

SALAMANDER: That's great! What's the secret eh?

GOD: Well the biggest secret is just here [points to Salamander's hips]. There's a rather special joint between your bones just here. It's called a 'Ball and Socket Joint'.

SALAMANDER: Wow! How does it work?

GOD: Well, its sort of multiaxial - it can move in any direction. And since its the nearest joint to your body, it controls the movement of all the rest of your leg.

SALAMANDER: Yes I can see that. But there are some other joints in my legs. What about them?

GOD: Oh, nothing special about them, just ordinary hinge joints. Good bony congruence, collateral ligaments, all that sort of stuff. But they'll help you to scratch your tum.

SALAMANDER: You're right, I can! But I'd still rather be a fish.

GOD: You great whinging Pom! After all that trouble. What's the problem now?

SALAMANDER: Well, when I was a fish I could see all round. Now I can't see a dicky bird.

GOD: Why not?

SALAMANDER: Everything gets in the way. Those rocks for instance.

GOD: Let me see.

[God gets down off his pedestal, and puts his head next to that of salamander]

GOD: Yes, I see what you mean. That's very awkward. Give me a moment, and I'll get some ideas.

[Long pause. . .clouds descend over the scene for a few

on the horizon?

GOD: You tell me? I can't see it from here. [Thinks: *I'm only kidding, of course. I can see everything, even round corners . . . but don't let on.*]

TREE FROG: A big black cloud. And the wind's turning a bit chilly too.

GOD [putting on his anorak]: I think I know what it is, its one of those wretched ice ages. Play havoc with my creative endeavours, they do. You'd better climb down quickly.

TREE FROG: It's starting to snow! What'll I do now?

GOD: Well, fortunately you can still go back into the water. It'll get quite cold there, but it won't freeze over.

TREE FROG: How long do I have to stay there?

GOD: Oh, not long. Ten or twenty thousand years, at a guess.

TREE FROG: Guess I haven't much choice. [Plunges back into the sea]

[There follows a series of pictures, of the landscape turning more and more wintry, trees disappear, icicles hang from the rocks, and then the sun comes up over the horizon, and the snow and icicles begin to melt. Treefrog pokes his nose out of the sea and sniffs around]

TREE FROG: It's getting warmer again.

GOD: Yes, I knew it would . . . You could try the land again.

TREE FROG [On land again]: Yes, it's O.K., but what's happened to all the trees.

GOD: Oh, they never survive the ice ages. But give it a few thousand years, and something'll grow again. . . It always does.

TREE FROG: Yes, but in the meantime I still want to see the world! But here I am again, close to the ground, and with nothing to climb.

[Long pause . . . clouds descend . . . and draw back again]

GOD: I think I've figured out your problem. Look here. [God shows a drawing he has been doing]. You see your feet are attached to your legs by hinges. So your knees can only move forwards and backwards. They can't swivel from side to side.

T.REX: Right, I get that.

GOD: But when you swing from side to side, your pelvis swings as well. So your hip joints move nearer your midline. [shows diagrams]

T.REX: Yes, I agree. So what?

GOD: So we need some rotation at your knee joints, as well as at your hip joints.

T.REX: But my knees are hinge joints. They won't rotate at all.

GOD: That's spot on . . . exactly right. That's the problem.

T.REX: Well, any ideas?

GOD: It needs a bit of thought. Let me see what I've got in my files.

[Searches through filing cabinets labeled "Cambrian", "Silurian", "Permian", "Ordovician"]

No it's not there. Let's try these.

[Cabinets labeled "Latest models", "Prototypes"]

No. it's not there either. But how about this. I think this is it.

[Cabinet labeled "Failed Ph.D. theses"]

Yes. This is it!

GOD: Yes, I remember him now. Bright lad! But far too theoretical. Still, I got the patent. Want to see the design?

T.REX: Sure.

GOD: It's called a *condylar joint*.

T.REX: Go on! None of this artsy fartsy stuff here.

GOD: No, its right on the level.

T.REX: Well explain it to me then.

GOD: Well, it's a special sort of joint that can allow lots of flexion and extension (like a hinge joint) but it will also rotate a bit.

T.REX: Go on! . . . It can't have much bony congruence, or the bones at the side would stop it rotating.

GOD: That's quite right.

T.REX: So how *does* it stay together?

