recent years, researchers have moved closer to answering the most important question in economics: why are some countries richer than others?

UNDERSTANDING growth is surely the most urgent task in economics. Across the world, poverty remains the single greatest cause of misery; and the surest remedy for poverty is economic growth. It is true that growth can create problems of its own (congestion and pollution, for instance), which may preoccupy many people in rich countries. But such ills pale in comparison with the harm caused by the economic backwardness of poor countries--that is, of the larger part of the world. The cost of this backwardness, measured in wasted lives and needless suffering, is truly vast.

To its shame, economics neglected the study of growth for many years. Theorists and empirical researchers alike chose to concentrate on other fields, notably on macroeconomic policy. Until the 1980s, with a few exceptions, the best brains in economics preferred not to focus on the most vital issue of all. But over the past ten years or so, this has changed. Stars such as Robert Lucas of the University of Chicago, who last year won the Nobel prize in economics, have started to concentrate on growth. As he says of the subject, "the consequences for human welfare . . . -are simply staggering. Once one starts to think about them, it is hard to think of anything else."

Early economists certainly thought about them. Adam Smith's classic 1776 book was, after all, called an "Inquiry into the Nature and Causes of the Wealth of Nations". Many building-blocks for understanding growth derive from him. Smith reckoned that the engine of growth was to be found in the division of labour, in the accumulation of capital and in technological progress. He emphasised the importance of a stable legal framework, within which the invisible hand of the market could function, and he explained how an open trading system would allow poorer countries to catch up with richer ones. In the early 19th century, David Ricardo formalised another concept crucial for understanding growth--the notion of diminishing returns. He showed how additional investment in land tended to yield an ever lower return, implying that growth would eventually come to a halt--though trade could stave this off for a while.

The foundations of modern growth theory were laid in the 1950s by Robert Solow and Trevor Swan. Their models describe an economy of perfect competition, whose output grows in response to larger inputs of capital (ie, physical assets of all kinds) and labour. This economy obeys the law of diminishing returns: each new bit of capital (given a fixed labour supply) yields a slightly lower return than the one before.

Together, these assumptions give the neoclassical growth model, as it is called, two crucial implications. First, as the stock of capital expands, growth slows, and eventually halts: to keep growing, the economy must benefit from continual infusions of technological progress. Yet this is a force that the model itself makes no attempt to explain: in the jargon, technological progress is, in the neoclassical theory, "exogenous" (ie, it arises outside the model). The second implication is that poorer countries should grow faster than rich ones. The reason is diminishing returns: since poor countries start with less capital, they should reap higher returns from each slice of new investment.

Theory into practice

Do these theoretical implications accord with the real world? The short answer is no. The left-hand chart on the next page shows average growth rates since 1870 of 16 rich countries for which good long-term data exist. Growth has indeed slowed since 1970. Even so, modern growth rates are well above their earlier long-run average. This appears to contradict the first implication, that growth will slow over time. It may be that an acceleration of technological progress accounts for this, but this should hardly console a neoclassical theorist, because it would mean that the main driving force of growth lies beyond the scope of growth theory .

What about the second implication--are poor countries catching up? The right-hand chart overleaf plots, for 118 countries, growth rates between 1960 and 1985 against their initial 1960 level of GDP per person. If poor countries were catching up, the plots on the chart should follow a downward-sloping pattern: countries that were poorer in 1960 should have higher growth rates. They do not. Indeed, if there is any discernible pattern in the mass of dots, it is the opposite: poorer countries have tended to grow more slowly.

Having arrived at neoclassical growth theory, however, economics by and large forgot about the subject. It had a model that was theoretically plausible, but did not seem to fit the facts. How best to proceed was unclear. Then, after a pause of 30 years, along came "new growth theory".

This new school has questioned, among other things, the law of diminishing returns in the neoclassical model. If each extra bit of capital does not, in fact, yield a lower return than its predecessor, growth can continue indefinitely, even without technological progress. A seminal paper was published in 1986 by Paul Romer (see references at the end). It showed that if you broaden the idea of capital to include human capital (that is, the knowledge and skills embodied in the workforce), the law of diminishing returns may not apply. Suppose, for example, that a firm which invests in a new piece of equipment also learns how to use it more efficiently. Or suppose it becomes more innovative as a by-product of accumulating capital. In either case, there can be increasing, not decreasing, returns to investment.

In this and other ways, new growth theorists can explain how growth might persist in the absence of technological progress. But, they have gone on to ask, why assume away such progress? A second strand of new growth theory seeks to put technological progress explicitly into the model (making it "endogenous", in the jargon). This has obliged theorists to ask questions about innovation. Why, for instance, do companies invest in

development? How do the innovations of one company affect the rest of the economy?

A further divergence from the neoclassical view follows. As a general rule, a firm will not bother to innovate unless it thinks it can steal a march on the competition and, for a while at least, earn higher profits. But this account is inconsistent with the neoclassical model's simplifying assumption of perfect competition, which rules out any "abnormal" profits. So the new growth theorists drop that assumption and suppose instead that competition is imperfect. Attention then shifts to the conditions under which firms will innovate most productively: how much protection should intellectual-property law give to an innovator, for instance? In this way, and not before time, technological progress has begun to occupy a central place in economists' thinking about growth.

In the latest resurgence of interest in growth theory, however, the original neoclassical approach has enjoyed something of a revival. Some economists are questioning whether the "new" theories really add much. For instance, the new theory emphasises human capital; arguably, this merely calls for a more subtle measure of labour than the ones used by early neocla More generally, it is argued that if factors of production (capital and labour) are properly measured and quality-adjusted, the neoclassical approach yields everything of value in the new theory, without its distracting bells and whistles. So it often proves in economics: the mainstream first takes affront at new ideas, then reluctantly draws on them, and eventually claims to have thought of them first.

The missing link

To non-economists, however, both approaches seem curiously lacking in one crucial respect. Whereas in popular debate about growth, government policy is usually the main issue, in both neoclassical and new growth theory discussion of policy takes place largely off-stage. To the extent that government policy affects investment, for instance, either could trace out the effects on growth--but the connection between policy and growth is tenuous and indirect. Each approach may take a strong view about the role

but both remain frustratingly uncommitted about the role of government.

An upsurge of empirical work on growth is helping to fill this hole--and, as a by-product, shedding further light on the relative merits of the new and neoclassical theories. The nuts and bolts of this work are huge statistical analyses. Vast sets of data now exist, containing information for more than 100 countries between 1960 and 1990 on growth rates, inflation rates, fertility rates, school enrolment, government

the rule of law is, and so on. Great effort has been devoted to analysing these numbers.

One key finding is "conditional convergence", a term coined by Robert Barro, a pioneer of the new empirical growth studi that if one holds constant such factors as a country's fertility rate, its human capital (proxied by various measures of educational attainment) and its government policies (proxied by the share of current government spending in GDP), poorer countries tend to grow faster than richer ones. So the basic insight of the neoclassical growth model is, in fact, correct. But since, in reality, other factors are not constant (countries do not have the same level of human capital or the same government policies), absolute convergence does not hold.

Whether this is a depressing result for poor countries depends on what determines the "conditional" nature of the catch-up process. Are slow-growing countries held back by government policies that can be changed easily and quickly? Or are more fundamental forces at work?

Most empirical evidence points to the primacy of government choices. Countries that have pursued broadly free-market policies--in

trade liberalisation and the maintenance of secure property rights--have raised their growth rates. In a recent paper, Jeffrey Sachs and Andrew Warner divided a sample of 111 countries into "open" and "closed". The "ope economies showed strikingly faster growth and convergence than the "closed" ones. Smaller government also helps. Robert Barro, among others, has found that higher government spending tends to be associated with slowe

Human capital--education and skills--has also been found to matter. Various statistical analyses have shown that countries with lots of human capital relative to their physical capital are likely to grow faster than those with less. Many economists argue that this was a factor in East Asia's success: in the early 1960s the Asian tigers had relatively well-educated workforces and low levels of physical capital.

A more difficult issue is the importance of savings and investme implication of the neoclassical theory is that higher investment should mean faster growth (at least for a while). The empirical studies

suggest that high investment is indeed associated with fast growth. But the investment is not enough by itself. In fact the causality may run in the opposite direction: higher growth may, in a virtuous circle, encourage higher saving and investment. This makes sense: communist countries, for instance, had extraordinarily high investment but, burdened with bad policies in other respects, they failed to turn this into high growth.

The number-crunching continues; new growth-influencing variables keep being added to the list. High inflation is bad for growth; political

counts; the results on democracy are mixed; and so on. The **emerging** conclusion is that the poorest countries can indeed catch up, and that their chances of doing so are maximised by policies that give a greater role to competition and incentives, at home and abroad.