GOD: Well, it needs a lot of ligaments. Let me show you the design.

GOD: [unfolding the original blueprint]

You see it's got collateral ligaments at the sides, just like a hinge joint, not much bony congruence, just like you said . . . and its got these ligaments in the middle. They're called cruciate ligaments.

T.REX: Gerraway! It'll never work!

GOD: Well to help it to move smoothly, its got these fibro-cartilaginous discs, called menisci. They help it all fit together. And it will rotate a bit as well as flex and extend. What do you think?

T.REX: Damn clever!

GOD: Watch your language, or I'll turn you back into a salamander.

T.REX: Sorry, God. I'll give it a try.

him a crate of Foster's]

KANGAROO: Thanks. Seriously, mate. . . though how d'you manage that jumping bit?

GOD: Well, really your legs are much the same as they were when you were a dinosaur, your tail's much the same, long and heavy, to balance the weight of your body when you stand on two legs. The real secret is here. . [points to Achilles tendon].

KANGAROO: That's my Achilles tendon. What's so special about that, eh?

GOD: Well, in most animals I've designed recently it's made of collagen . . quite unstretchable. But for you I used something different . . new material eh? . . elastin. You see, when you land from one of those jumps of yours it stretches quite a lot, and so, when you start the next jump, it propels you upwards, like a catapult. Call it 'elastic recoil.

KANGAROO: Pretty clever.

GOD: Any small adjustments you'd like me to make?

KANGAROO: Well, I've STILL got a headache. And I don't like the taste of disprins.

GOD: [Thinks: '*I suppose he DID have a rather disturbed upbringing*'] Well, Kanga, I'm sorry about that, there's nothing much I can do. You'll just have to put up with it. I'll send you our best physio.

KANGAROO: O.K., but thanks all the same for the new legs. [Disappears over the horizon, in three jumps:

TWOINNG, TWOINNG, TWOINNG]

GOD: [Watching rain clouds approaching] Uh-oh! Looks like rain. Hope we don't have to build one of those ark-things again.

[Rain starts to pour down, occasionally floods develop, and forests start to grow]

GOD: Well things *have* changed in these parts. It used to be near desert, but now it's a great forest. Still, we got away without major floods this time . . not like that time we all got holed up on Mount Ararat. I wonder what's happened to kangaroo?

[God finally finds Kangaroo struggling through dense bush]

KANGAROO: Hi! God, where've you been since I last saw you? Isn't this terrible? I'm totally bushed. I've no idea where I am. My tail gets in the way, I can't see where I'm going. It's hopeless being a kangaroo in this forest. Any suggestions?

GOD: I think we should bring out a completely new model for the eocene period, one that's custom built for climbing trees. . . 'Designer species' we call it in the trade.

KANGAROO: But God, don't leave me here! . . .You can use all of my components to design the new model, you know . .but don't leave me here!

GOD: I dare say we could use a few of your parts. Let me spend some time at the drawing board.

[Mist shrouds the forests for several eons, and then they clear to reveal the new model - a lemur]

GOD: Well, we found that most of your old components could still be used in the new model. How do you like it?

LEMUR: Well, I'm smaller than I was, but no harm in that. I can get about in these trees better. But the best thing is my feet and hands. I can hold the branches with them.

GOD: Yes - in the profession we call them 'prehensile hands and feet', with 'opposable thumbs and big toes'.

LEMUR: They're pretty cool. I can hold on with all four limbs,

GOD: Great. By the way, how did you do in computer science Ad I?

CHIMP (face red with embarrassment): Got an E, failed specials, but I didn't really try very hard. Anyway I don't really need it. Computing is much simpler if you're a chimpanzee or an orang, than if you're a monkey.

GOD: Foolish creature! Ever heard of 'the survival of the fittest'? You'll regret it, mark my words!

[Some time later]

CHIMP: I'm hungry! I can't get enough to eat living in trees.

GOD: Well, I suppose I should have expected your appetite to increase quite a bit when I changed you from a monkey to an ape. But if you came to the ground once in a while you'd be able to travel further, and gather more food that way. Why don't you give it a try.

[*CHIMP* descends, and ambles off on all fours to look for food]

[Some time later]

GOD: How're you getting along now, eh? Have you found a better food supply?