But surely, you might think, this hides a contradiction? The new growth theory suggests that correct government policies can permanently raise growth rates. Empirical cross-country analysis, however, seems to show that government is better--a conclusion that appeals to many neoclassical theorists. This tension is especially pronounced for the East Asian tigers. Advocates of free markets point to East Asia's trade liberalisation in the 1960s, and its history of low government spending, as keys to the Asian miracle. Interventionists point to subsidies and other policies designed to promote investment.

Reflecting the present spirit of rapprochement between the growth models, it is now widely argued that this contradiction is more apparent than real. Work by Alwyn Young, popularised by Paul Krugman, has shown that much of the Asian tigers' success can be explained by the neoclassical model. It resulted from a rapid accumulation of capital (through high investment) and labour (through population growth and increased labour-force participation). On this view, there is nothing particularly miraculous about Asian growth: it is an example of "catch-up". Equally, however, the outlines of East Asian success fit the new growth model. Endogenous growth theory says that government policy to increase human capital or foster the right kinds of investment in physical capital can permanently raise economic growth.

The question is which aspect of East Asian policies was more important--which, up to a point, is the same as asking which growth model works best. Although debate continues, the evidence is less micro-level encouragement of particular kinds of investment was crucial in Asia. Some economists dissent from that judgment, but they are a minority. Most agree that broader policies of encouraging education, opening the economy to foreign technologies, promoting trade and keeping taxes low mattered more.

One more heave

There is no doubt that the neoclassical model of the 1950s, subsequently enhanced, together with the theories pioneered by Mr Romer, have greatly advanced economists' understanding of growth. Yet the earlier doubt remains. Both models, in their purest versions, treat the role of government only indirectly. The new empirical work on conditional convergence has set out to put this right. The fact remains that in the earlier theoretical debate between the neoclassical and the new schools, the question that matters most--what should governments do to promote growth?--was often forgotten.

A new paper by Mancur Olson makes this point in an intriguing way. The starting-point for today's empirical work is a striking fact: the world's fastest-growing economies are a small subgroup of exceptional performers among the poor countries. Viewed in the earlier theoretical is actually rather awkward. Mr Romer's theories would lead you to expect that the richest economies would be the fastest growers: they are not. The basic neoclassical theory suggests that the poorest countries, on the whole, should do better than the richest: they do not. Neither approach, taken at face value, explains the most striking fact about growth in the world today.

Mr Olson argues that the simplest versions of both theories miss a crucial point. Both assume that, given the resources and technology at their disposal, countries are doing as well as they can. Despite

their differences, both are theories about how changes in available resources affect output--that is, both implicitly assume that, if resources d output cannot either. But suppose that poor countries simply waste lots of resources. Then the best way for them to achieve spectacular growth is not to set about accumulating more of the right kind of resources--but to waste less of those they already have.

Marshalling the evidence, Mr Olson shows that slow-growing poor countries are indeed hopelessly failing to make good use of their resources. Take labour, for instance. If poor countries were using labour as well as they could, large emigrations of labour from poor to rich countries (from Haiti to the United States, for instance) ought to raise the productivity of workers left behind (because each worker now has more capital, land and other resources to work with). But emigration does not have this effect.

Data on what happens to migrants in their new homes are likewise inconsistent with the two growth theories. Immigrants' incomes rise by far more than access to more capital and other resources would that labour (including its human capital, entre-preneurial spirit, cultural traits and the rest) was being squandered in its country of origin. When workers move, their incomes rise partly because there is more capital to work with--but also by a further large margin, which must represent the wastage incurred before. Mr Olson adduces similar evidence to show that capital and knowledge are being massively squandered in many poor countries.

This offers a rationale for the pattern of g rationale that, consistent with the recent work on conditional convergence, places economic policies and institutions at the very centre. According to this view, it is putting it mildly to say that catch-up is possible: the economic opportunities for poor countries are, as the tigers have shown, phenomenal. The problem is not so much a lack of resources, but an inability to use existing resources well. It is surely uncontroversial to say that this is the right way to judge the performance of communist countries (those exemplars of negative value-added) before 1989. Mr Olson's contention is that most of today's poor countries are making mistakes of an essentially similar kind.

The question still remains: what are the right policies? One must turn again to the empirical evidence. That seems a frustrating answer because, suggestive though recent work on conditional convergence may be, such findings will always be contested. Citizens of the world who sensibly keep an eye on what economists are up to can at least take pleasure in this: the profession has chosen for once to have one of its most vigorous debates about the right subject.