CHIMP: It's better. I get more fruit than I used to when I was in the trees, and I even manage to catch other animals now and then, and have a real feast. But its hard work traveling on the ground. I can't move very far or very fast. Somehow I don't think I was really designed for it. And my head ache is getting worse. Sometimes I just feel like giving up. Why did I ever leave the sea?

GOD: Oh, come on now! After all this. Don't give up now. We've nearly got things just right for you. If you're

willing, I'll really do some hard thinking, and see if I can improve the design. But if you're not, forget it. I'll just turn you back into a fish.

CHIMP [Anxiously gnawing his finger nails]: What an awful decision! What if it doesn't work. All the long journey since I was a fish! Come to nothing! Can't you see it in the zoology textbooks of the future? 'Chimpanzee - an interesting curiosity amongst the primates - this development became extinct in the mid-pleistocene. No known descendants.' Something like that. What an epitaph!

GOD: But just imagine if it worked! You'd make history! You'd make the Tyrannosaurus look like something out of a museum. Just think of the reviews you'd get in 'Nature'!

CHIMP: You make it sound so attractive. But are you really sure you can do it?

GOD: [Brimming with confidence] Of course, no problem, look at all my past successes. Put it this way: Are you for progress or against it? Its your choice you know. You're entirely free.

CHIMP: Well, if you put it that way, its obvious. I'm game if you are.

GOD: Well then, I'll spend some time in the design labs, and see what I can work out. I'll show you it all, before I do anything drastic.

CHIMP: Fair enough.

GOD: O.K. [Thinks: '*What have I let myself in for now. I must say I layed the sales-talk on a bit thick just now. And after all this time, I do feel a little bit responsible for him. And I'm not really so sure I CAN get it to work.*']

[clouds descend, GOD is seen occasionally through the clouds, slide rule in hand, furrowed brow, occasional glimpses through the murk of peculiar ape-like prototypes with all sorts of bodily form and gait. At last the clouds

draw back, and GOD, drenched in sweat, shirt sleeves rolled up above his elbows, appears with a set of blueprints under his arm.]

GOD: Here, come and have a look at these.

[Unfolds the designs before chimpanzee]

CHIMP: What a strange creature! Is that what you think I'm destined for?

GOD: I hope so.

CHIMP: It's got such enormous legs. And it stands quite upright on two legs. Bit 'big-headed' too, if you don't mind my saying so. If I didn't know you, I'd say you were right off your rocker this time. Explain it to me.

GOD: Well, it's pretty complicated. The basic idea is that if you could stand quite upright on two legs you'd use much less effort than if you walked on all fours. But of course it means a lot of changes in your legs. We need to make them bigger and stronger, because you'd get no support from your arms. And we have to make your arms smaller, and lighter, or you'd become top heavy. But those are just the most obvious changes required.

CHIMP: I might as well go into this with my eyes open. Tell me the rest.

GOD: Well, briefly, we have to make changes in the lumbar vertebrae, in the hip bone, hip joint, knee, and especially in the foot. The lumbar vertebrae need to become bigger, because they're supporting all of the trunk, whereas, as you are now, the upper part of your trunk is supported by your arms.

CHIMP: I can see that.

GOD: And in addition, we have to bend the lumbar vertebrae backwards - technically we call it a 'lumbar lordosis'. Helps you to stand upright.

CHIMP: I can see that too. I don't have one'o them 'lumbar lordosis' things at present. What about the hip bone.

GOD: Well, at present this part [points to CHIMP's ilium] faces directly backwards. So the powerful muscles which pass down to your femur act as extensors. In the prototype I've swung the ilium round, so that it faces laterally mainly.

CHIMP: That means that most of those muscles become abductors, not extensors. *Very odd . . . quite weird, I'd say . . .*What's that for?

GOD: Well, if you're going to walk on two legs, then about half the time you'll have only one leg on the ground, and the other one off. So the leg off the ground is likely to sag unless some major change is made. So if we have more powerful hip abductors, we can hold up the pelvis and stop the *OPPOSITE* leg sagging when it's off the ground.

CHIMP: Far out! What about the knee joint?

GOD: For a start it will hyperextend a little. But also it has a special locking mechanism, so that it's most stable when it's hyperextended.

CHIMP: [excited] I get it! It means you can stand upright without needing to use your knee extensors.

GOD: Exactly. You're following well

CHIMP: What about the feet? They don't look much good for holding things with.