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Helping the poorest of the poor



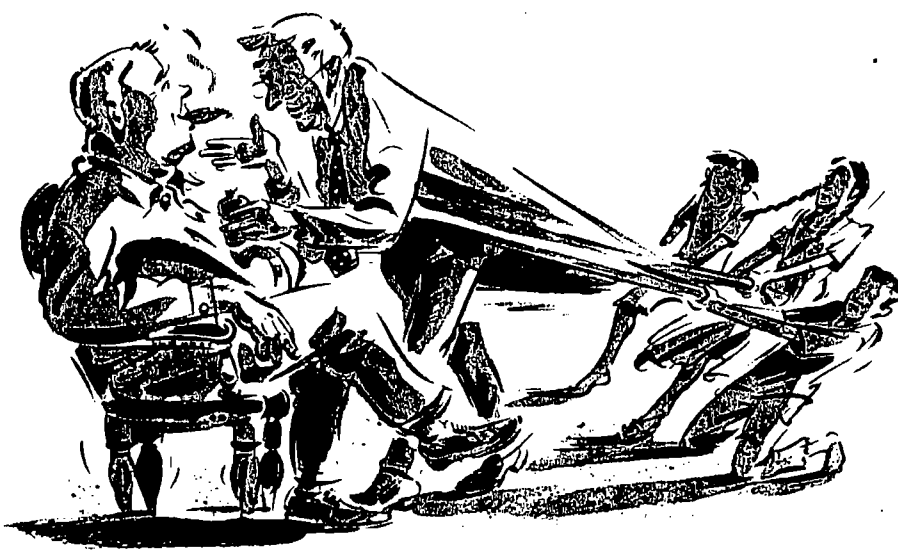
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SCIENCE AND TECHNOLOGY



Balms for the poor

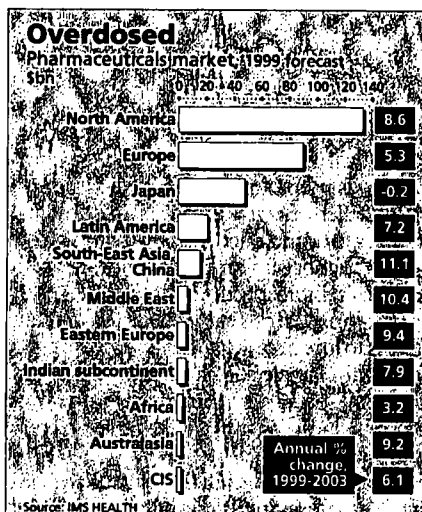
Infectious diseases hinder developing countries from developing. Making existing drugs cheaper there would help. Making entirely new drugs would help even more

PEEER over the counter at a pharmacy in America, Europe or Japan and you see a wealth of drugs. Americans and Europeans spend more than \$220 billion a year on prescription medicines for everything from high blood pressure to low mood—a powerful incentive for pharmaceutical companies to keep them supplied with current remedies and to concoct new ones (see chart). Of course, drugs for such diseases as river blindness and sleeping sickness are not routinely found on western shelves since there is little demand for them. But walk into a dispensary in, say, Cameroon, and you discover that such drugs are equally scarce there—not because they are not needed, but because nobody can afford them.

Lack of money not only restricts access to existing drugs and vaccines and means of dispensing them; it also offers little incentive for drug companies to develop new medicines for people in poor countries. Globally, the World Health Organisation (WHO) estimates that more than \$56 billion a year is spent on health research—but less than 10% of that sum is directed toward diseases that afflict 90% of the world's population.

As Piers Whitehead of Mercer Consulting notes, large drug companies are more like

supermodels than charities: they won't get out of bed and into work for less than \$350m in annual sales for any given product. This is because turning a gleam in a researcher's eye into a handful of useful pills is an expensive and time-consuming business: on average, it costs \$300m and takes more than a decade. Between 1975 and 1997, an impressive 1,223 new compounds were launched on the mar-



ket. But as Patrice Trouiller, a consultant with Médecins sans Frontières (MSF), an aid group, points out, only 11 of them were designed for tropical diseases.

The problem is not merely one of human welfare, important though that is. Many economists, among them Jeffrey Sachs of Harvard University (see pages 17-20), believe it is also an issue of economic development. Better access to better medicines is not the only way to improve the health of poor countries, but it is a significant one. And creating new drugs and vaccines is such a technology-intensive business that the developing world is likely to remain dependent on western pharmaceutical firms for years to come.

New pills, old ills

Encouraging the development of new medicines is difficult because it requires both the push of financial incentives (to offset the risk of research in largely uncharted fields) and the pull of secure funding (to ensure that there is a paying market once the drugs are ready). Recently, however, some new ideas about how to solve these problems have emerged, based on new alliances between industry and the public sector.

One approach is that being taken by the new Medicines for Malaria Venture (MMV), which brings together public-sector organisations and drug companies under the umbrella of the WHO. Robert Ridley, director of MMV, sees the venture as a "not-for-profit virtual drug company", combining public- and private-sector research through funding collaborative discovery and development projects. Drug companies have millions of molecules in their chemical libraries created for more lucrative diseases such as cancer, along with thousands of old drugs currently used for other ailments, which could be developed for malaria at roughly a tenth of the cost of starting from scratch.

But finding the money to finance the research is not easy. MMV aims to register one new antimalarial product every five years, and is likely to need \$30m a year to do so. The drug companies' gifts-in-kind are worth millions, but the bulk of the required money is still expected to come from public funds and philanthropic institutions. Initial promises of \$5m have enabled MMV to begin the process of project selection, and the venture will be formally launched later this year.

Seth Berkley, head of the International AIDS Vaccine Initiative (IAVI), is hoping to do something similar for AIDS vaccines. Roughly \$2 billion a year is spent on research into AIDS treatments, most of which are either too costly or too complicated for use in poor countries. But IAVI estimates that only

Flying high

COCAINE, as addicts well know, has curious effects on the body. One of them is "reverse tolerance": rather than becoming accustomed to cocaine with increasing exposure (as happens with, say, alcohol), the brain becomes more sensitive. With each hit, responses, such as fidgeting, are more exaggerated. This sensitisation is thought to be a first step in creating an overwhelming craving for the drug that eventually leads to addiction.

In humans, studying cocaine sensitisation is tricky since most governments have strong views on giving drugs to the uninitiated, and tend to enforce them with lengthy prison sentences. So instead researchers have turned to creatures such as the fruit fly, *Drosophila melanogaster*, to probe the cellular basis for cocaine craving. In this week's issue of *Science*, biologists Jay Hirsh, Sarah Chaney and Rozi Andretic of the University of Virginia report that an appetite for cocaine seems to be connected to the mechanisms which control circadian rhythm—the so-called "body clock".

Fruit flies, like humans, have an internal biological clock that governs their activity over a 24-hour cycle. Ms Andretic recently found that the brain makes use of a biochemical called dopamine to regulate its circadian rhythm.

Other experiments on mice and flies have shown that dopamine is also involved in cocaine sensitisation. So the researchers put the two together and decided to see whether disrupting the body's internal clock might also affect cocaine craving.

When exposed to purified "freebase" cocaine, fruit flies behave surprisingly like junkies. They twitch, gnaw and groom themselves compulsively while wandering about in circles. As the drug dose rises, such erratic movements become more severe until the fly is paralysed and drops dead. Ordinarily, one cocaine hit is enough to sensitise a fly. But Dr Hirsh's team found that mutant *Drosophila* lacking genes called "Clock", "Period", "Cycle" and "Doubletime"—all of which are known to

control circadian rhythm—also lack heightened responses to cocaine even after multiple doses. In fact, "Doubletime" mutants proved particularly resistant to the drug, requiring substantially higher quantities before behaving strangely.

In fruit flies, a biochemical called tyramine seems to be responsible for such drug responses, and Dr Hirsh thinks that tyramine regulation is the chemical link between these two very different processes. After a single cocaine dose, the enzyme that makes tyramine becomes more active in normal flies. In the circadian-gene mutants, however, the enzyme's activity stays steady after a dose of the drug, so tyramine levels remain low. The absence of the circadian genes, which seem to regulate the release of tyramine, prevents flies from becoming more responsive to cocaine.

Whether sky-high flies can teach scientists much about human addiction remains to be seen. Only about a fifth of the people who use cocaine actually become addicted to it: the puzzle lies in understanding what distinguishes the casual user from the hardcore addict. But if the propensity to addiction is also genetically controlled in humans, it could provide a mechanism to address the problem at the cellular level, by regulating tyramine or its vertebrate equivalent. It might then be possible to treat cocaine addiction as a disease, rather than a criminal activity.



Fruit flies on the rocks

\$250m is spent creating vaccines, few of which are potentially useful for poor countries where about 95% of HIV infections occur. Dr Berkley wants to make life as easy as possible for potential vaccine developers by mustering expertise and money to help companies negotiate regulatory hurdles and organise clinical trials in developing countries.