GOD: No, I've done away with the prehensile foot idea. For starters, your two hands are quite good enough for holding things with. There's no point in having prehensile feet. If you're going to walk on the ground you won't need to grasp it with your feet, like you did with the branches of trees. And besides, in the new design the other changes I had to make just aren't compatible with prehensile feet.

CHIMP: Why not?

GOD: Well, its complex, but if you're going to walk easily on the ground, and particularly if you're going to go

faster and start running, there'll be an enormous impact each time your foot hits the ground. And that impact will be transmitted up the whole of your body to your head. You think you've got problems now with your headache. Just imagine if your head was being given a big bump from below at each stride. I know you've always had headaches. . .It was solving this one that was my biggest worry of all. . . .Quite a headache for me, I musty say.

CHIMP: How DID you solve it then?

GOD: Well several things contribute to the solution. First, in the new design, the knee is meant to be almost fully extended when your foot hits the ground, and when it leaves it to start swinging forwards. But, in between, it flexes a bit, and that absorbs some of the impact.

CHIMP: What else?

GOD: The lumbar vertebrae have been changed a bit. They've got much bigger discs between them than in your design. That helps to absorb the shock as well.

CHIMP: But what about this creature's feet?

GOD: Again there's several things I had to think about. First of all your heel. When you were a lemur, or a monkey, your heel was a useful lever, to allow you to push forwards from your foot, while your toes grasped a branch. When you were an ape you put the whole of your foot on the ground. Your heel was still a useful lever, but you were flat footed, so that you had this bad problem with the impact at each step. But in the new design, when you walk, your heel goes down first, and then you'll *ROLL* forwards on to the flat of your foot.

CHIMP: I get it! So the shock is absorbed gradually, rather than as a sudden impact.

GOD: Quite right. And in addition I've made your foot arch upwards a bit.

CHIMP: I can see that. Why do you do that? Surely it'll

collapse when you put weight on it.

GOD: Well, no. . . You see I've put several strong ligaments connecting the bones tightly together on the under side of the foot. They make the foot fairly rigid, but still a bit springy, because the arch flattens a little bit when the body's weight is on it.

CHIMP: I can see now why a prehensile foot wouldn't be any good in the new design. And another thing - that bit about a springy foot reminds me a bit of my Achilles tendon when I was a kangaroo.

GOD: Ah, I see you haven't forgotten everything you learnt in the introductory courses. . . Yes, its the same principle. Elastic recoil. As you put weight on your foot, the springiness absorbs energy, so you don't need to use so much effort to start the next stride.

CHIMP: But looking at the foot bones of that creature, they're very different from mine.

GOD: Yes. All the tarsal bones are bigger than in apes, since you need a large and strong heel. And this joint . . . we call it the 'talo-navicular joint' in the trade . . . it's further from the ground. That means that the upper surface of the calcaneus is roughly horizontal, whereas in your foot it slopes medially.

CHIMP: Anything else?

GOD: Oh quite a lot of changes to muscle attachments, but don't worry your head about that.

CHIMP: Well, overall I like the model. I'll give it a go.

GOD: Just one last thing that worries me. I warned you that some day you'd need very good computing skills. Did you ever pass Ad II?

CHIMP: I got a B+ in the late pleistocene.

GOD: I'd have preferred a straight A. But still since you're so keen, I'll give you the benefit of the doubt. Now, any last worries?

since I was a dinosaur, and now, as soon as I can hold my head straight up, it disappears like magic.

GOD: Sounds a reasonable explanation.

FRED: And you know what? Now my head's stopped aching, I can think much better. I'd pass in computer science easy-peasy now. No trouble. But I can't be bothered. I've got much better things to do now with my time.

GOD: Such as what?

FRED: Well, you see this peculiar stone I've found.

[Fred points to a large white stone, egg-shaped and about 15 inches long]

GOD: I know what that is. Its a fossilized dinosaur egg, left over from the permian.

FRED: Is that what it is? Well, whatever it is, I've a great idea what to do with it.

[Fred picks up the egg, and starts throwing it in the air. He gets more and more excited as he does so, and strange wild cries emerge from his mouth. . . .And as the sun goes down over Mount Ruapehu, the lone figure of Fred can still be seen in the distance over the paddock, with his new toy]

GOD: Uh-oh! I think I've might have started something that could get a bit out of hand. P'raps I'm not omnipotent after all!