IAVI is also trying to use the tricky issue of intellectual property to expand access to new vaccines. Patents have long been a sore point between the companies which own them and developing countries (such as South Africa) which want to get their hands on nifty new medicines and resent having to pay the premiums which patent-holders expect as a reward for their innovation. IAVI will invest in drug companies if they promise to provide their vaccines to poor countries (though not rich ones) at just above manufacturing cost, rather than including the usual hefty margin. If they do not, IAVI has the right to transfer the patent to another producer. IAVI has already struck a deal with one biotech company, Alphavax of North Carolina, along these lines and is hoping to do business with large pharmaceutical firms

as well. Another proposal is to allow companies that agree to develop an HIV vaccine a limited extension to their patents on blockbuster drugs in their most lucrative markets.

A different approach, being championed by MSF, is to make a virtue of the rarity of tropical diseases in the West. Since 1983 America has offered incentives in the form of tax credits and marketing monopolies to companies willing to develop drugs for "orphan" diseases, which afflict fewer than 200,000 people and so offer markets too small to attract much attention from pharmaceutical companies. The European Commission is preparing similar legislation, and Dr Trouiller of MSF is lobbying for tropical diseases to be included in it. But although orphan drug legislation has been a boon to America's biotech companies, which can use the prospect of a market of a few million dollars to lure investors, that is scarcely loose change for large pharmaceutical firms. And since only big firms can manufacture drugs in large quantities, it is crucial to engage their interest too.

A bill now before Congress could do just that. The Lifesaving Vaccine Technology Act

of 1999, introduced by Nancy Pelosi, aims to encourage drug makers to develop vaccines for malaria, tuberculosis and HIV, which together kill almost 8m people each year. The legislation proposes substantial tax credits on research and development expenses, and would cost about \$25m a year.

But while the bill has received backing from both politicians and industry executives for its tax credits, it may face opposition to its explicit endorsement of "tiered pricing"—the simple idea that poor countries be charged less than rich ones for drugs. In the past, American congressmen have complained that it is "unfair" that their voters should pay 100 times more for a measles vaccine than, say, a mother in Bangladesh.

Such opposition to tiered pricing alarms drug companies, according to Arnie Batson, a vaccine consultant with the World Bank. Even more worrying, says Walter Vandersmissen, head of government affairs at Smith-Kline Beecham Biologicals, is the prospect that rich countries might allow the import of discounted drugs from poor countries, and undercut the drug industry's sales in their profitable markets. (At the moment, America

and the European Union strictly control imports of drugs made outside their borders.)

Though many in the pharmaceutical industry are impressed by these proposals, some feel that there are now too many competing "initiatives" and that they all fall short of inspiring novel drug development. Mr Vandersmissen considers them "interesting think-tank exercises". The best way to stimulate new research, he believes, is to prove that sustainable markets can be created for relatively expensive medicines already on the shelf. This is the aim of a new international consortium, the Global Alliance for Vaccines and Immunisation, to be launched next year. It brings together the World Bank, the WHO, wealthy donor countries, poor recipient ones, philanthropic organisations and the drug industry, with the aim of improving access to existing vaccines and developing new ones.

According to Geoffrey Lamb, head of "resource mobilisation" at the World Bank, one way to finance such a programme is through a global trust fund for vaccines for needy countries. But wealthy donor governments are not keen to tie up large sums of money for long periods of time on uncertain odds. A more likely prospect, in Mr Lamb's view, is "contingent lending", in which donors promise to give money and needy countries promise to buy a vaccine if and when a useful one appears.

Ultimately, says Tim Evans, director of health sciences at the Rockefeller Foundation, rich donor countries prefer to give their money to projects (such as drug donation and immunisation programmes) which show results in a couple of years, rather than put up with the long and uncertain slog of developing new medicines. But some donors are prepared to take a more long-term view. The biggest splash has been made by the Bill and Melinda Gates Foundation. Since last December, the foundation has given \$50m for malaria vaccine development, \$25m for AIDS vaccine research and \$100m to the Gates Children's Vaccine Programme which aims to improve access to expensive new shots against hepatitis-B, *Haemophilus influenzae* and rotavirus.

Though such contributions are welcomed by international health workers, they are, in Mr Evans's view, largely "catalytic"—enough to kickstart a reaction among drug developers and public health authorities, but not enough to sustain it. He would like to see a new group of donors: multinational corporations whose business in poor countries depends on a healthy workforce, who would benefit from novel drugs for their old ailments. In the end, developing new medicines for the world's poorest will depend on appeals to both altruism and self-interest. Balancing the two may prove the toughest trick of all for the new alliances between the public and private sector.

Volcanoes

Now, listen carefully

CENTURIES ago, only seers and oracles could predict when a volcano was going to vent its fury. More recently, they have been replaced by electronic sensors and computer models which are, frankly, not much better at giving warning of impending eruptions. Milton Garcés, a geophysicist at the University of Hawaii in Manoa, thinks this could soon change. In some cases, he says, a volcano will tell you when it is about to blow its top—it is just a matter of listening to it in the right way.

Vulcanologists have, in fact, been listening to volcanoes for years, but not in the way that Dr Garcés suggests. Most monitoring of volcanoes happens through the ground. The sloshing of magma deep in the heart of a volcano generates rumbles, called seismic waves, through the earth. Previous attempts to predict volcanic eruptions have been based on changes in the quality of these waves from deep, high frequency quakes to more shallow, low frequency rumblings. But this approach is unreliable. The problem, Dr Garcés thinks, is that the complex structure of the earth distorts seismic waves travelling through the ground as they encounter different layers of rock and soil.

Sound waves above the ground, in contrast, pass through the air with relatively little interference, so they should be much easier to interpret. For five years, Dr Garcés and his colleagues have been listening to these external "acoustic" sounds made by volcanoes. Their latest research, about to be published in *Geophysical Research Letters*, compared seismic and acoustic monitoring of a volcano in southern Japan, and found that

the sound waves gave a much clearer warning of its eruption.

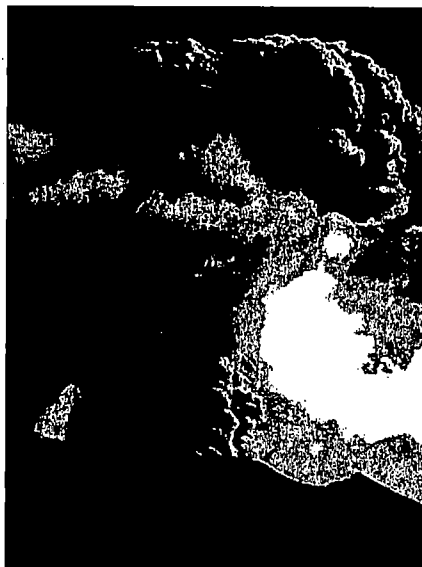
As well as being less distorted, acoustic waves are a more direct measure of what is going on inside a volcano than seismic waves. That is because a volcanic explosion is driven by pressure changes as the volcano builds up and releases excess gas, and sound waves are nothing more than those pressure changes propagating through the air. The kinds of sound waves Dr Garcés is interested in are "infrasonic" waves, with frequencies below about 20Hz, and so beyond the range of human hearing.

In May last year, Dr Garcés and his colleagues surrounded the Sakurajima volcano with ten seismometers buried in the ground and ten microphones placed above the ground. They took readings for several days before the volcano exploded on May 19th. Two days before the explosion, there was a clear increase in the number and strength of both kinds of signals, suggesting that infrasonic signals associated with eruptions follow similar patterns to seismic signals, and can thus be used to monitor eruptions.

But when they compared the two sets of readings more closely, the researchers found the infrasonic ones to be superior. The seismic signals varied a lot from one place to another, whereas the infrasonic ones were more consistent. And just before the explosion, there were clearer changes in the character of infrasonic signals than there were in the seismic ones: the infrasonic signals switched from brief, distinct events to a sustained vibration of the atmosphere. This transition was harder to distinguish in the seismic signals, because distinct seismic events often merge into each other anyway as they resonate through the ground.

Looking at infrasonic wave patterns alone will not guarantee that volcanic eruptions can be predicted. Dr Garcés and others are also working on computer models that describe what is actually going on inside a volcano, to see if those processes produce the kinds of infrasonic waves observed. They then hope to be able to link their measurements to useful information, such as how much and what kind of stuff the volcano will spew and how powerful the eruption will be.

This approach could find widespread use. For, in order to make sure that countries comply with the Comprehensive Test Ban Treaty and do not surreptitiously set off nuclear weapons, a huge network of acoustic listening posts is being built all over the world. It will also be able to monitor misbehaving volcanoes. In another decade or so, Dr Garcés reckons that it might be possible to integrate infrasonic, seismic and other readings with a computer model to predict the time of an eruption to within a day or two. Far more reliably, in other words, than the oracles of old.



Sakurajima speaks

Helping the poorest

ONE world, two fates. Of children who die before their fifth birthday, 98% are in the developing world. Of people who are HIV positive, some 95% are in poor countries. Of the millions who die prematurely of tuberculosis, malaria, measles, tetanus and whooping cough, all but a few thousand live in the poor world. Indeed, tuberculosis alone kills more people each year than lung cancer, the most prevalent cancer and the terror of the West. The gap is widening between rich and poor countries, especially between the very richest and the very poorest. Although that has happened for a century or more, the continued early deaths of the poor and their children are a reproach to us all. What is to be done to save those millions of young lives?

The good news is that there is some new thinking about ways to respond to this challenge. Aid agencies and drug companies are talking to each other in more constructive ways than they once did. For donor countries, this is not mere altruism: as international travel grows, rich-world governments acquire a direct interest in halting diseases such as tuberculosis, which may otherwise infect their own citizens. But affordable drugs are only part of the cure. Developing-country governments can do more to improve the health of their people than simply getting hold of western money and ingenuity.

Part of the new thinking lies in the application of economics to what has too often been a purely emotional pitch for aid. Since it published an influential report on health in 1993, the World Bank has consistently advanced the argument that unhealthy countries are condemned to slow growth. The idea that ill health reinforces poverty is less familiar than the view that poverty causes ill health, but equally true. However, one of the main virtues of the World Bank's argument is that it allows multinational aid donors to talk straight to developing-country finance ministers, who typically have more clout in the allocation of resources than do their colleagues in the health ministry.

Now, economists are tackling—or struggling with—another aspect of the health of the poor: their lack of access to drugs. Jeffrey Sachs, a Harvard economist, has drawn attention to the scale of the problem: poor countries cannot afford expensive medicines, and drug companies naturally tend to focus their research on finding cures for the ills of the rich (see pages 17-20 and 63) rather than the afflictions of the poor. Americans and Europeans rarely suffer from schistosomiasis, which afflicts 200m people worldwide, or lymphatic filariasis, which makes life miserable for another 120m. So the market is said to be too small to attract research. Gone are the days when Jonas Salk refused to patent polio vaccine, saying that to do so would be “like patenting the sun”. When a drug compa-



ny spends millions to develop a vaccine, it wants an economic return.

The machinery that might guarantee such a return is now taking shape. The World Bank, the World Health Organisation and other do-gooding bodies have formed alliances with the pharmaceutical industry to promote research on affordable drugs for neglected tropical ailments. Legislation under consideration in the American Congress and to be proposed by the European Commission would also give a helping hand. All this talk still needs to be backed by money, though. Others need to emulate Bill Gates's medical philanthropy.

Important though such initiatives are, they are not enough to heal the poor. The remarkable fall in mortality rates in Europe and North America a century ago owed little to drugs and almost everything to improved nutrition and better public health arrangements: reliable water supplies, safe drains, regular rubbish collection. Yet one in six of the world's people lack safe drinking water; most of the giant cities of Africa and Asia have no sewerage system; and rubbish collection is so disorganised that between a third and half of their garbage lies uncollected. The main answers lie in making local government more efficient and more accountable. Another is money—although appropriate technology can cut costs. It is quicker to help the poor by ensuring that the water sellers on whom they rely have access to safe water than by struggling to install expensive piped supplies to the home; and wiser to arrange for septic tanks to be emptied promptly than to build water-borne sewerage systems.

Education for health

With some of the diseases that kill the poor, the surest answer is to change habits. No single change would save more lives than if people routinely washed their hands before touching food. They need, too, to filter what they drink, to feed babies hygienically, to use mosquito nets, to avoid drunken driving—and to practise safe sex. One success story is sex education in Senegal: along with condom distribution and prompt treatment of other sexually transmitted diseases, this has helped to keep HIV infection rates in Dakar below 2%, compared with 20% in Kenya's Nairobi.

Spreading such messages needs government enthusiasm. But education ministers may not think it their job to teach personal hygiene, while politicians may prefer building hospitals to preaching the virtues of hand-washing. In fact, good health care also entails reorganising national systems so that they concentrate on primary care for the poor, rather than five-star clinics for those, like the president and his cronies, who ought to pay for their own care.

Even drug-buying could be done more effectively. Poor-